Numerical and Functional Index

Descriptions

Common Specifications

Individual Specifications
Introduction to the CMOS Logic Family

The standard CMOS Logic Family has excellent characteristics such as low power dissipation, a wider range of operating power supply voltage, high noise margin, etc.; however, it has popularly been thought of as a medium speed element because the upper limit of the operating frequency is a few MHz at 5 V supply voltage compared to other standard logic families.

Matsushita Electronics Corporation has been conducting research and development of high-speed CMOS for application to high-speed electronic equipment as well, and has succeeded in the development of a new CMOS Logic family, the MN74HC Series, which has a pin configuration and operating speed in accordance with LS TTL.

Because of the standardized design of output drive characteristics, customers find system design easy by using the MN74HC Series, and the series will be expanded for applications to all electronic equipments for consumer and industry use. For further applications of small and thin equipments, we have succeeded in supplying the Pana-flat package as the MN74HC00S Series. We are continually developing and introducing new products of high quality, high performance and high reliability, and we sincerely hope you will find this catalog for design engineers useful.

October, 1986

International Marketing Division
Semiconductor Group
Matsushita Electronics Corporation
The circuit examples in this manual have been used to describe the characteristics and properties of these products. The contents of the manual are complete as far as necessary to assure accuracy and reliability, and Panasonic assumes no responsibility with respect to problems resulting from the use of the circuits described herein or patents by third persons. Specifications may also be changed without notice in order to make improvements.
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<td>Encoders</td>
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<td>Comparator</td>
<td>MN74HC688</td>
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<tr>
<td>Others</td>
<td>MN74HC183, MN74HC280, MN74HCT280</td>
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<td></td>
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</table>
Descriptions
Descriptions

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1. Outline of MN74HC Series

The MN74HC Series is designed to be used in systems where low-power dissipation, a wider range of supply voltage and high noise margins are required, featuring basic logical functions and complete compatibility with LS TTL in pin configuration and operating speed. Easy system design is possible because of the standardization of output drive characteristics. The MN74HC Series consists of the MN74HCOO Series standard DIL package, and the MN74HCOOS Series, which has enabled smaller and thinner electronic equipment by adopting a small Pana-flat package.

* Features of the MN74HC Series
(1) High-speed operation (VCC 5V)
   Typical gate propagation delay times:
   \( t_{pd1} = 6 \text{ ns typ.} \) \( (C_L = 15 \text{ pF}) \)

2. Comparison with Other Logic Families

Comparison between MN74HCOO (Quad 2-Input NAND Gates) and other logic families with same functions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>H CMOS</th>
<th>LS TTL</th>
<th>TTL</th>
<th>B-Type CMOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage</td>
<td>1.4~6V</td>
<td>5±5%V</td>
<td>5±5%V</td>
<td>3~15V</td>
</tr>
<tr>
<td>Power Dissipation (typ.)</td>
<td>1mW/Gate</td>
<td>2mW/Gate</td>
<td>10mW/Gate</td>
<td>1mW/Gate</td>
</tr>
<tr>
<td>Quiescent Power (max.)</td>
<td>100μW/Gate</td>
<td>22mW/Gate</td>
<td>110mW/Gate</td>
<td>40μW/Gate</td>
</tr>
<tr>
<td>Propagation Delay Time (typ.)</td>
<td>6ns</td>
<td>10ns</td>
<td>10ns</td>
<td>50~100ns</td>
</tr>
<tr>
<td>Output Current (IOL) (min.)</td>
<td>2.5mA</td>
<td>8mA</td>
<td>16mA</td>
<td>0.36mA</td>
</tr>
<tr>
<td>Noise Margin</td>
<td>1V</td>
<td>0.4V</td>
<td>0.4V</td>
<td>1V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>−40~+85°C</td>
<td>0~+70°C</td>
<td>0~+70°C</td>
<td>−40~+85°C</td>
</tr>
</tbody>
</table>

3. Ordering and Numbering System

The following indications information is needed for orders.

(Type Number)

S: Pana-flat package (small package)
Empty: Standard plastic DIL package
Device No. XX(X): Same function and pin configuration as 74LS TTL
4XXX: Same function and pin configuration as CMOS 4000 Series.
High-speed COMS
74HCOO Series
MOS Integrated Circuit manufactured by Matsushita Electronics Corporation
4. Basic Circuitry and Construction of MN74HC MOS

The basic explanation gives, as an example, the inverter of the MN74HC Series.

As shown in Figure 1, the 74HC MOS inverter consists of a p-channel enhancement type MOS transistor (P1) and an n-channel enhancement type MOS transistor (N1). Input is made by commonly connecting each gate, and output is made by commonly connecting each drain. VCC (+) is the source of the p-channel MOS transistor, and GND (−) is the source of the n-channel MOS transistor. In this figure, the voltage (Vo) of the output (O) is considered when the voltage (Vi) of input (I) changes from VCC to GND.

4.1 When input (I) is GND level

VGP (voltage between gate and source) of P1 is (VCC−GND), and P1 switches ON because negative deep bias is applied to the gate. VGN (voltage between gate and source) of N1 is 0, and N1 becomes OFF. Output (O) becomes, partially pressured by the resistor ratio of P1 and N1, output voltage (Vo) becomes approximately VCC because ON and OFF resistance become, respectively, tens of ohms and several hundreds of MOhm. In this instance, no current flows from VCC to GND.

4.2 When the input (I) is an intermediate level between VCC and GND

P1 and N1 become ON and output (O) becomes intermediate level partially pressured by P1 ON and N1 ON resistors. In this instance, output voltage (Vo) becomes approximately VCC and GND when the input voltage (Vi) is near the level of GND and VCC, respectively. Current flows from VCC to GND.

4.3 When the input (I) is VCC level

When VGP of P1 and VGP of N1 are zero and (VCC−GND), P1 and N1 become OFF and ON, respectively. Accordingly, the operation becomes completely the reverse of the order in 4.1, the voltage (Vo) of output (O) becomes approximately GND level, and no current flows from VCC to GND. The quadrature axis shows an input voltage and the axis of ordinates shows an output voltage in Fig. 2. The dotted line of the axis of ordinates shows current flowing from VCC to GND; current flows (Icc) only when the inverter changes.

A sectional view of the 74HC MOS inverter is shown in Fig. 3. There should be perfect separation between the p-channel and n-channel MOS transistors in order for the 74HC MOS inverter to be used on the signal silicon substrate; for this purpose, a pn conjunction is used.
In this figure, the p-channel MOS transistor is grown on the n-type silicon substrate and the n-channel MOS transistor is grown on the p-well in the substrate. When power is switched on, the substrate and p-well become in a condition of reverse bias of \((V_{CC} - GND)\), because the n-type substrate and p-well are connected to \(V_{CC}\) and GND respectively. Therefore, the p- and n-channel transistors can operate independently of each other. A parasitic diode is inserted into the 74HC MOS circuit, as shown in Fig. 4, and, when the rating at each terminal is exceeded, excessive forward current may flow to these diodes, and the IC may be damaged. For this reason, absolute maximum ratings must be maintained.

As shown in Fig. 4, input protection diodes such as \(D_1\), \(D_1'\), and \(D_2\) are used for the protection of the CMOS input gate from static electricity. These diodes are used in all products of the MN74HCOO Series (although only \(D_2\) is used in the MN74HC4049/S and MN74HC4050/S).

5. Handling of the MOS Device
Circuits for protection against static electricity are used in all MEC MOS ICs; however, the IC will be damaged by accidental excessively high voltage. Accordingly, the following cautions should be followed in order to handle the device safely.

(1) During use
Be sure to ground the person (by a resistor of 1M\(\Omega\)) handling the ICs and also any charged materials on the work discharged.

(2) For storage and transport
It is necessary to use an MEC — specified container and/or conductive material. These containers are used to either short or insulate ICs.

(3) Test and Handling
When testing and moving an IC from one carrier to another, be sure to handle it on a conductive board (metal table, etc.) Also be sure to ground the person to the conduction table (by a metal chain or lead wire). Testing and handling equipment should also be grounded to the metal table. A signal should not be input when the device is in the OFF mode.

(4) Securing
It is necessary to secure the MOS IC after all parts have been secured, and it is best to ground the IC, the metal portion of the printed-circuit board, the jigs, tools and workers in order to prevent a failure in the process line.

If the printed-circuit board can't be grounded, the worker should first touch the printed-circuit board before he touches the MOS IC to the printed-circuit board.

(5) Soldering
The soldering iron, even a low-voltage one, and the soldering bath should also be grounded.

(6) Static electricity
Workers should wear clothes which do not attract static electricity (avoid using work clothing made of nylon or other synthetic fibers). Care should be taken even after the MOS IC is secured to the printed-circuit board. Conductive clips or tape should be connected to the terminals of the circuit board in order to protect from static electricity through the board, because the board is only an extension of the lead wire of the device secured to the board until the assembled board is installed in the system and the appropriate voltage is applied.
6. Symbols and Terms

**Current**

+ is current flowing into an element and — is current flowing out from the element.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_I$</td>
<td>Input current</td>
<td>Sink current at the specified input voltage and $V_{CC}$</td>
</tr>
<tr>
<td>$I_{OH}$</td>
<td>Output HIGH current</td>
<td>Sink driving current at the specified output HIGH voltage and $V_{CC}$</td>
</tr>
<tr>
<td>$I_{OL}$</td>
<td>Output LOW current</td>
<td>Sink driving current at specified output LOW voltage and $V_{CC}$</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Quiescent power supply current</td>
<td>Sink current into the $V_{CC}$ terminal at the specified input voltage $V_{CC}$</td>
</tr>
<tr>
<td>$I_{OZ}$</td>
<td>Output OFF current</td>
<td>Current which flows into or out from an off-state tri-state output when the output is connected to $V_{CC}$ or GND</td>
</tr>
<tr>
<td>$I_{IL}$</td>
<td>Input LOW current</td>
<td>Current which flows into an element at the specified input LOW voltage and $V_{CC}$</td>
</tr>
<tr>
<td>$I_{IH}$</td>
<td>Input HIGH current</td>
<td>Current which flows into an element at the specified input HIGH voltage and $V_{CC}$</td>
</tr>
<tr>
<td>$I_{CCL}$</td>
<td>Quiescent LOW power supply current</td>
<td>Current which flows into the $V_{CC}$ terminal at the specified input LOW voltage and $V_{CC}$ against all inputs</td>
</tr>
<tr>
<td>$I_{CCH}$</td>
<td>Quiescent HIGH power supply current</td>
<td>Current which flows into the $V_{CC}$ terminal at the specified input HIGH voltage and $V_{CC}$ against all terminals</td>
</tr>
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</table>

**Voltage**

GND is the lowest voltage which is applied to an element; all voltages are relative in value to GND.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>Power supply voltage</td>
<td>Highest positive (+) voltage</td>
</tr>
<tr>
<td>GND</td>
<td>Power supply voltage</td>
<td>Highest negative (−) voltage of a single power supply; reference voltage level to others; GND</td>
</tr>
<tr>
<td>$V_{EE}$</td>
<td>Power supply voltage</td>
<td>One of the negative power supply voltages and highest negative power supply voltage which is a reference voltage to others</td>
</tr>
<tr>
<td>$V_{IH}$</td>
<td>Input HIGH voltage</td>
<td>Input voltage range showing logical HIGH of the system</td>
</tr>
<tr>
<td>$V_{IL}$</td>
<td>Input LOW voltage</td>
<td>Input voltage range showing logical LOW of the system</td>
</tr>
<tr>
<td>$V_{OH}$</td>
<td>Output HIGH voltage</td>
<td>Voltage range of the output terminal at the specified output load and power supply voltage</td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Output LOW voltage</td>
<td>Voltage range of the output terminal at the specified output load and power supply voltage</td>
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</table>

**Analog symbol**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{ON}$</td>
<td>ON resistance</td>
<td>Effective ON resistance of analog-transmission gate at the specified input voltage, output load and $V_{CC}$</td>
</tr>
<tr>
<td>$\Delta R_{ON}$</td>
<td>$\Delta$ ON resistance</td>
<td>Difference of effective ON resistance between the two transmission gates of the analog-switch at the specified input voltage, output load and $V_{CC}$</td>
</tr>
</tbody>
</table>
Common Specifications
Common Specifications

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4. AC Characteristics ..................................................................... 22
5. External Diagrams of Packages .................................................. 24
Common Specifications

High-speed CMOS logic IC MN74HC00 Series operates in the range of $V_{CC} = +1.4 \sim 6.0 \text{ V}$ (GND=0V), and each specification is guaranteed at $V_{CC}=2.0\text{V}, 4.5\text{V}$ and 6.0V.

The high-speed CMOS logic IC operates in the wider range; therefore, it is not so critical relative to power supply regulation as the conventional logic IC (TTL, LS TTL).

It operates at $V_{CC} = +1.4 \text{ V (min.)}$ if the noise margin and interfacing problem with other equipment are not considered.

In addition, it operates at $V_{CC} = +6.0 \text{ V (max.)}$ if power dissipation and interface are not considered. Unused terminals should be connected to $V_{CC}$, GND or other input terminals. Countermeasures against static electricity are taken for the input/output terminals of the high-speed CMOS logic IC; however, we recommend careful handling even so.

Individual specifications are described in the individual data sheets; common specifications are summarized as follows.

1. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$ \pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$ \pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$ \pm 25$ (STD), $ \pm 35$ (Bus driver)</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$ \pm 50$ (STD), $ \pm 70$ (Bus driver)</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
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</tr>
<tr>
<td>MN74HCXX</td>
<td>$T_{a}=-40 \sim +60\degree\text{C}$</td>
<td>$P_{D}$</td>
<td>400</td>
</tr>
<tr>
<td>MN74HCXSS</td>
<td>$T_{a}=-40 \sim +60\degree\text{C}$</td>
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<td>275</td>
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<tr>
<td></td>
<td>$T_{a}=+60 \sim +85\degree\text{C}$</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
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</tr>
<tr>
<td></td>
<td>$T_{a}=+60 \sim +85\degree\text{C}$</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>0~$V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{a}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}$, $t_{f}$</td>
<td>($V_{CC}$)</td>
<td>0~1000</td>
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<tr>
<td></td>
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<td>2.0V</td>
<td>0~1000</td>
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<td></td>
<td></td>
<td>4.5V</td>
<td>0~500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0V</td>
<td>0~400</td>
</tr>
</tbody>
</table>

---

Panasonic
2. Main Characteristic Figures

Necessary main characteristics are shown by the example of MN74HC00 (Quad 2-Input NAND Gates)

---

**Fig. 5** $I_D - V_{DS}$ characteristics (p-channel)

**Fig. 6** $I_D - V_{DS}$ characteristics (n-channel)

**Fig. 7** Propagation characteristics (with buffer)

**Fig. 8** Propagation characteristics (with buffer)

**Fig. 9** Load capacity vs. propagation delay characteristics

**Fig. 10** Power dissipation vs. input frequency characteristics
### 3. DC characteristics (GND=0V)

#### Table 3 Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
<tr>
<td></td>
<td>Type</td>
<td></td>
<td>V&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Ta=25℃</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I&lt;sub&gt;o&lt;/sub&gt;</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>HC</td>
<td>V&lt;sub&gt;IH&lt;/sub&gt;</td>
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<td>1.5</td>
</tr>
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<td>HC</td>
<td>V&lt;sub&gt;IL&lt;/sub&gt;</td>
<td>2.0</td>
<td>0.3</td>
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<td>HC</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>2.0</td>
<td>1.9</td>
</tr>
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<td>4.5</td>
<td>4.4</td>
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<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>HCT</td>
<td></td>
<td>4.5</td>
<td>4.4</td>
</tr>
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<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>HC</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>2.0</td>
<td>0.0</td>
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<td>4.5</td>
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<td>6.0</td>
<td>0.32</td>
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<td>HCT</td>
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<td></td>
</tr>
<tr>
<td>Input current</td>
<td>HC</td>
<td>I&lt;sub&gt;i&lt;/sub&gt;</td>
<td>6.0</td>
<td>±0.1</td>
</tr>
<tr>
<td></td>
<td>HCT</td>
<td></td>
<td>5.5</td>
<td>±0.1</td>
</tr>
<tr>
<td>Analog switch OFF current</td>
<td>HC</td>
<td>I&lt;sub&gt;s&lt;/sub&gt;</td>
<td>6.0</td>
<td>±0.1</td>
</tr>
<tr>
<td></td>
<td>HCT</td>
<td></td>
<td>5.5</td>
<td>±0.1</td>
</tr>
<tr>
<td>3-state output Off state current</td>
<td>HC</td>
<td>I&lt;sub&gt;o&lt;/sub&gt;</td>
<td>6.0</td>
<td>±0.5</td>
</tr>
<tr>
<td></td>
<td>HCT</td>
<td></td>
<td>5.5</td>
<td>±0.5</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>SSI</td>
<td>I&lt;sub&gt;cc&lt;/sub&gt;</td>
<td>6.0</td>
<td>2.0</td>
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<tr>
<td></td>
<td>HCT</td>
<td></td>
<td>5.5</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>FF</td>
<td>I&lt;sub&gt;cc&lt;/sub&gt;</td>
<td>6.0</td>
<td>4.0</td>
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<tr>
<td></td>
<td>HCT</td>
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<td>5.5</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>MSI</td>
<td>I&lt;sub&gt;cc&lt;/sub&gt;</td>
<td>6.0</td>
<td>8.0</td>
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<tr>
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<td>HCT</td>
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<td>5.5</td>
<td>8.0</td>
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Common Specifications

4. AC Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_i$</td>
<td>Input frequency</td>
<td>$t_w$</td>
<td>Pulse width</td>
</tr>
<tr>
<td>$f_o$</td>
<td>Output frequency</td>
<td>$t_{hold}$</td>
<td>Hold time</td>
</tr>
<tr>
<td>$f_{max}$</td>
<td>Maximum clock frequency</td>
<td>$t_{su}$</td>
<td>Set-up time</td>
</tr>
<tr>
<td>$t_r, t_f$</td>
<td>Clock input rise &amp; fall time</td>
<td>$t_{PHZ}$</td>
<td>3-state output disable time $H \rightarrow Z$</td>
</tr>
<tr>
<td>$t_{PLH}$</td>
<td>Propagation time (propagation delay time) $L \rightarrow H$</td>
<td>$t_{PLZ}$</td>
<td>3-state output disable time $L \rightarrow Z$</td>
</tr>
<tr>
<td>$t_{PHL}$</td>
<td>Propagation time (propagation delay time) $H \rightarrow L$</td>
<td>$t_{PZH}$</td>
<td>3-state output enable time $Z \rightarrow H$</td>
</tr>
<tr>
<td>$t_{TLH}$</td>
<td>Rise time $L \rightarrow H$</td>
<td>$t_{PZL}$</td>
<td>3-state output enable time $Z \rightarrow L$</td>
</tr>
<tr>
<td>$t_{THL}$</td>
<td>Fall time $H \rightarrow L$</td>
<td>$t_r$</td>
<td>Recovery time</td>
</tr>
</tbody>
</table>

**Fig. 11** Set-up time, hold time, propagation time, recovery time, rise time fall time for MN74HC

**Fig. 12** 3-State output propagation time for MN74HC
• **Clock rise, fall time ($t_r$, $t_f$)**
The upper limit of $t_r$ and $t_f$ changes depending on the device and power supply voltage. Unless otherwise specified in the individual data sheet, clock input rise and fall times are less than 6 ns.

• **Output rise, fall time ($t_{\text{TLH}}$ & $t_{\text{THL}}$)**

**Table 5 $t_{\text{TLH}}$ and $t_{\text{THL}}$ Characteristics Table** (GND=0V, $T_a=25^\circ$C, $t_i \leq 6$ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{\text{CC}}$ (V)</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>$t_{\text{TLH}}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{\text{THL}}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>
5. External Diagrams of Package

Fig. 13 Plastic DIL-14 pin

Fig. 14 14-pin Panaflat package (SO-14D)

Fig. 15 Plastic DIL-16 pin

Fig. 16 16-pin Panaflat package (SO-16D)

Fig. 17 Plastic DIL-20 pin

Fig. 18 20-pin Panaflat package (SO-20D)
Individual Specifications
High-Speed CMOS Logic MN74HC Series

MN74HC00/MN74HC00S

Quad 2-Input NAND Gates

Description
MN74HC00/MN74HC00S contain four 2-input positive isolation NAND gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for the protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic diagram (1 gate)

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vi, Vo</td>
<td>-0.5 ~ Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Iik</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Iign</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC00</td>
<td></td>
<td>PD</td>
<td></td>
</tr>
<tr>
<td>Ta=-40 ~ +60°C</td>
<td></td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=+60 ~ +85°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
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<tr>
<td>MN74HC00S</td>
<td></td>
<td>PD</td>
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<tr>
<td>Ta=-40 ~ +60°C</td>
<td></td>
<td>275</td>
<td>mW</td>
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<tr>
<td>Ta=+60 ~ +85°C</td>
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<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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### Operating Conditions

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 - 6.0</td>
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<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>$V_{i}, V_{o}$</td>
<td>0 - $V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40 - +85°C</td>
<td></td>
<td>°C</td>
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<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0</td>
<td>0 - 1,000 ns</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 - 500 ns</td>
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<td>0 - 400 ns</td>
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### DC Characteristics (GND=0V)

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<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
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<td>$V_{i}$, $I_{O}$</td>
<td>$T_a=25°C$, $T_a=-40°C$</td>
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<td></td>
<td></td>
<td></td>
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<td>typ.</td>
<td>max.</td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
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<td></td>
<td></td>
<td>6.0</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
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<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
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<td>-20.0</td>
<td>4.4</td>
<td>4.5</td>
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<td>6.0</td>
<td>-20.0</td>
<td>5.9</td>
<td>6.0</td>
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<td>6.0</td>
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<td>6.0</td>
<td>20.0</td>
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<td>0.1</td>
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<td>5.2</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td></td>
<td></td>
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<tr>
<td>Input current</td>
<td>$I_{i}$</td>
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<td>$V_{i}=V_{CC}$ or GND</td>
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<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{i}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>2.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{i}$, $I_{O}$</td>
<td>$T_a=25°C$, $T_a=-40°C$</td>
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<td>typ.</td>
<td>max.</td>
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<td>Output rise time</td>
<td>$t_{TLH}$</td>
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<td>255</td>
<td>75</td>
<td>95</td>
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<tr>
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<td>4.5</td>
<td></td>
<td>15</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
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</tr>
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<td>6.0</td>
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<td>13</td>
<td>16</td>
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<tr>
<td>Propagation time (H → L)</td>
<td>$t_{PHL}$</td>
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<td>25</td>
<td>75</td>
<td>95</td>
</tr>
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<td></td>
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<td>4.5</td>
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</table>
MN74HC02/MN74HC02S

Quad 2-Input NOR Gates

Description
MN74HC02/MN74HC02S contain four 2-input isolation NOR gate circuits.
Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.
Resistors and diodes are provided in VCC and GND for the protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic diagram (1 gate)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5 to +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>−0.5 to VCC + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IILK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Ta</td>
<td>−65 to +150</td>
<td>°C</td>
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<tr>
<td>Power dissipation</td>
<td>MN74HC02</td>
<td>Pd</td>
<td>400</td>
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<td></td>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td>MN74HC02S</td>
<td>Pd</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

Panasonic
# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 – 6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 – $V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40 – +85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r-f}$</td>
<td>2.0</td>
<td>0 – 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 – 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 – 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

# DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_I$</th>
<th>$I_O$</th>
<th>$T_{a=25^\circ C}$</th>
<th>$T_{a=-40^\circ C \sim +85^\circ C}$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.5</td>
<td>0.3</td>
<td>2.0</td>
<td>1.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>3.15</td>
<td>0.9</td>
<td>4.5</td>
<td>4.4</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>4.2</td>
<td>1.2</td>
<td>6.0</td>
<td>5.9</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-4.0</td>
<td>4.5</td>
<td>1.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-4.0</td>
<td>5.2</td>
<td>3.2</td>
<td>4.0</td>
<td>5.36</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>20.0</td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>2.0</td>
<td>5.2</td>
<td>0.32</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>2.0</td>
<td>5.2</td>
<td>0.32</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>μA</td>
</tr>
</tbody>
</table>

# AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_{a=25^\circ C}$</th>
<th>$T_{a=-40^\circ C \sim +85^\circ C}$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>25.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>8.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>7.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{TFL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>20.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>7.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>6.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>25.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td>(L → H)</td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>8.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>25.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
<tr>
<td>(H → L)</td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>8.0</td>
<td>15.0</td>
<td>ns</td>
</tr>
</tbody>
</table>

Panasonic
**MN74HC03/MN74HC03S**

Quad 2-Input NAND Gates (Open Drain)

### Description

MN74HC03/MN74HC03S contain four 2-input open drain positive isolation NAND gate circuits. Input transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for the protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

### Logic Diagram (1 gate)

![Logic Diagram](image)

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vi, Vo</td>
<td>−0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Ik</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Io</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, IcGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th></th>
<th>MN74HC03</th>
<th>BN74HC03S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=−40~+60°C</td>
<td>Pd</td>
<td>400</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MN74HC03</th>
<th>BN74HC03S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=−40~+60°C</td>
<td>Pd</td>
<td>275</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} )</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4~6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>( V_I )</td>
<td>0~( V_{CC} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td>( V_O )</td>
<td>( \ast )0~8.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>-40~+85 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r ), ( t_f )</td>
<td>( V_{CC}=2.0 ) V</td>
<td>0~1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{CC}=4.5 ) V</td>
<td>0~500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{CC}=6.0 ) V</td>
<td>0~400 ns</td>
<td></td>
</tr>
</tbody>
</table>

\( \ast \) Even if output voltage \( V_O \) is less than the absolute maximum rating, Output current \( I_O \) might happen to be over the absolute maximum rating.

In this case, pull-up resistance \( R (\geq 3900) \), which is within the absolute maximum rating, is needed to connect with the output pin.

# DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} )</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td>( V_I )</td>
<td>( I_O )</td>
<td>( T_a=25^\circ C )</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_H )</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.3</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_L )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.0</td>
<td>( mA )</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>5.2</td>
<td>( mA )</td>
<td>0.32</td>
</tr>
<tr>
<td>Output Low voltage</td>
<td>( V_O )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>( mA )</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>( mA )</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Output current (High-Z)</td>
<td>( I_OZ )</td>
<td>6.0</td>
<td>( V_H, V_{IL}, V_O=V_{CC} ) or GND</td>
<td>±0.5</td>
<td>±5</td>
</tr>
</tbody>
</table>

# AC Characteristics (GND=0V, Input Transition time \( \leq 6 \)ns, \( C_L=50pF \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} )</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td>( V_I )</td>
<td></td>
<td>( T_a=25^\circ C )</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>18</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L→Z)</td>
<td>( t_{PLZ} )</td>
<td>2.0</td>
<td>13</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>10</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>9</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time (Z→L)</td>
<td>( t_{FZL} )</td>
<td>2.0</td>
<td>14</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>
**MN74HC04/MN74HC04S**

Hex Inverters

**Description**

MN74HC04/MN74HC04S contain six inverter circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

![Logic diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>−0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>−0.5 ~ Vcc +0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIP</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOP</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGD</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>MN74HC04</th>
<th>Ta=−40 ~ +60 °C</th>
<th>Pd</th>
<th>400 mW</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ta=+60 ~ +85 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC04S</td>
<td>Ta=−40 ~ +60 °C</td>
<td>Pd</td>
<td>275 mW</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
<tr>
<td></td>
<td>Ta=+60 ~ +85 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>0~$V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40~+85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2.0~1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5~500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0~400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics ($GND=0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CL}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{I}$</td>
<td>$I_o$</td>
<td>$T_a=25^\circ C$</td>
<td>$T_a=-40~+85^\circ C$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
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</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
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<tr>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>1.9</td>
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<td>5.9</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>0.0</td>
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</tr>
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<td>20.0</td>
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<td>20.0</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or $GND$</td>
<td>±0.1</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CL}$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or $GND$, $I_o=0$</td>
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</table>

## AC Characteristics ($GND=0V$, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ C$</td>
<td>$T_a=-40~+85^\circ C$</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td>75</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>75</td>
<td></td>
<td>95</td>
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<td>4.5</td>
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<td>19</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>100</td>
<td></td>
<td>125</td>
</tr>
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<td>25</td>
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<td></td>
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<td>17</td>
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<td>21</td>
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<tr>
<td>Propagation time (H → L)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>100</td>
<td></td>
<td>125</td>
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<td>4.5</td>
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<td>6.0</td>
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</table>
High-Speed CMOS Logic MN74HC Series

**MN74HCT04/MN74HCT04S**

Hex Inverters (TTL Input)

**Description**
MN74HCT04/MN74HCT04S contain six inverter circuits. All inputs are compatible with TTL logic level: 0.8V or less is logic "0" input and 2.0V or more is logic "1".

Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.

Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic Diagram**

![Logic Diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VI, VO</td>
<td>−0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IOUT</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>PD</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HCT04</td>
<td></td>
<td>Decrease to 200m Watt the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td>MN74HCT04S</td>
<td></td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HCT04</td>
<td></td>
<td>Decrease to 200m Watt the rate of 3.8mW/°C</td>
<td></td>
</tr>
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</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation supply voltage</td>
<td>$V_{CC}$</td>
<td>4.5~5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40~+85 °C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
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</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$V_{CC}$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{HH}$</td>
<td>4.5</td>
<td>1.5</td>
<td></td>
<td>1.5</td>
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<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>2.0</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>4.5</td>
<td>0.3</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
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<td>5.5</td>
<td>1.2</td>
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<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>-20.0</td>
<td>4.4</td>
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<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>-4.0</td>
<td>3.86</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>4.5</td>
<td>$V_{HH}$</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{HH}$</td>
<td>4.0</td>
<td>0.32</td>
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<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>5.5</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>±0.1</td>
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</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>5.5</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>2.0</td>
<td></td>
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</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$V_{CC}$</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>4.5</td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>4.5</td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>4.5</td>
<td>7</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
<td>4.5</td>
<td>6</td>
<td>20</td>
<td>25</td>
</tr>
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</table>
MN74HCU04/MN74HCU04S

Hex Inverters (Unbuffered)

**Description**
MN74HCU04/MN74HCU04S contain six inverter circuits without buffer. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

![Logic diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VO</td>
<td>−0.5 ~ VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIL</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65 ~ +150</td>
<td>°C</td>
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**Power dissipation**

<table>
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<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
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<tr>
<td>MN74HCU04</td>
<td>PD</td>
<td>400</td>
<td>mW Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta= −40 ~ +60 °C</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Ta= +60 ~ +85 °C</td>
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</tr>
<tr>
<td>MN74HCU04S</td>
<td>PD</td>
<td>275</td>
<td>mW Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta= −40 ~ +60 °C</td>
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</tr>
<tr>
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<td></td>
<td>Ta= +60 ~ +85 °C</td>
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</table>
High-Speed CMOS Logic MN74HC Series

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
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<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4—6.0</td>
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<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>V_I, V_O</td>
<td>0—VCC</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_A</td>
<td>-40—+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_r, t_f</td>
<td>0—1000</td>
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<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>0—500</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0—400</td>
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<td>ns</td>
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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40—+85°C</td>
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<tr>
<td>Input HIGH voltage</td>
<td>V_H</td>
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<tr>
<td>Input LOW voltage</td>
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<td>6.0</td>
<td>1.1</td>
<td>1.1</td>
<td>V</td>
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<tr>
<td>Output HIGH voltage</td>
<td>V_OH</td>
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<td>V</td>
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<td>4.5</td>
<td>4.0</td>
<td>4.0</td>
<td>V</td>
</tr>
<tr>
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<td>6.0</td>
<td>5.5</td>
<td>5.5</td>
<td>V</td>
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<tr>
<td>Output LOW voltage</td>
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<td>V</td>
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<td>4.5</td>
<td>V</td>
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<tr>
<td>Input current</td>
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<td>±1.0</td>
<td>μA</td>
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<tr>
<td>Quiescent supply current</td>
<td>I_CC</td>
<td>6.0</td>
<td>V_I==V_CC or GND, I_O=0</td>
<td>2.0</td>
<td>20.0</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>Ta=25°C</td>
<td>Ta=−40—+85°C</td>
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<td>Output rise time</td>
<td>t_TLH</td>
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<td>ns</td>
</tr>
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<td>8</td>
<td>19</td>
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<td>6.0</td>
<td>7</td>
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<tr>
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<td>t_TNL</td>
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<td>20</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
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<td>7</td>
<td>19</td>
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<td>6.0</td>
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<tr>
<td>Propagation time (L→H)</td>
<td>t_PLH</td>
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<td>20</td>
<td>ns</td>
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<td>6</td>
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<td></td>
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<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
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<td>20</td>
<td>ns</td>
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</table>
MN74HC08/MN74HC08S
Quad 2-Input AND Gates

**Description**
MN74HC08/MN74HC08S contain four 2-input positive isolation AND gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

![Logic Diagram](image.png)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>(-0.5 \sim V_{CC}+0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_O )</td>
<td>( \pm 25 )</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC, I_{GND}} )</td>
<td>( \pm 50 )</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150)</td>
<td>(^\circ)C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td><strong>MN74HC08</strong></td>
<td><strong>( P_D )</strong></td>
<td><strong>400</strong> mW</td>
</tr>
<tr>
<td></td>
<td>( T_a = -40 \sim +60 ^\circ)C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( T_a = +60 \sim +85 ^\circ)C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MN74HC08S</strong></td>
<td><strong>( P_D )</strong></td>
<td><strong>275</strong> mW</td>
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<tr>
<td></td>
<td>( T_a = -40 \sim +60 ^\circ)C</td>
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<tr>
<td></td>
<td>( T_a = +60 \sim +85 ^\circ)C</td>
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</tr>
</tbody>
</table>

**Pin configuration (top view)**

![Pin Configuration](image.png)

---

Panasonic
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>40~85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r_i}$</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$t_{i_f}$</td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$</th>
<th>Test Conditions</th>
<th>$T_{A}=25{}^\circ C$</th>
<th>$T_{A}=-40{}^\circ C+85{}^\circ C$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td>$V_{I}$ $I_{O}$</td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-9</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_{IH}$ -20.0</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>-20.0</td>
<td>4.4</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>5.9</td>
<td>5.9</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-4.0</td>
<td>3.86</td>
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<td></td>
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<td>6.0</td>
<td>-5.2</td>
<td>5.36</td>
<td>5.26</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$V_{IH}$ 20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>0.32</td>
<td>0.37</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>0.32</td>
<td>0.37</td>
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<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>2.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_{L}=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$</th>
<th>Test Conditions</th>
<th>$T_{A}=25{}^\circ C$</th>
<th>$T_{A}=-40{}^\circ C+85{}^\circ C$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td></td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{TTL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>
**High-Speed CMOS Logic MN74HC Series**

**MN74HC10/MN74HC10S**

**Triple 3-Input NAND Gates**

**Description**

MN74HC10/MN74HC10S contain three 3-input positive isolation AND gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

![Logic diagram](image)

**Absolute Maximum Ratings**

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<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 ~ +7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VI, VO</td>
<td>-0.5 ~ VCC + 0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I1K</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I0K</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I0</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGN</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC10</td>
<td></td>
<td>400 mW</td>
<td></td>
</tr>
<tr>
<td>Ta = -40 ~ +60 °C</td>
<td>PD</td>
<td>Decrease to 200 mW at the rate of 8 mW/°C</td>
<td></td>
</tr>
<tr>
<td>Ta = +60 ~ +85 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC10S</td>
<td></td>
<td>275 mW</td>
<td></td>
</tr>
<tr>
<td>Ta = -40 ~ +60 °C</td>
<td>PD</td>
<td>Decrease to 200 mW at the rate of 3.8 mW/°C</td>
<td></td>
</tr>
<tr>
<td>Ta = +60 ~ +85 °C</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 - 6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 - $V_{CC}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40~+85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, f}$</td>
<td>2.0</td>
<td>0~1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400 ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>4.5</td>
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<tr>
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<td>6.0</td>
<td>$V_{IH}$</td>
<td>6.0</td>
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<td>4.5</td>
<td>$V_{IL}$</td>
<td>3.86</td>
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<td>6.0</td>
<td>$V_{IL}$</td>
<td>5.36</td>
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<tr>
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<td>$V_{OL}$</td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>0.0</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}$</td>
<td>0.0</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>0.32</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_O=0$</td>
<td>2.0</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50$ pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{CC}$ (V)</td>
<td>$T_{a=25°C}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
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<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>
MN74HC11/MN74HC11S

Triple 3-Input AND Gates

**Description**
MN74HC11/MN74HC11S contain three 3-input positive isolation AND gate circuits.
Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.
Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic Diagram**

![Logic Diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>-0.5 ~ VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_K</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_O</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_O</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_CC, I_GND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC11</td>
<td>P_D</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta = -40 ~ +60°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
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</tr>
<tr>
<td>Ta = +60 ~ +85°C</td>
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<tr>
<td>MN74HC11S</td>
<td>P_D</td>
<td>275</td>
<td>mW</td>
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<tr>
<td>Ta = -40 ~ +60°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
<tr>
<td>Ta = +60 ~ +85°C</td>
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</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>1.4–6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vih vo</td>
<td>0–Vcc</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>Ta</td>
<td>-40–+85</td>
<td></td>
<td>°C</td>
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<tr>
<td>Input rise and fall time</td>
<td>tr tf</td>
<td>2.0</td>
<td>0–1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0–500</td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0–400</td>
<td>ns</td>
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## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vih Vih</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>Vih</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>Vil</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
<td></td>
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<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>Voh</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>-20.0</td>
<td>4.4</td>
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<td>6.0</td>
<td>-20.0</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>-4.0</td>
<td>3.86</td>
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<td>6.0</td>
<td>-5.2</td>
<td>5.36</td>
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<td>Output LOW voltage</td>
<td>Vol</td>
<td>2.0</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>20.0</td>
<td>0.1</td>
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<td>0.1</td>
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<td>4.5</td>
<td>4.0</td>
<td>0.32</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0</td>
<td>Vih=Vcc or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>Icc</td>
<td>6.0</td>
<td>Vih=Vcc or Ged GND=0, Io=0</td>
<td>2.0</td>
</tr>
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</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, C L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vih Vih</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td>Output rise time</td>
<td>tTLH</td>
<td>2.0</td>
<td>25</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>tTHL</td>
<td>2.0</td>
<td>20</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>tPLH</td>
<td>2.0</td>
<td>25</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>tPHL</td>
<td>2.0</td>
<td>25</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

**MN74HC14/MN74HC14S**

Hex Inverting Schmitt Triggers

**Description**

MN74HC14/MN74HC14S contains six inverter circuits with Schmitt triggers at all input terminals. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Because the circuit threshold voltage differs ($V_{IH}$, $V_{IL}$) when the input waveform rises and falls, wider applications are possible for the line receiver, waveform shaping and multi-vibrator in addition to the normal inverter. Resistors and diodes are provided in $V_{CC}$ and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Logic Diagram (1 Gate)**

![Logic Diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC, I_{GND}}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC14</th>
<th>MN74HC14 S</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40 \sim +60^\circ C$</td>
<td>$P_D$</td>
<td>$P_D$</td>
</tr>
<tr>
<td>$T_a = +60 \sim +85^\circ C$</td>
<td>$400$</td>
<td>$275$</td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>0 ~ VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40 ~ +85°C</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output HIGH voltage</td>
<td>VOH</td>
<td>2.0 4.5 6.0</td>
<td>VIL -20.0 µA</td>
<td>min. typ. max.</td>
<td>min. typ. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.2</td>
<td>VIL -4.0 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>VOL</td>
<td>2.0 4.5 6.0</td>
<td>VIL 4.0 mA</td>
<td>min. typ. max.</td>
<td>min. typ. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0</td>
<td>VIL=VCC or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0</td>
<td>VIL=VCC or GND, IO=0</td>
<td>2.0 20.0</td>
<td>µA</td>
</tr>
<tr>
<td>Input threshold voltage</td>
<td>VTH+</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>0.7 1.1 1.5</td>
<td>0.7 1.5</td>
</tr>
<tr>
<td></td>
<td>VTH−</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>0.3 0.7 1.0</td>
<td>0.3 1.0</td>
</tr>
<tr>
<td>Hysteresis voltage</td>
<td>VH</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>0.1 0.3 1.0</td>
<td>0.1 1.0</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤ 6ns, C=50 pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>tTLH</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>25 75 95</td>
<td>ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>tTHL</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>20 70 95</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>tPLH</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>25 75 95</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>tPHL</td>
<td>2.0 4.5 6.0</td>
<td></td>
<td>25 75 95</td>
<td>ns</td>
</tr>
</tbody>
</table>
MN74HC20/MN74HC20S

Dual 4-Input NAND Gates

■ Description

MN74HC20/MN74HC20S contain two 4-input positive isolation NAND gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.

Resistors and diodes are provided in \( V_{CC} \) and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Logic diagram (1 gate)

\[
\begin{aligned}
A & \rightarrow & \text{Gate} & \rightarrow & Y \\
B & \rightarrow & \text{Gate} & \rightarrow & Y \\
C & \rightarrow & \text{Gate} & \rightarrow & Y \\
D & \rightarrow & \text{Gate} & \rightarrow & Y
\end{aligned}
\]

■ Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{io} )</td>
<td>(-0.5 \sim V_{CC} + 0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{PK} )</td>
<td>(+ 20)</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>(+ 20)</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>(+ 25)</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC, I_{GND}} )</td>
<td>(+ 50)</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150)</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC20 ( T_a = -40 \sim +60°C )</td>
<td>( P_D )</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC20S ( T_a = +60 \sim +85°C )</td>
<td>( P_D )</td>
<td>275</td>
<td>mW</td>
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</tbody>
</table>

Decay to 200mW at the rate of 8mW/°C
Decay to 200mW at the rate of 3.8mW/°C

Panasonic
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td></td>
<td>1.4 - 6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td></td>
<td>0 - ( V_{CC} )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td></td>
<td>(-40 ~ +85)°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_I )</td>
<td>( I_O )</td>
<td>( V_{1} = V_{CC} ) or GND</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_H )</td>
<td>2.0</td>
<td>1.5</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_L )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>( -20.0 )</td>
<td>( -20.0 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( -20.0 )</td>
<td>( -20.0 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( -20.0 )</td>
<td>( -20.0 )</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( V_{IH} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( V_{IH} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>( V_{IH} )</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or GND</td>
<td>( \pm 0.1 )</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or GND, ( I_O = 0 )</td>
<td>2.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time \( \leq 6\)ns, \( C_L = 50\)pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td></td>
<td>( Ta=25°C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>( Ta=25°C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Propagation time (L ( \rightarrow ) H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>( Ta=25°C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Propagation time (H ( \rightarrow ) L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>( Ta=25°C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td>25</td>
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<tr>
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<td>6.0</td>
<td></td>
<td>25</td>
</tr>
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</table>
High-Speed CMOS Logic MN74HC Series

MN74HC21/MN74HC21S

Dual 4-Input AND Gates

Description
MN74HC21/MN74HC21S contain two 4-input positive isolation AND gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic diagram (1 gate)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>−0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IiK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IiO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC/IOUT</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC21 Tα=−40~+60°C</td>
<td>Pd</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC21 S Tα=−40~+60°C</td>
<td>Pd</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC21 S Tα=+60~+85°C</td>
<td>Pd</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td>mW</td>
</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4–6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0–$V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40 ~ +85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2.0</td>
<td>0–1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0–500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0–400 ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature $T_a=25^\circ C$</th>
<th>$T_a=-40~+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td></td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td></td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td></td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>$\mu A$</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>$\mu A$</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>$\mu A$</td>
<td>5.9</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-4.0</td>
<td>$mA$</td>
<td>3.86</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-5.2</td>
<td>$mA$</td>
<td>5.36</td>
<td>5.26</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>$mA$</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>$mA$</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_O=0$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\mu F$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature $T_a=25^\circ C$</th>
<th>$T_a=-40~+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>
MN74HC27/MN74HC27S
Triple 3-Input NOR Gates

■ Description
MN74HC27/MN74HC27S contain three 3-input positive isolation NOR gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Logic diagram (1 gate)

![Logic diagram](image)

■ Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VO</td>
<td>$-0.5 \sim VCC + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGG</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC27</td>
<td>PD</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>PD</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74 HC27S</td>
<td>PD</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>PD</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td></td>
<td></td>
<td>1.4 – 6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td></td>
<td></td>
<td>0 – ( V_{CC} )</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td></td>
<td></td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND = 0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_I ), ( I_O )</td>
<td>( T_a = 25°C )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = -40 ) to +85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_{IH} )</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td></td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td></td>
<td>2.0</td>
<td>-20.0 ( \mu A )</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td></td>
<td>2.0</td>
<td>-20.0 ( \mu A )</td>
<td>1.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.4</td>
<td>4.4</td>
<td>V</td>
</tr>
<tr>
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<td></td>
<td>6.0</td>
<td>5.9</td>
<td>5.9</td>
<td>V</td>
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<td>4.5</td>
<td>-4.0 ( mA )</td>
<td>3.86</td>
<td>V</td>
</tr>
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<td></td>
<td>6.0</td>
<td>-5.2 ( mA )</td>
<td>5.36</td>
<td>V</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td></td>
<td>2.0</td>
<td>-20.0 ( \mu A )</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.32</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0 ( \mu A )</td>
<td>0.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.32</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>6.0 ( V_I = V_{CC} ) or GND</td>
<td>±0.1</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>6.0 ( V_I = V_{CC} ) or GND, ( I_O = 0 )</td>
<td>2.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND = 0V, Input transition time \( \leq 6 \) ns, \( C_L = 50 \) pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_I )</td>
<td>( T_a = 25°C )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = -40 ) to +85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_{IH} )</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td>Propagation time (L ( \rightarrow ) H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td>Propagation time (H ( \rightarrow ) L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
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<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
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</table>
**MN74HC30/MN74HC30S**

8-Input NAND Gates

**Description**
MN74HC30/MN74HC30S contain one 8-input positive isolation NAND gate circuits.
Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.
Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

![Logic diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 ~ +7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>-0.5 ~ VCC + 0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIL</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOH</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGN</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>TSTG</td>
<td>-65 ~ +150 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC30</td>
<td>Ta = -40 ~ +60°C</td>
<td>PD</td>
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<tr>
<td></td>
<td>MN74HC30S</td>
<td>Ta = -60 ~ +85°C</td>
<td>PD</td>
</tr>
</tbody>
</table>
# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4–6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>0–( V_{CC} )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>-40–+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0</td>
<td>0–1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0–500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0–400</td>
<td>ns</td>
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</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_{I} )</td>
<td>( I_{O} )</td>
<td>( T_{A} = 25{°C} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>-4.0</td>
<td>mA</td>
<td>3.86</td>
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<td></td>
<td>4.5</td>
<td>-5.2</td>
<td>mA</td>
<td>5.36</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>4.0</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_{I} )</td>
<td>6.0</td>
<td>( V_{I}=V_{CC} ) or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I}=V_{CC} ) or GND, ( I_{O}=0 )</td>
<td>2.0</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time \( \leq 6{\text{ns}} \), \( C_{L}=50{\text{pF}} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_{CC} )</td>
<td>( T_{A} = 25{°C} )</td>
<td>( T_{A} = -40{°C} +85{°C} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>43</td>
<td>150</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>12</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>( t_{PDL} )</td>
<td>2.0</td>
<td>35</td>
<td>125</td>
</tr>
<tr>
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<td>4.5</td>
<td>14</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>21</td>
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</tbody>
</table>
MN74HC32/MN74HC32S

Quad 2-Input OR Gates

**Description**
MN74HC32/MN74HC32S contain four 2-input positive isolation OR gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

```
     +-----+  +-----+
    |     |  |     |
    A     B  Y
```

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>–0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VI,VO</td>
<td>–0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I1k</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I0k</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I0</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC,IGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>–65~+150</td>
<td>℃</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC32</th>
<th>Pd</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=–40~+60℃</td>
<td></td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=+60~+85℃</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/℃</td>
<td></td>
</tr>
<tr>
<td>MN74HC32S</td>
<td>Pd</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=–40~+60℃</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/℃</td>
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</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,I_{O}}$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40~+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r,f}$</td>
<td>2.0~1000</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>$T_{a=25}$°C</th>
<th>$T_{a=-40+85}$°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
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<td>0.9</td>
<td>0.9</td>
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<td>V</td>
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<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
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<td>2.0</td>
<td>1.9</td>
<td>V</td>
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<td>4.5</td>
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<td>-20.0</td>
<td>5.9</td>
<td>6.0</td>
<td>5.9</td>
<td>V</td>
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<td>V</td>
</tr>
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<td></td>
<td>4.5</td>
<td>-5.2</td>
<td>5.36</td>
<td>5.26</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>μA</td>
</tr>
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<td></td>
<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>5.2</td>
<td>0.32</td>
<td>0.37</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>5.2</td>
<td>0.32</td>
<td>0.37</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td></td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_{a=25}$°C</th>
<th>$T_{a=-40+85}$°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
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<td>Propagation time (H→L)</td>
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</table>
MN74HC42/MN74HC42S

BCD-to-Decimal Decoder

Description

MN74HC42/MN74HC42S are BCD-to-Decimal Decoders. Only outputs from 10 outputs (Y0~Y9) corresponding to inputs (A~D) become “L”. All other outputs become “H”. When input becomes over 9, all outputs become “H”.

Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent of CMOS, and an operation speed of LS TTL. Each output can directly drive LS TTL 10-inputs. Resistors and diode are provided between the Vcc and GND to protect the input and output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth Table

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Logic Diagram

[Logic Diagram Image]
### Absolute Maximum Ratings

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>±20</td>
<td>mA</td>
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<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
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#### Power dissipation

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<th>$T_{A}=+60 \sim +85°C$</th>
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<tr>
<td>MN74HC42</td>
<td>$P_{D}$ 400 mW</td>
<td>$P_{D}$ 275 mW</td>
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Decrease to 200 mW at the rate of 8 mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Operating supply voltage</td>
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<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0~$V_{CC}$</td>
<td>V</td>
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<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
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<td>Input rise and fall time</td>
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<td>2.0~1000 ns</td>
<td>ns</td>
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<td>4.5~500 ns</td>
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<td></td>
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<td>6.0~400 ns</td>
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### DC Characteristics (GND=0V)

<table>
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<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
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<td></td>
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<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td>$T_{A}=25°C$</td>
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<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
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<td>$V_{IH}$</td>
<td>4.4</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\text{pF}$)

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<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
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<td>$Ta=25\degree\text{C}$</td>
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<td>typ.</td>
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<td>95</td>
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<td>Output fall time</td>
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<td>Propagation time</td>
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<td>A,B,C,D→Y (H→L)</td>
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#### AC Characteristics Measuring Waveforms

![AC Characteristics Measuring Waveforms Diagram](image-url)
High-Speed CMOS Logic MN74HC Series

**MN74HC51/MN74HC51S**

Dual AND-OR Invert Gates

**Description**
MN74HC51/MN74HC51S contain two AND-OR-INVERT gates. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic diagram (1 gate)**

```
A1 o---I>~
B1 o---I>o--
C1 o---I>o--
D1 o---I>o--
F1 o---

A2 o--Coo----
B2 o--Qc>-'----
C2 o--Qc)---
D2 o--;:>0---'

A1 e---I>~
B1 e---I>o--
C1 e---I>o--
D1 e---I>o--
F1 e---

A2 e--Coo----
B2 e--Qc>-'----
C2 e--Qc)---
D2 e--;:>0---'
```

**Absolute Maximum Ratings**

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_IN, V_OUT</td>
<td>-0.5~V_CC+0.5</td>
<td>V</td>
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<td>Input protection diode current</td>
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<td>Output parasitic diode current</td>
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<td>mA</td>
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<td>mA</td>
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<td>℃</td>
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*Decrease to 200mW at the rate of 8mW/°C*

Panasonic
### High-Speed CMOS Logic MN74HC Series

#### Operating Conditions

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<th>Parameter</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
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<tr>
<td>Operating supply voltage</td>
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<td>0 - V_{CC}</td>
<td>V</td>
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<tr>
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#### DC Characteristics (GND=0V)

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<th>Test Conditions</th>
<th>Temperature</th>
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<td></td>
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<td>I_{0}</td>
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<td>1.5</td>
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<td>3.15</td>
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<td>0.9</td>
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<td>1.2</td>
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<td>-20.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td></td>
<td>-20.0</td>
<td>4.4</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>-20.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>2.0</td>
<td>-4.0</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td></td>
<td>-5.2</td>
<td>5.36</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td></td>
<td>-5.2</td>
<td>5.36</td>
</tr>
</tbody>
</table>

#### AC Characteristics (GND=0V, Input transition time ≤6ns, C_{L}=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V_{CC}</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>40</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>39</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>10</td>
<td>21</td>
</tr>
</tbody>
</table>
MN74HC73/MN74HC73S

Dual J-K Flip-Flops with Clear

**Description**

MN74HC73/MN74HC73S contain two J-K flip-flop circuits with clear. Each flip-flop has independent clear, J-K, clock input and complementary Q and Q outputs. Input data is transferred to the output on the negative going edge of the clock pulse. Clear operates at LOW level regardless of the clock. Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to CMOS, and an operation speed of LS TTL. Each output can directly drive LS TTL 10-inputs. Resistors and diode are provided between the $V_{cc}$ GND to protect the input and output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLR</th>
<th>CLK</th>
<th>J</th>
<th>K</th>
<th>Q</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>×</td>
<td>×</td>
<td>Q0</td>
<td>Q0</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. L: Rise of negative direction
3. Q0: Q level prior to determination of input condition shown in table
4. Q0: Q level prior to determination of input condition shown in table
5. Toggle: With L change, output becomes a complement of the previous condition

**Logic diagram (1 gate)**

![Logic diagram](image-url)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>−0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

- **MN74HC73**
  - Ta=−40~+60°C: PD=400 mW
  - Ta=+60~+85°C: PD=275 mW
  - Decrease to 200mW at the rate of 8mW/°C
- **MN74HC73S**
  - Ta=−40~+60°C: PD=275 mW
  - Ta=+60~+85°C: PD=200mW at the rate of 3.8mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>0~VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>−40~+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VIL, IO</td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40~+85°C</td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>−20.0 μA</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>μA</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>μA</td>
<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>−5.2 mA</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>−5.2 mA</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>−5.2 mA</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>IIL</td>
<td>6.0</td>
<td>VIL=VCC or GND</td>
<td>±0.1</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0</td>
<td>VIL=VCC or GND, I0=0</td>
<td>4.0</td>
<td>40.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time CLK→Q, Q (L→H)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time CLK→Q, Q (H→L)</td>
<td>t_{PLH}</td>
<td>2.0</td>
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<td>17</td>
<td>15</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum pulse width CLR</td>
<td>tw</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t_{su}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_h</td>
<td>2.0</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t_{rem}</td>
<td>2.0</td>
<td></td>
<td>2</td>
<td>15</td>
</tr>
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<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max.}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (tpHL, tpHJ)

2. Waveforms

- tPHL, tPHT, tREF, tMAX, tpHL, tpHJ (CLK→Q, \overline{Q}), t\text{rem}, t_h

\[ \text{tpHL, tpHJ} \]

\[ \text{tPHL, tPHT} \]

\[ \text{tREF, tMAX} \]

\[ \text{tpHL, tpHJ} \]

\[ \text{tPHL, tPHT} \]

\[ \text{tREF, tMAX} \]
MN74HC74/MN74HC74S

Dual D-Type Flip-Flops with Preset and Clear

**Description**
MN74HC74/MN74HC74S contain two D-type flip-flop circuits with preset and clear. Each flip-flop has independent clear, preset, data, clock input and complementary Q and Q̅ outputs. Input data is transferred to the output on the positive going edge of the clock pulse. Preset and clear operate at LOW level regardless of the clock. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to CMOS, and an operation speed of LS TTL. Each output can directly drive LS TTL 10-inputs. Resistors and diodes are provided between the Vcc and GND to protect the input and output from damage by static electricity. Same pin configuration and function as the standard 74LS/74LS logic family.

**Truth table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>CLR</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. ✓: Rise of positive direction
3. Q₀: Q level prior to determination of input condition shown in table
4. Q̅₀: Q̅ level prior to determination of input condition shown in table
5. H*: When preset and clear are low, Q and Q̅ are HIGH; however, when preset and clear simultaneously change to HIGH, requirements of Q and Q̅ cannot be predicted.

**Logic Diagram (1 Gate)**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation              | $P_D$  | $400$           | mW   |
| MN74HC74                       | $T_a = -40 \sim +60^\circ C$ | Decrease to 200mW at the rate of 8mW/°C |
| MN74HC74S                      | $T_a = -40 \sim +60^\circ C$ | Decrease to 200mW at the rate of 3.8mW/°C |

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4-6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0- $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2.0-1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5-500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0-400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics ($GND = 0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_I, I_O$</td>
<td>$T_a = 25^\circ C$</td>
<td>$T_a = -40 \sim +85^\circ C$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>0</td>
<td>-20.0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
<td>or $V_{IL}$</td>
<td>20.0</td>
<td>μA</td>
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<tr>
<td></td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>-4.0</td>
<td>mA</td>
<td>5.9</td>
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<td></td>
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<td>$V_{IL}$</td>
<td>-5.2</td>
<td>mA</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>$V_{IH}$</td>
<td>20.0</td>
<td>μA</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>or $V_{IH}$</td>
<td>20.0</td>
<td>μA</td>
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<td>4.5</td>
<td>$V_{IL}$</td>
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<td>0.37</td>
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<td>$V_{IL}$</td>
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<td>mA</td>
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<td>Input current</td>
<td>$I_I$</td>
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<td>$V_I = V_{CC}$ or GND</td>
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<td>±1.0</td>
<td>μA</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
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<td>$V_I = V_{CC}$ or GND, $I_O = 0$</td>
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<td>40.0</td>
<td>μA</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>$T_a=25^\circ$C</td>
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<td>$T_a=-40^\circ$~$+85^\circ$C</td>
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<td>Output rise time</td>
<td>$t_{THL}$</td>
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<td>95</td>
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<tr>
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<td>4.5</td>
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<td>6.0</td>
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<td>Output fall time</td>
<td>$t_{TLH}$</td>
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<td>6.0</td>
<td>6</td>
<td>13</td>
<td>16</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>32</td>
<td>150</td>
<td>190</td>
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<tr>
<td>CLK→Q, $\overline{Q}$ (L→H)</td>
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<td>14</td>
<td>30</td>
<td>38</td>
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<td>6.0</td>
<td>11</td>
<td>26</td>
<td>33</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>32</td>
<td>150</td>
<td>190</td>
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<tr>
<td>CLK→Q, $\overline{Q}$ (H→L)</td>
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<td>14</td>
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<td>38</td>
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<td>6.0</td>
<td>11</td>
<td>26</td>
<td>33</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>150</td>
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<td>PR,CLR→Q, $\overline{Q}$ (L→H)</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
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<td>32</td>
<td>150</td>
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<tr>
<td>PR,CLR→Q, $\overline{Q}$ (H→L)</td>
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<td>13</td>
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<tr>
<td>Minimum Set-up time</td>
<td>$t_{su}$</td>
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<td>95</td>
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<td>Minimum pulse width</td>
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<td>PR, CLR</td>
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<td>9</td>
<td>15</td>
<td>19</td>
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<td></td>
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<td>6.0</td>
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<td>16</td>
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<tr>
<td>Minimum recovery time</td>
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<td>95</td>
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<tr>
<td>PR, CLR</td>
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<td>4.5</td>
<td>4</td>
<td>15</td>
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<tr>
<td>Maximum clock frequency</td>
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<td>6.0</td>
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</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

2. Waveforms

[1] $t_{PLH}, t_{PHL}, t_{max}, t_{PLH}/t_{PHL}$ (CLK→Q, $\overline{Q}$), $t_{rem}, t_{h}$

[2] $t_{PLH}/t_{PHL}$ (CLR→Q, $\overline{Q}$), $t_{w}$
MN74HC75/MN74HC75S

4-Bit Bistable Latch

Description
MN74HC75/MN74HC75S are 4-bit bistable latches with Q, \overline{Q} output. These are suited for temporary binary data memory circuits between the data processing unit and the I/O, or between display units. Data at data input (D) is transferred to output Q, when enable pin (G) is “H”; output Q follows the data input state so long as the enable is “H”. When the enable becomes “L”, output is maintained as is until when the enable becomes “H”. Output Q indicates the data input state when the enable changes from “H” to “L”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>D</td>
<td>G</td>
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<tr>
<td>L</td>
<td>H</td>
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<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>X</td>
<td>L</td>
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</tbody>
</table>

Note:
1. \(\times\): Either HIGH or LOW; it doesn’t matter
2. Q₀: Q level prior to determination of input condition shown in table
3. \(\overline{Q₀}\): Q level prior to determination of input condition shown in table

Logic Diagram

---

Panasonic
# Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;IN&lt;/sub&gt;, V&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>−0.5~V&lt;sub&gt;CC&lt;/sub&gt;+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I&lt;sub&gt;IK&lt;/sub&gt;</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I&lt;sub&gt;OK&lt;/sub&gt;</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;, I&lt;sub&gt;GND&lt;/sub&gt;</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T&lt;sub&gt;STG&lt;/sub&gt;</td>
<td>−65~+150</td>
<td>°C</td>
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### Power Dissipation

<table>
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<td>MN74HC75</td>
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<tr>
<td>Ta=−40~+60°C</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td>Decrease to 400mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>MN74HC75S</td>
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<tr>
<td>Ta=−40~+60°C</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td>Decrease to 275mW at the rate of 3.8mW/°C</td>
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# Operating Conditions

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;IN&lt;/sub&gt;, V&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>0~V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>−40~+85°C</td>
<td>°C</td>
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<tr>
<td>Input rise and fall time</td>
<td>t&lt;sub&gt;R&lt;/sub&gt;, t&lt;sub&gt;F&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
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<td>4.5, 0~500ns</td>
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<td>6.0, 0~400ns</td>
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# DC Characteristics (GND=0V)

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tr>
<td></td>
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<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
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<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;1&lt;/sub&gt;, I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
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<td>1.5, 1.5</td>
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<tr>
<td></td>
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<td>3.15</td>
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<td>4.2, 4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>V&lt;sub&gt;L&lt;/sub&gt;</td>
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<td>−20.0</td>
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<td>−20.0</td>
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<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
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<td>V&lt;sub&gt;1&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tr>
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<td>( T_a=-40^{\circ}^\circ +85^{\circ}C )</td>
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<td>Output rise time</td>
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<td>19</td>
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<td>155</td>
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<td>6.0</td>
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<td>Propagation time ( D\rightarrow Q \ (H\rightarrow L) )</td>
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<td>155</td>
<td>ns</td>
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<td>26</td>
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</tr>
<tr>
<td>Propagation time ( D\rightarrow Q \ (L\rightarrow H) )</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>14</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20</td>
<td>21</td>
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<tr>
<td>Propagation time ( D\rightarrow Q \ (H\rightarrow L) )</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>14</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Propagation time ( G\rightarrow Q \ (L\rightarrow H) )</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>125</td>
<td>155</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>16</td>
<td>31</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td>25</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Propagation time ( G\rightarrow Q \ (H\rightarrow L) )</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>125</td>
<td>155</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>17</td>
<td>31</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>25</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit ($t_{PLH}$, $t_{PHL}$)

2. Waveforms

---

Panasonic
MN74HC76/MN74HC76S

Dual J-K Flip-Flops with Preset and Clear

**Description**

MN74HC76/MN74HC76S contain two J-K flip-flop circuits with preset and clear. Each flip-flop has independent J, K, clear, preset, clock input and complementary Q and Q outputs. Input data is transferred to the output on the negative going edge of the clock pulse. Preset and clear operate at low level regardless of the clock. Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to CMOS, and an operation speed of LS TTL. Each output can directly drive LS TTL 10-inputs. Resistor and diode are provided between the Vcc and GND to protect the input and output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>CLR</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

**Pin configuration (top view)**

- **Note:**
  1. X: Either HIGH or LOW; it doesn’t matter
  2. X: Rise of negative direction
  3. Q0: Q level prior to determination of input condition shown in table
  4. Q0: Q level prior to determination of input condition shown in table
  5. Toggle: With change, output becomes a complement of the previous condition
  5. H*: When preset and clear are low, Q and Q are HIGH; however, when preset and clear simultaneously change to HIGH, requirements of Q and Q cannot be predicted.

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>-0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIP</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IPO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, ICGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>TSTG</td>
<td>-65~+150°C</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC76</td>
<td>PD 400</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>MN74HC76S</td>
<td>PD 275</td>
<td>mW</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>0~VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40~+85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VIL, IO</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>VIH</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>VOH</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>−4.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>−5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>VOL</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0</td>
<td>VI=VCC or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0</td>
<td>VI=VCC or GND, IO=0</td>
<td>4.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;TLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>15</td>
<td>19</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>7</td>
<td>15</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>18</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>CLK→Q, Q&lt;sup&gt;¬&lt;/sup&gt; (L→H)</td>
<td></td>
<td>4.5</td>
<td>18</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>18</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>CLK→Q, Q&lt;sup&gt;¬&lt;/sup&gt; (H→L)</td>
<td></td>
<td>4.5</td>
<td>17</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>20</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>PR, CLR→Q, Q&lt;sup&gt;¬&lt;/sup&gt; (L→H)</td>
<td></td>
<td>4.5</td>
<td>20</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>19</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>PR, CLR→Q, Q&lt;sup&gt;¬&lt;/sup&gt; (H→L)</td>
<td></td>
<td>4.5</td>
<td>19</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>19</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;ω&lt;/sub&gt;</td>
<td>2.0</td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>PR, CLR</td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t&lt;sub&gt;su&lt;/sub&gt;</td>
<td>2.0</td>
<td>9</td>
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<td>4.5</td>
<td>9</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>9</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t&lt;sub&gt;h&lt;/sub&gt;</td>
<td>2.0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
<td>2.0</td>
<td>1</td>
<td>75</td>
<td>95</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1</td>
<td>75</td>
<td>95</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>-</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>30</td>
<td>50</td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

2. Waveforms
MN74HC77/MN74HC77S

4-Bit Bistable Latch

**Description**
MN74HC77/MN74HC77S are 4-bit bistable latches. These are suited for temporary binary data memory circuits between the data processing unit and the I/O, or between display units. Data at data input (D) are transferred to output Q, when enable pin (G) is “H”; output Q follows the data input state so long as the enable is “H”. When the enable becomes “L”, output is maintained as is until when the enable becomes “H”. Output Q indicates the data input state when the enable changes from “H” to “L”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>G</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>X</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. $\times$: Either HIGH or LOW; it doesn’t matter
2. $Q_0$: $Q$ level prior to determination of input condition shown in table

**Logic Diagram (1 gate)**

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC77</td>
<td>$T_a=-40 \sim +60°C$</td>
<td>$P_D$</td>
<td>400 mW</td>
</tr>
<tr>
<td>MN74HC77S</td>
<td>$T_a=-40 \sim +85°C$</td>
<td>$P_D$</td>
<td>275 mW</td>
</tr>
</tbody>
</table>

- Decrease to 200mW at the rate of 8mW/°C
- Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$2.0 \sim 1000$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5 \sim 500$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0 \sim 400$</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_a=25°C$</td>
<td>$T_a=-40 \sim +85°C$</td>
</tr>
<tr>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>$2.0 \sim 4.5 \sim 6.0$</td>
<td>$1.5 \sim 3.15 \sim 4.2$</td>
<td>$1.5 \sim 3.15 \sim 4.2$</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>$2.0 \sim 4.5 \sim 6.0$</td>
<td>$0 \sim 0.9 \sim 1.2$</td>
<td>$0 \sim 0.9 \sim 1.2$</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>$2.0 \sim 4.5 \sim 6.0 \sim 4.5 \sim 6.0$</td>
<td>$-20.0 \sim -4.0 \sim -5.2$</td>
<td>$\mu A \sim mA \sim mA$</td>
</tr>
<tr>
<td></td>
<td>Or</td>
<td>$V_{IH}$</td>
<td>$-20.0 \sim -20.0$</td>
<td>$\mu A \sim mA$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>$2.0 \sim 4.5 \sim 6.0 \sim 4.5 \sim 6.0$</td>
<td>$20.0 \sim 20.0 \sim 4.0 \sim 5.2$</td>
<td>$\mu A \sim mA \sim mA$</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>$6.0 \sim 6.0 \sim 6.0$</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1 \sim \pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>$6.0 \sim 6.0 \sim 6.0$</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>$4.0 \sim 40.0$</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

| Parameter                  | Symbol | VCC (V) | Test Conditions | Temperature |          |          |          |          |          |          |          |          |          |
|----------------------------|--------|---------|----------------|-------------|----------|----------|----------|----------|----------|----------|----------|----------|
|                            |        |         |                | Ta=25°C     | Ta=-40~+85°C |          |          |          |          |          |          |          |
|                            |        |         |                | min. typ. max. | min. max. |          |          |          |          |          |          |          |
| Output rise time           | t_{TLH}| 2.0     | 4.5            | 6.0         | 25       | 75       | 95       | 6         | 15       | 19       | 95       |          | ns       |
| Output fall time           | t_{THL}| 2.0     | 4.5            | 6.0         | 20       | 75       | 95       | 7         | 15       | 19       | 95       |          | ns       |
| Minimum Set-up time        | t_{su} | 2.0     | 4.5            | 6.0         | 2        | 20       | 125      | 17        | 25       | 21       |          |          | ns       |
| Minimum Hold time          | t_{h}  | 2.0     | 4.5            | 6.0         | -        | 0        | 0        | -         | 0        | 0        |          |          | ns       |
| Minimum pulse width        | t_{w}  | 2.0     | 4.5            | 6.0         | 6        | 15       | 95       | 13        | 19       | 16       |          |          | ns       |
| Propagation time D→Q (L→H) | t_{PLH} | 2.0     | 4.5            | 6.0         | 15       | 25       | 155      | 21        | 31       | 26       |          |          | ns       |
| Propagation time D→Q (H→L) | t_{PHL} | 2.0     | 4.5            | 6.0         | 14       | 25       | 155      | 21        | 31       | 26       |          |          | ns       |
| Propagation time G→Q (L→H) | t_{PLH} | 2.0     | 4.5            | 6.0         | 11       | 25       | 155      | 21        | 31       | 26       |          |          | ns       |
| Propagation time G→Q (H→L) | t_{PHL} | 2.0     | 4.5            | 6.0         | 13       | 25       | 155      | 21        | 31       | 26       |          |          | ns       |
- Switching Time Measuring Circuit and Waveforms
  [1] $t_{PLH}$, $t_{THL}$, $t_w$, $f_{max}$, $t_{PLH/PHL}$ (CLK→Q, $\overline{Q}$), $t_{em}$, $t_h$
  1. Measuring Circuit ($t_{PLH/PHL}$)

- Waveforms

  ![Waveforms Diagram](image)

- Switching Time Measuring Circuit and Waveforms
  [2] $t_{PLH/PHL}$ (CLR→Q, $\overline{Q}$), $t_w$
  1. Measuring Circuit ($t_{PLH/PHL}$)

- Waveforms

  ![Waveforms Diagram](image)
MN74HC86/MN74HC86S

Quad 2-Input Exclusive OR Gate

- **Description**
  MN74HC86/MN74HC86S contain quad 2-input exclusive OR (XOR) gate. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL; LS TTL 10-inputs can be directly driven. A resistor and diode are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS74LS.

- **Logic Diagram (1 gate)**

![Logic Diagram](image)

- **Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL,VIH</td>
<td>-0.5 ~ VCC + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IiK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC,IGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ta = -40 ~ +60°C</td>
<td>PD</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta = +60 ~ +85°C</td>
<td></td>
<td>Decr to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td>MN74HC86S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ta = -40 ~ +60°C</td>
<td>PD</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>Ta = +60 ~ +85°C</td>
<td></td>
<td>Decr to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
</tbody>
</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4–6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>0–( V_{CC} )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>–40–+85°C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0</td>
<td>0–1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0–500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0–400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_I )</th>
<th>( I_O )</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_A=25°C )</td>
<td>( T_A=-40°C +85°C )</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td></td>
<td>0.3</td>
<td>( V_{IL} )</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0.9</td>
<td></td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td></td>
<td>1.9</td>
<td>( V_{IH} )</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>4.4</td>
<td>( V_{IH} )</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>5.9</td>
<td>( V_{IH} )</td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>3.86</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>5.36</td>
<td>5.26</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>4.0</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>5.2</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND</td>
<td>±0.1</td>
<td>±0.1</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND, ( I_O=0 )</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td></td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_A=25°C )</td>
<td>( T_A=-40°C +85°C )</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>
MN74HC107/MN74HC107S

Dual J-K Flip-Flops with Clear

**Description**
MN74HC107/MN74HC107S contain dual J-K flip-flop with clear, and each flip-flop has independent J, K, clock, clear input and complementary output Q and Q. Input data is transferred to the output on the negative-going edge of the clock pulse. Clear operates on the low level regardless of the clock.

Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL; LS TTL 10-inputs can be directly driven.

A resistor and diode are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS.

**Truth table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLR</td>
<td>CLK</td>
</tr>
<tr>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Data input is transferred to output on the negative-going edge from HIGH to LOW of the clock
2. ×: Either HIGH or LOW; it doesn’t matter
3. Q_o: (Q_o): Q (Q) level prior to determination of input condition shown in table
4. Toggle: With × change, output becomes a complement of the previous condition

**Logic Diagram**

Panasonic
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>−0.5~V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{STG}</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC107</th>
<th>Ta=−40~+60°C</th>
<th>P_{D}</th>
<th>400</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=+60~+85°C</td>
<td>P_{D}</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC107S</th>
<th>Ta=−40~+60°C</th>
<th>P_{D}</th>
<th>275</th>
<th>Decrease to 200mW at the rate of 3.8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=+60~+85°C</td>
<td>P_{D}</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>−40~+85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{R}, t_{F}</td>
<td>2.0</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
<td>I_{O}</td>
<td>V_{I}</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>3.15</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.5</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
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<td>Output HIGH voltage</td>
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<td></td>
<td>V_{I}, V_{OH}</td>
<td>μA</td>
</tr>
<tr>
<td></td>
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<td>1.9</td>
<td>4.4</td>
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<td>Output LOW voltage</td>
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<td>6.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<p>| Input current | I_{I} | V_{I}=V_{CC} or GND | ±0.1 | ±1.0 | μA |
| Quiescent supply current | I_{CC} | V_{I}=V_{CC} or GND, I_{O}=0 | 4.0  | 40.0 | μA |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{cc}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a = 25^\circ C$</td>
<td>$T_a = -40\sim +85^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
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<td>Output fall time</td>
<td>$t_{THL}$</td>
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<td>4.5</td>
<td>6.0</td>
<td>20</td>
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<td>Propagation time $CLK\rightarrow \overline{Q}$ \ L H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
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<td>34</td>
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<td>Propagation time $CLK\rightarrow \overline{Q}$ \ H L)</td>
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<td>37</td>
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<td>48</td>
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<td>Propagation time $CLR\rightarrow \overline{Q}$ \ H L)</td>
<td>$t_{PHL}$</td>
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<td>42</td>
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<td>Minimum Set-up time</td>
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<td>Minimum Hold time</td>
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<td>6.0</td>
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<td>$t_{W}$</td>
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<td>Minimum recovery time</td>
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<td>15</td>
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<td>Maximum clock frequency</td>
<td>$f_{max}$</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
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</tbody>
</table>

 Panasonic

—86—
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (\(t_{PLH}, t_{PHL}\))

2. Waveforms

- \(t_{PLH}/t_{PHL}\) (CLR\(\rightarrow\)Q, \(\overline{Q}\), \(t_{W}\))

1. Measuring Circuit (\(t_{PLH}, t_{PHL}\))
MN74HC109/MN74HC109S
Dual J-K Flip-Flops with Preset and Clear

- **Description**
  MN74HC109/MN74HC109S contain dual J-K flip-flop with preset and clear and each flip-flop has independent J, K, clock, clear, preset input and complementary output Q and Q̅. Input data is transferred to the output on the rising edge of the clock pulse. Clear and preset operate on the low level regardless of the clock. Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL; LS TTL 10-inputs can be directly driven.

  A Resistors and diode are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>CLR</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

  Note:
  1. ×: Either HIGH or LOW; it doesn’t matter
  2. ×: Rise of positive direction
  3. Q̅o: Q̅ level prior to determination of input condition shown in table
  4. Q̅o: Q level prior to determination of input condition shown in table
  5. Toggle: With change, output becomes a complement of the previous condition
  6. H*: When preset and clear are low, Q and Q̅ are HIGH; however, when preset and clear simultaneously change to HIGH, requirements of Q and Q̅ cannot be predicted.

- **Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC, I_{GND}}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC109</th>
<th>$T_a=40 \sim +60^\circ C$</th>
<th>$P_D$</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a=60 \sim +85^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC109S</th>
<th>$T_a=40 \sim +65^\circ C$</th>
<th>$P_D$</th>
<th>Decrease to 200mW at the rate of 3.8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a=60 \sim +85^\circ C$</td>
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</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$2.0$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 1000$</td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 400$</td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics ($GND=0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ C$</td>
<td>$T_a=-40 \sim +85^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_o$</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>$2.0$</td>
<td>$1.5$</td>
<td>$1.5$</td>
</tr>
<tr>
<td></td>
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<td>$4.5$</td>
<td>$3.15$</td>
<td>$3.15$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>$4.2$</td>
<td>$4.2$</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>$2.0$</td>
<td>$0.3$</td>
<td>$0.3$</td>
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<td>$4.5$</td>
<td>$0.9$</td>
<td>$0.9$</td>
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<td></td>
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<td>$6.0$</td>
<td>$1.2$</td>
<td>$1.2$</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
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<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
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<td>$4.5$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
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<td>$6.0$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
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<td></td>
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<td>$6.0$</td>
<td>$-5.2$</td>
<td>$mA$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>$2.0$</td>
<td>$20.0$</td>
<td>$\mu A$</td>
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<td>$20.0$</td>
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<td>$20.0$</td>
<td>$\mu A$</td>
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<td>$4.0$</td>
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<td>$5.2$</td>
<td>$mA$</td>
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<tr>
<td>Input current</td>
<td>$I_I$</td>
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<td>$V_{I}=V_{CC}$ or $GND$</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>$6.0$</td>
<td>$V_{I}=V_{CC}$ or $GND, I_{O}=0$</td>
<td>$4.0$</td>
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</table>
### AC Characteristics (GND=0V, Input transition time \( \leq 6\text{ns} \), \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
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<td></td>
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<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
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<td>6.0</td>
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<td>Output fall time</td>
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</tr>
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<td>6.0</td>
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<td></td>
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<tr>
<td>Propagation time CLK→Q, ( \bar{Q} ) (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>125</td>
<td>25</td>
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<tr>
<td>Propagation time CLK→Q, ( \bar{Q} ) (H→L)</td>
<td>( t_{PFL} )</td>
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<td></td>
<td>125</td>
<td>25</td>
</tr>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>Propagation time PR, CLR→Q, ( \bar{Q} ) (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>125</td>
<td>25</td>
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</tr>
<tr>
<td>Propagation time PR, CLR→Q, ( \bar{Q} ) (H→L)</td>
<td>( t_{PFL} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>125</td>
<td>25</td>
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<td>4.5</td>
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<td>21</td>
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<td></td>
<td>6.0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum pulse width PR, CLR</td>
<td>( t_w )</td>
<td>2.0</td>
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<td>75</td>
<td>15</td>
</tr>
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<td>4.5</td>
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<td>13</td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{SU} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
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<td>6.0</td>
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</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_h )</td>
<td>2.0</td>
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<td></td>
<td></td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td></td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td>6.0</td>
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</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
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<td>35</td>
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</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

[1] \( t_{\text{TLH}}, t_{\text{THL}}, t_{\text{sw}}, t_{\text{max}}, t_{\text{PLH}}/t_{\text{PHL}} \) (CLK->Q, Q), \( t_{\text{rem}}, t_{\text{h}} \)

1. Measuring Circuit (\( t_{\text{PLH}}, t_{\text{PHL}} \))

[2] \( t_{\text{PLH}}/t_{\text{PHL}} \) (CLR->Q, \( \overline{Q} \)), \( t_{\text{w}} \)

1. Measuring Circuit (\( t_{\text{PLH}}, t_{\text{PHL}} \))

2. Waveforms
MN74HC112/MN74HC112S
Dual J-K Flip-Flops with Preset and Clear

■ Description

MN74HC112/MN74HC112S contain dual J-K flip-flop with clear, and each flip-flop has independent J, K, preset, clock, clear input and complementary output Q and Q. Input data is transferred to the output on the negative going edge of the clock pulse. Clear operates on the low level regardless of the clock. Adoption of the silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL; LS TTL 10-inputs can be directly driven.

A Resistors and diode are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>CLR</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. χ: Rise of negative direction
3. Qo: Q level prior to determination of input condition shown in table
4. Qo: Q level prior to determination of input condition shown in table
5. Toggle: With χ change, output becomes a complement of the previous condition
5. H*: When preset and clear are low, Q and Q are HIGH; however, when preset and clear simultaneously change to HIGH, requirements of Q and Q cannot be predicted.

■ Logic Diagram
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC, IGND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 $\sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, f}$</td>
<td>6.0</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>5.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>$1.5$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3.15$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.2$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>$0.3$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.9$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1.2$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

### Output HIGH voltage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>$1.9$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$2.0$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.4$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$5.9$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

### Output LOW voltage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>$0.0$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.1$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.32$</td>
<td>$V_{OL}$</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

### Input current

| Parameter                        | Symbol       | $V_{CC}$ or $V_{OL}$ | $V_{OL}$ | $\mu A$ |
|---------------------------------|--------------|----------------------|---------|^---------|---------|
| Input current                   | $I_I$        | $6.0$                | $0.1$   | $\mu A$ |

### Quiescent supply current

| Parameter                        | Symbol       | $V_{CC}$ or $V_{OL}$ | $I_{OL}$ | $\mu A$ |
|---------------------------------|--------------|----------------------|---------|^---------|---------|
| Quiescent supply current        | $I_{CC}$     | $6.0$                | $4.0$   | $\mu A$ |

---

Panasonic
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\)pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>( t_{\text{TLH}} )</td>
<td>2.0</td>
<td>8</td>
<td>75</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{\text{THL}} )</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time CLK→Q, ( \overline{Q} ) (L→H)</td>
<td>( t_{\text{PLH}} )</td>
<td>2.0</td>
<td>16</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>25</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Propagation time CLK→Q, ( \overline{Q} ) (H→L)</td>
<td>( t_{\text{PHL}} )</td>
<td>2.0</td>
<td>16</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>25</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Propagation time PR, CLR→Q, ( \overline{Q} ) (L→H)</td>
<td>( t_{\text{PLH}} )</td>
<td>2.0</td>
<td>17</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>25</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Propagation time PR, CLR→Q, ( \overline{Q} ) (H→L)</td>
<td>( t_{\text{PHL}} )</td>
<td>2.0</td>
<td>19</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>25</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Minimum pulse width PR, CLR</td>
<td>( t_{\text{w}} )</td>
<td>2.0</td>
<td>7</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{\text{su}} )</td>
<td>2.0</td>
<td>7</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>17</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_{\text{h}} )</td>
<td>2.0</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{\text{rem}} )</td>
<td>2.0</td>
<td>1</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{\text{max.}} )</td>
<td>2.0</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>30</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>35</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>
- High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit and Waveforms

  ![Diagram of Measuring Circuit](image)

  **[1] t_{PLH}, t_{PHL}, t_{s}, t_{max}, t_{PLH/PHL} (CLK→Q, Q), t_{rem}, t_{h}**

  1. Measuring Circuit (t_{PLH}, t_{PHL})

  ![Diagram of Waveforms](image)

  **[2] t_{PLH}/t_{PHL} (CLR→Q, Q), tw**

  1. Measuring Circuit (t_{PLH}, t_{PHL})

  ![Diagram of Waveforms](image)

---

Panasonic
**MN74HC125/MN74HC125S**

Quad TRI-STATE Buffers

- **Description**
  MN74HC125/MN74HC125S are high-speed non-inverted buffers consisting of quad tri-state outputs. High-speed operation is possible for driving a large capacitance bus line owing to large current output. The gate can be controlled by tri-state input (C), when output becomes enabled at LOW. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level
3. X: Either HIGH or LOW; doesn't matter.
4. Hi-Z: Hi-impedance

- **Logic Diagram**

- **Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>–0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vi, V0</td>
<td>–0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Iok</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Igd</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>–65~+150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation MN74HC125</td>
<td>Pd</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=–40~+60°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power dissipation MN74HC125S</td>
<td>Pd</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=–40~+60°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt;(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;, V&lt;sub&gt;o&lt;/sub&gt;</td>
<td>0~V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>-40~+85°C</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

| Input rise and fall time           | t<sub>r</sub>, t<sub>f</sub> | V<sub>CC</sub>=2.0V | 0~1000 ns    |      |
|                                    |                                  | V<sub>CC</sub>=4.5V | 0~500 ns     |      |
|                                    |                                  | V<sub>CC</sub>=6.0V | 0~400 ns     |      |

# DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;I&lt;/sub&gt;</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;IH&lt;/sub&gt;</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
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<td>Output LOW voltage</td>
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<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.1</td>
<td>±1.0</td>
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<tr>
<td>3-state output off state current</td>
<td>I&lt;sub&gt;OZ&lt;/sub&gt;</td>
<td>6.0</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;IH&lt;/sub&gt; or V&lt;sub&gt;IL&lt;/sub&gt;, V&lt;sub&gt;O&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.5</td>
<td>±5.0</td>
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<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND, I&lt;sub&gt;O&lt;/sub&gt;=0</td>
<td>8.0</td>
<td>80.0</td>
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## AC Characteristics (GND=0V, Input transition time ≤ 6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
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<td>T&lt;sub&gt;a&lt;/sub&gt;=25°C</td>
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<td>max.</td>
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<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
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<td>75</td>
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<tr>
<td>Propagation time (Z→H)</td>
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<td>100</td>
<td>125</td>
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<td>Propagation time (Z→L)</td>
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<td>6.0</td>
<td>7</td>
<td>17</td>
<td>21</td>
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</table>
• Switching Time Measuring Circuit and Waveforms

(1) \( t_{THL}, t_{THL}, t_{PLH}, t_{PHL} \)
1. Measuring Circuit

\[ \text{Measuring Circuit} \]

(2) \( t_{PHZ}, t_{PZH} \)
1. Measuring Circuit

\[ \text{Measuring Circuit} \]

(3) \( t_{PZL}, t_{PZL} \)
1. Measuring Circuit

\[ \text{Measuring Circuit} \]
MN74HC126/MN74HC126S
Quad TRI-STATE Buffers

MN74HC126/MN74HC126S are high-speed non-inverted buffers consisting of quad tri-state outputs. High-speed operation is possible for driving a large capacitance bus line owing to large current output. The gate can be controlled by tri-state input (C), when output becomes enabled at HIGH. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven.

Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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<tr>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>L</td>
<td>Hi-Z</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level
3. ×: Either HIGH or LOW; doesn’t matter.
4. Hi-Z: Hi-Impedance

■ Logic Diagram

\[ \text{C} \rightarrow \text{A} \rightarrow \text{Y} \]

■ Absolute Maximum Ratings

<table>
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<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vih, Vo</td>
<td>-0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Iik</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Icnd</td>
<td>±70</td>
<td>mA</td>
</tr>
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<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65~+150</td>
<td>°C</td>
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<tr>
<td>Power dissipation</td>
<td>MN74HC126</td>
<td>Ta=−40~+60°C, Ta=+60~+85°C</td>
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<td>MN74HC126S</td>
<td>Ta=−40~+60°C, Ta=+60~+85°C</td>
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</table>

Panasonic
## Operating Conditions

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
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<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
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<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
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<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$V_{CC}=2.0V$</td>
<td>$-40~+85$ °C</td>
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<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$V_{CC}=4.5V$</td>
<td>$0~500$ ns</td>
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<td>$V_{CC}=6.0V$</td>
<td>$0~400$ ns</td>
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## DC Characteristics (GND=0V)

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<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>$V_i$</td>
<td>$I_o$</td>
<td>$T_a=25^\circ C$</td>
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<td>typ.</td>
<td>max.</td>
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<td>Input current</td>
<td>$I_i$</td>
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<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
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<td>Quiescent supply current</td>
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<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
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## AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_{L}=50\)pF)

<table>
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<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<td>Propagation time (Z→H)</td>
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<td>100</td>
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<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>17</td>
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</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

2. Waveforms (tPHZ, tPZH, tPLZ, tPZL)
MN74HC132/MN74HC132S
Quad 2-Input NAND Schmitt Triggers

- **Description**
  MN74HC132/MN74HC132S contain quad 2-input NAND with Schmitt triggers at all input terminals. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Because the circuit threshold voltage differs ($V_{IH}$, $V_{IL}$) when the input waveform rises and falls, wider applications are possible for the line reciever, waveform shaping and multi-vibrator in addition to the normal inverter. Resistors and diode are provided in $V_{CC}$ and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

- **Logic Diagram**

- **Pin configuration (top view)**

- **Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 ~ 7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{IL}$, $V_{OL}$</td>
<td>$-0.5 ~ V_{IL} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{OK}$</td>
<td>$± 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$± 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$± 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{CND}$</td>
<td>$± 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 ~ +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC132</td>
<td>$Ta = -40 ~ +60°C$</td>
<td>$P_{D}$</td>
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<tr>
<td></td>
<td>MN74HC132S</td>
<td>$Ta = -40 ~ +60°C$</td>
<td>$P_{D}$</td>
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<tr>
<td></td>
<td></td>
<td>$Ta = +60 ~ +85°C$</td>
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<td></td>
<td>MN74HC132S</td>
<td>$Ta = +60 ~ +85°C$</td>
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</table>

Decrease to 200mW at the rate of 8mW/°C
Decrease to 200mW at the rate of 3.8mW/°C
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40~+85</td>
<td></td>
<td>°C</td>
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### DC Characteristics ($GND=0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{IL}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{IH}$</td>
<td>-20.0 $\mu A$</td>
<td>$V_I$</td>
<td>$V_{CC}$ or GND</td>
<td>$T_a=25°C$</td>
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<tr>
<td></td>
<td>$V_{IL}$</td>
<td>-2.0 $\mu A$</td>
<td>$I_o$</td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
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<td>4.4</td>
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<td>6.0</td>
<td>5.9</td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>-20.0 $\mu A$</td>
<td>$V_{IL}$</td>
<td>3.86</td>
<td>3.76</td>
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<tr>
<td></td>
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<td>5.2</td>
<td>5.36</td>
<td>5.26</td>
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<td></td>
<td>6.0</td>
<td>-2.0</td>
<td>$V_{IL}$</td>
<td>1.9</td>
<td>1.9</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>0.1</td>
<td>0.1</td>
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<td>4.5</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>20.0 $\mu A$</td>
<td>$V_{IL}$</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>5.2</td>
<td>5.26</td>
<td>5.26</td>
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<tr>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>$V_{IL}$</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_o=0$</td>
<td>2.0</td>
<td>20.0</td>
</tr>
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</table>

### AC Characteristics ($GND=0V$, Input transition time $\leq 6\text{ns}$, $C_L=50\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>0.7</td>
<td>1.35</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
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<td>1.55</td>
<td>2.69</td>
<td>3.15</td>
<td>1.55</td>
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<tr>
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<td>2.1</td>
<td>3.55</td>
<td>4.2</td>
<td>2.1</td>
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<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.75</td>
<td>1.0</td>
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<td></td>
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<td>0.9</td>
<td>1.85</td>
<td>2.45</td>
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<tr>
<td></td>
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<td>1.2</td>
<td>2.45</td>
<td>3.2</td>
<td>1.2</td>
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<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>0.2</td>
<td>0.60</td>
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<td>0.4</td>
<td>0.84</td>
<td>2.1</td>
<td>0.4</td>
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<td></td>
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<td>0.5</td>
<td>1.10</td>
<td>2.5</td>
<td>0.5</td>
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<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
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<td>75</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>15</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>100</td>
<td>20</td>
<td>25</td>
</tr>
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<td>4.5</td>
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<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>100</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>
MN74HC133/MN74HC133S
13-Input NAND Gate

Description
MN74HC133/MN74HC133S contain 13-input positive isolation NAND gate. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic Diagram

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL,VIH</td>
<td>−0.5~VCC,+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIL</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOH</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC,IGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P D</td>
<td></td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC133</td>
<td>Ta=−40~+60°C</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>Ta=+60~+85°C</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
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<tr>
<td>MN74HC133S</td>
<td>Ta=−40~+60°C</td>
<td>275</td>
<td>mW</td>
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<tr>
<td></td>
<td>Ta=+60~+85°C</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td></td>
<td>1.4 ~ 6.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, V0</td>
<td></td>
<td>0 ~ VCC</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td></td>
<td>-40 ~ +85 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td></td>
<td>2.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 ~ 1000</td>
<td>ns</td>
</tr>
<tr>
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<td>ns</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>0 ~ 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 ~ 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>VIH</td>
<td>2.0</td>
<td>V1</td>
<td>1.5</td>
<td>1.5</td>
</tr>
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<td>3.15</td>
<td>3.15</td>
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<td></td>
<td>6.0</td>
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<td>4.2</td>
<td>4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
<td>2.0</td>
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<td>0.3</td>
<td>0.3</td>
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<tr>
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<td>4.5</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>VOH</td>
<td>2.0</td>
<td>V1H</td>
<td>-20.0</td>
<td>-20.0</td>
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<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>4.5</td>
<td>VIL</td>
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<td>-4.0</td>
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<td>Output LOW voltage</td>
<td>VOL</td>
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<td>V1H</td>
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<td>20.0</td>
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<td>4.5</td>
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<td>4.5</td>
<td>VIL</td>
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<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0</td>
<td>V1=VCC or GND</td>
<td>±0.1</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0</td>
<td>V1=VCC or GND, IO=0</td>
<td>2.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤ 6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;TLH&lt;/sub&gt;</td>
<td>2.0</td>
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<td>Ta=25 °C</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>95</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>2.0</td>
<td></td>
<td>Ta=25 °C</td>
<td>ns</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>95</td>
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<tr>
<td>Propagation time (L→H)</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td></td>
<td>Ta=25 °C</td>
<td>ns</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>min.</td>
<td>150</td>
</tr>
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<td></td>
<td></td>
<td>typ.</td>
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<td>max.</td>
<td>38</td>
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<tr>
<td>Propagation time (H→L)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td></td>
<td>Ta=25 °C</td>
<td>ns</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>14</td>
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<td>typ.</td>
<td>25</td>
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<tr>
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<td>max.</td>
<td>31</td>
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</tbody>
</table>
MN74HC137/MN74HC137S
3-to-8 Line Decoder with Address Latches (Inverted Output)

Description
MN74HC137/MN74HC137S are high-speed 3-to-8 line decoders with three address latches. Addresses are stored, when GL input is "H". When enable input G1 is "H" and G2 is "L", the output depending on A, B and C inputs become "L", and all other outputs become "H". Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td>Select</td>
</tr>
<tr>
<td>GL</td>
<td>G1</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level
3. ×: Either HIGH or LOW; doesn't matter

Logic Diagram

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC137</td>
<td>$T_a = -40 \sim +60^\circ C$</td>
<td>PD</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>MN74HC137S</td>
<td>$T_a = -40 \sim +60^\circ C$</td>
<td>PD</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 \sim V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$V_{CC}=2.0V$</td>
<td>0 \sim 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=4.5V$</td>
<td>0 \sim 500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=6.0$</td>
<td>0 \sim 400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND = 0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_A = 25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>4.4</td>
<td>4.4</td>
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<td></td>
<td>6.0</td>
<td>$-20.0$</td>
<td>5.9</td>
<td>5.9</td>
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<td>4.5</td>
<td>$-4.0$</td>
<td>3.86</td>
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<td>6.0</td>
<td>$-5.2$</td>
<td>5.36</td>
<td>5.26</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>$20.0$</td>
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<td>0.1</td>
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<td>4.5</td>
<td>$20.0$</td>
<td>0.0</td>
<td>0.1</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$20.0$</td>
<td>0.0</td>
<td>0.1</td>
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<td>$4.0$</td>
<td>0.32</td>
<td>0.37</td>
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<td></td>
<td>6.0</td>
<td>$5.2$</td>
<td>0.32</td>
<td>0.37</td>
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<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>6.0</td>
<td>$V_I = V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I = V_{CC}$ or GND, $I_O = 0$</td>
<td>8.0</td>
<td>80.0</td>
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</table>

Panasonic
### AC Characteristics (GND=0V, Input transition time $\leq 6\text{ns}$, $C_L=50\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$Ta=25^\circ\text{C}$</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$Ta=-40\sim+85^\circ\text{C}$</td>
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<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>23</td>
<td>75</td>
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<td>6.0</td>
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<td>9</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>8</td>
<td>13</td>
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<tr>
<td>Output fall time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>19</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>49</td>
<td>150</td>
</tr>
<tr>
<td>(L→H)</td>
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<td>4.5</td>
<td></td>
<td>24</td>
<td>30</td>
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<tr>
<td></td>
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<td>6.0</td>
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<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>49</td>
<td>150</td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Minimum pulse width</td>
<td>$t_w$</td>
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<td>$\leq 6$</td>
<td>100</td>
</tr>
<tr>
<td>GL→Y</td>
<td></td>
<td>4.5</td>
<td></td>
<td>$\leq 6$</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>$\leq 6$</td>
<td>17</td>
</tr>
<tr>
<td>Minimum set-up time</td>
<td>$t_{SU}$</td>
<td>2.0</td>
<td></td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>A, B, C</td>
<td></td>
<td>4.5</td>
<td></td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>$t_h$</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>16</td>
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</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

[PNG]

\[ t_{\text{THL}}, t_{\text{PHL}}, t_{\text{up}}, t_{\text{max}}, t_{\text{PHL}}/t_{\text{PHL}} \text{ (CLK→Q, \overline{Q}), } t_{\text{rem}}, t_{\text{h}} \]

1. Measuring Circuit \((t_{\text{PHL}}, t_{\text{PHL}})\)

2. Waveforms

[PNG]
MN74HC138/MN74HC138S
3-to-8 Line Decoder

**Description**

MN74HC138/MN74HC138S are high-speed 3-to-8 line decoders decoding one of eight output lines depending on the condition of three select inputs (A, B, and C) and three enable inputs (G1, G2A, and G2B).

The enable input consists of an active LOW of 2-inputs and an active HIGH of 1-input, with makes the subsidiary connection easy. Low power dissipation and high noise margin equivalent to standard CMOS; operation speed of LS TTL. LS TTL 10 inputs can be directly driven.

Resistors and diode are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable</th>
<th>Select</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>G2</td>
<td>C</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
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<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. G2 = G2A + G2B
2. ×: Either HIGH or LOW; it doesn't matter.

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC138 $T_{a} = -40 \sim +60$°C</td>
<td>$P_{D}$</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC138S $T_{a} = -40 \sim +60$°C</td>
<td>$P_{D}$</td>
<td>275</td>
<td>mW</td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of 8mW/°C and 3.8mW/°C.

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0 \sim $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0 \sim 1000 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{r}, t_{f}$</td>
<td>4.5 \sim 500 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{r}, t_{f}$</td>
<td>6.0 \sim 400 ns</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions $V_{I}$, $I_{O}$</th>
<th>Temperature $T_{a}=25$°C $T_{a}=-40 \sim +85$°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage $V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage $V_{IL}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>$-4.0$</td>
<td>$-4.0$</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage $V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
<td>1.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
<td>4.4</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>$-5.2$</td>
<td>5.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>$-4.0$</td>
<td>3.86</td>
<td>V</td>
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<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>$-5.2$</td>
<td>5.36</td>
<td>V</td>
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<tr>
<td>Output LOW voltage $V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
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<td>0.0</td>
<td>V</td>
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<tr>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>0.0</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>0.0</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td>Input current $I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current $I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
<td>80.0</td>
<td>μA</td>
</tr>
</tbody>
</table>
**AC Characteristics** (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25℃</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>tTLH</td>
<td>2.0</td>
<td>4.5</td>
<td>25</td>
<td>75</td>
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<td>4.5</td>
<td>6.0</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>tTHL</td>
<td>2.0</td>
<td>4.5</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>tPLH</td>
<td>2.0</td>
<td>4.5</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>(L→H)</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>tPHL</td>
<td>2.0</td>
<td>4.5</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time Enable G1</td>
<td>tPLH</td>
<td>2.0</td>
<td>4.5</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>→Y (L→H)</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time Enable G1</td>
<td>tPHL</td>
<td>2.0</td>
<td>4.5</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>→Y (H→L)</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time Enable G2</td>
<td>tPLH</td>
<td>2.0</td>
<td>4.5</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>A, G2B→Y</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td>(L→H)</td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time Enable G2</td>
<td>tPHL</td>
<td>2.0</td>
<td>4.5</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td>A, G2B→Y</td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

![Switching Time Measuring Circuit diagram](image)
MN74HC139/MN74HC139S
Dual 2-to-4 Line Decoders

- **Description**
MN74HC139/MN74HC139S are high-speed silicon gate CMOS, 2-to-4 line decoders decoding one of 4 output lines depending on the condition of two select inputs (A and B) and one enable input (G). Two independent 2-to-4 line decoder/demultiplexers are used on one chip. Low power dissipation and high noise margin equivalent to standard CMOS; operation speed of LS TTL. LS TTL 10 inputs can be directly driven. A resistor and diode are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS.

- **Truth table**

<table>
<thead>
<tr>
<th>Enable</th>
<th>Select</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Y0</td>
</tr>
<tr>
<td>G</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter

- **Logic Diagram**

![Logic Diagram Image]
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

- **MN74HC139**
  - $T_a=-40 \sim +85$ °C: $P_D=400$ mW, Decrease to 200mW at the rate of 8mW/°C
  - $T_a=+60 \sim +85$ °C: $P_D=275$ mW, Decrease to 200mW at the rate of 3.8mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>0 $\sim$ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$ °C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>2.0 $\sim$ 1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 $\sim$ 500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 $\sim$ 400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>-20.0</td>
<td>-20.0</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>-20.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Panasonic
High-Speed CMOS Logic MN74HC Series

MN74HC139/MN74HC139S

### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_CC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40°C−+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Propagation time A, B→Y (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time A, B→Y (H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Propagation time Enable G→Y (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time Enable G→Y (H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

- **Switching Time Measuring Circuit and Waveforms**
  1. Measuring Circuit (t_{PLH}, t_{PHL})
  2. Waveforms

---

![Switching Time Measuring Circuit and Waveforms](image-url)
MN74HC147/MN74HC147S
10-to-4 Line Priority Encoder

Description
MN74HC147/MN74HC147S are 10-to-4 line priority encoders which prioritize the highest input and encode ten data lines to four data lines, when two or more input data are applied simultaneously. The binary signal 0 is encoded when all nine data inputs are “H”. When all inputs and outputs are “L”, the encoder is active. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in V_{CC} and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
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<td>×</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
High-Speed CMOS Logic MN74HC Series

Logic Diagram

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I!,!O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC!,!I_{GND}}$</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$ °C</td>
<td></td>
</tr>
</tbody>
</table>

Power dissipation

<table>
<thead>
<tr>
<th>MN74HC147</th>
<th>$T_a = -40 \sim +60°C$</th>
<th>$P_D$</th>
<th>400 mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC147S</td>
<td>$T_a = +60 \sim +85°C$</td>
<td>$P_D$</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>MN74HC147S</td>
<td>$T_a = -40 \sim +60°C$</td>
<td>$P_D$</td>
<td>275 mW</td>
</tr>
<tr>
<td>MN74HC147S</td>
<td>$T_a = +60 \sim +85°C$</td>
<td>$P_D$</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>-40~+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{R}, t_f$</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_A=25°C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>4.2</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.5</td>
<td>4.2</td>
<td>3.15</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
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<td>0.9</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
</tr>
<tr>
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<td>-20.0</td>
<td>μA</td>
<td>4.4</td>
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<td>-20.0</td>
<td>μA</td>
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<td>mA</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
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<td></td>
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<td>4.5</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
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<td>6.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
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<td></td>
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<td>4.0</td>
<td>mA</td>
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<td></td>
<td></td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

MN74HC147/MN74HC147S

AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>tTILH</td>
<td>2.0</td>
<td></td>
<td>Ta=25°C</td>
<td>min.</td>
</tr>
<tr>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>Output fall time</td>
<td>tTHL</td>
<td>2.0</td>
<td></td>
<td>Ta=40°C~+85°C</td>
<td>75</td>
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<td>4.5</td>
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<td></td>
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<td></td>
<td>6.0</td>
<td></td>
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<td>13</td>
</tr>
</tbody>
</table>

- Propagation time
  1. 9 → A, B, C (L→H)
  2. 9 → A, B, C (H→L)
  3. 9 → D (L→H)
  4. 9 → D (H→L)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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</thead>
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<tr>
<td>Propagation time</td>
<td>tPLH</td>
<td>2.0</td>
<td></td>
<td>Ta=25°C</td>
<td>min.</td>
</tr>
<tr>
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<td>4.5</td>
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<td></td>
<td>175</td>
</tr>
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<td></td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td></td>
<td>Ta=40°C~+85°C</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td></td>
<td>30</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (tPLH,tPHL)
  2. Waveforms

Panasonic
8-to-3 Line Priority Encoder

**Description**
MN74HC148/MN74HC148S are 8-to-3 line priority encoders which detect the most LOW out of eight input signals and output a binary code signal. Input consists of eight input signals (0 - 7) and an EI input. When EI input is “H”, encoding stops and all outputs become “H”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>A2</td>
</tr>
<tr>
<td>0</td>
<td>H</td>
</tr>
<tr>
<td>1</td>
<td>H</td>
</tr>
<tr>
<td>2</td>
<td>H</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
</tr>
<tr>
<td>4</td>
<td>H</td>
</tr>
<tr>
<td>5</td>
<td>H</td>
</tr>
<tr>
<td>6</td>
<td>H</td>
</tr>
<tr>
<td>7</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
H: HIGH level
L: LOW level
\( \times \): Either HIGH or LOW; it doesn’t matter
## Logic Diagram

![Logic Diagram](image)

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{IL}, V_{OL}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC, I_{GND}}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{Stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC148</td>
<td>$P_D$</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a = -40 \sim +60$ °C</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td>$T_a = +60 \sim +85$ °C</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC148S</td>
<td>$P_D$</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a = -40 \sim +60$ °C</td>
<td></td>
<td>Decrease to 200mW at the rate of 9mW/°C</td>
<td></td>
</tr>
<tr>
<td>$T_a = +60 \sim +85$ °C</td>
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</tr>
</tbody>
</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VI, VO</td>
<td>0~VCC</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40~+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>0~1000</td>
<td>0~500 ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V1</td>
<td>I0</td>
<td>V1, I0</td>
<td>T&lt;sub&gt;a=25°C&lt;/sub&gt;</td>
<td>T&lt;sub&gt;a=-40~+85°C&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>VIH</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
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</tr>
<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
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<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>VOH</td>
<td>2.0</td>
<td>4.5</td>
<td>4.4</td>
<td>V</td>
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<td>5.9</td>
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<td>8.0</td>
<td>8.0</td>
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<tr>
<td>Output LOW voltage</td>
<td>VOL</td>
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<td>0.0</td>
<td>0.0</td>
<td>V</td>
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<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
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<tr>
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<td>6.0</td>
<td>0.32</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>I&lt;sub&gt;i&lt;/sub&gt;</td>
<td>6.0</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND, I&lt;sub&gt;o&lt;/sub&gt;=0</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics

(GND=0V, Input transition time ≤6ns, $C_L=50\,\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>$T_a=25,\text{°C}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
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<td>$T_a=-40\text{°C}$</td>
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<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
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</tr>
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<td></td>
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<td>15</td>
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<td>13</td>
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<td>Output fall time</td>
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<td>15</td>
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<td>6.0</td>
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<td>13</td>
<td>6</td>
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<td>$0\rightarrow A_0, A_1, A_2$</td>
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<tr>
<td>(L→H)</td>
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<td>6.0</td>
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<td>13</td>
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<td>Propagation time</td>
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<tr>
<td>(H→L)</td>
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<td>6.0</td>
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<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>175</td>
<td>35</td>
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<td>$0\rightarrow EO$ (L→H)</td>
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<td>4.5</td>
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<td>6.0</td>
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<td>6.0</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
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</tr>
<tr>
<td>$0\rightarrow GS$ (L→H)</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>$0\rightarrow GS$ (H→L)</td>
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<td>30</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$E\rightarrow A_0, A_1, A_2$</td>
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<td></td>
<td></td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>(L→H)</td>
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<td>4.5</td>
<td></td>
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<td>6.0</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<tr>
<td>$E\rightarrow GS$ (L→H)</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<td>30</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$E\rightarrow GS$ (H→L)</td>
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<td></td>
<td></td>
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<td></td>
<td>6.0</td>
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</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

2. Waveforms

---

![Circuit Diagram](image)

---

Panasonic
MN74HC151/MN74HC151S
8-Channel Digital Multiplexer

- **Description**

MN74HC151/MN74HC151S are digital multiplexer, which selects one input from 8-channel data input according to select input (A, B, C), transfer data to the reverse phase outputs W and Y mutually. When strobe input is “L”, the output is selected by the select input combination. When strobe input is “H”, output W is “H” and output Y is “L”.

Adopting silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be driven directly. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard 54LS/74LS logic family.

### Truth Table

<table>
<thead>
<tr>
<th>Select</th>
<th>Input</th>
<th>Strobe</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>B</td>
<td>A</td>
<td>Y</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
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<td>H</td>
<td>L</td>
<td>H</td>
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<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
   D0, D1, ..., D7: respective data input level
## Logic diagram

![Logic diagram](image)

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{cc}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{i}, V_{o}$</td>
<td>$-0.5 \sim V_{cc} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{ik}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{ok}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{o}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{cc}, I_{cqd}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC151</td>
<td>$T_{a}= -40 \sim +60 \text{°C}$</td>
<td>$P_{D}$</td>
</tr>
<tr>
<td></td>
<td>MN74HC151S</td>
<td>$T_{a}= +60 \sim +85 \text{°C}$</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{cc}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{cc}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{i}, V_{o}$</td>
<td>0~$V_{cc}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{a}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0~400</td>
<td>ns</td>
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</tbody>
</table>
## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_1 )</th>
<th>( I_0 )</th>
<th>( T_a=25°C )</th>
<th>( T_a=-40°~+85°C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>( \mu A )</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>( \mu A )</td>
<td>4.4</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-4.0</td>
<td>( \mu A )</td>
<td>5.9</td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-5.2</td>
<td>mA</td>
<td>3.86</td>
<td>5.36</td>
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<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>mA</td>
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<td>0.37</td>
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<tr>
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<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
<td>0.37</td>
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<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>20.0</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>30</td>
<td>34</td>
<td>38</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>30</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_1=V_{CC} ) or GND</td>
<td>±0.1</td>
<td>±1.0</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_1=V_{CC} ) or GND, ( I_0=0 )</td>
<td>8.0</td>
<td>80.0</td>
<td>μA</td>
<td></td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50pF \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( T_a=25°C )</th>
<th>( T_a=-40°~+85°C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
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<td>75</td>
<td>95</td>
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<tr>
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<td>4.5</td>
<td>8</td>
<td>15</td>
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<td></td>
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<td>6.0</td>
<td>7</td>
<td>13</td>
<td>16</td>
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<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
<td>95</td>
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<td>7</td>
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<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>23</td>
<td>40</td>
<td>50</td>
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<td>4.5</td>
<td>34</td>
<td></td>
<td>43</td>
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<tr>
<td>Propagation time A, B, C→Y (H→L)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>21</td>
<td>35</td>
<td>44</td>
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<td></td>
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<td>37</td>
</tr>
<tr>
<td>Propagation time A, B, C→W (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>22</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>34</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Propagation time A, B, C→W (H→L)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>22</td>
<td>40</td>
<td>50</td>
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<td></td>
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<td>4.5</td>
<td>34</td>
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<td>43</td>
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</table>
### AC/Characteristics (Cont’d)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
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<td>$T_a=25^\circ C$</td>
<td>$T_a=-40^\circ C$</td>
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<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>S→Y (L→H)</td>
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<td>4.5</td>
<td></td>
<td>17</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>Propagation time</td>
<td>$t_{PHL}$</td>
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<td></td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>S→Y (H→L)</td>
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<td></td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
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<td></td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>12</td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>S→W (L→H)</td>
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<td>2.0</td>
<td></td>
<td>17</td>
<td>20</td>
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<td></td>
<td></td>
<td>4.5</td>
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<td>6.0</td>
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<td>Propagation time</td>
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<td>25</td>
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<td>4.5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>12</td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>D→Y (L→H)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>17</td>
<td>20</td>
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<td></td>
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<td>4.5</td>
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<td></td>
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</tr>
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<td></td>
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<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>12</td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>D→W (L→H)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>17</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>12</td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>D→W (H→L)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Switching Time Measuring Circuit and Waveforms**

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)
2. Waveforms

---

![Switching Time Measuring Circuit](image)

![Waveforms](image)

---

Panasonic

---

130
High-Speed CMOS Logic MN74HC Series

MN74HC153/MN74HC153S

Dual 4-Input Multiplexer

**Description**

MN74HC153/MN74HC153S are dual 4-input multiplexer which transfer one of four data to output Y according to the common select input (A, B). Each multiplexer has respective enable input multiplexer functions at LOW level. At HIGH level, output is fixed LOW.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth table**

<table>
<thead>
<tr>
<th>Select Inputs</th>
<th>Data Inputs</th>
<th>Enable</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>B A</td>
<td>C0 C1 C2 C3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>× ×</td>
<td>× × × ×</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L L</td>
<td>L × × ×</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L L</td>
<td>H × × ×</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L H</td>
<td>× L × ×</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L H</td>
<td>× H × ×</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H L</td>
<td>× × L ×</td>
<td>L</td>
<td>L</td>
</tr>
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<td>H L</td>
<td>× × H ×</td>
<td>L</td>
<td>H</td>
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<tr>
<td>H H</td>
<td>× × × L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H H</td>
<td>× × × H</td>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>-0.5 - 7.0 V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;O&lt;/sub&gt;</td>
<td>-0.5 - V&lt;sub&gt;CC&lt;/sub&gt; + 0.5 V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I&lt;sub&gt;P&lt;/sub&gt;</td>
<td>± 20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>± 20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>± 25 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;, I&lt;sub&gt;GND&lt;/sub&gt;</td>
<td>± 50 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T&lt;sub&gt;TStg&lt;/sub&gt;</td>
<td>-65 - 150 °C</td>
<td></td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
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</thead>
<tbody>
<tr>
<td>MN74HC153</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>400 mW</td>
</tr>
<tr>
<td>MN74HC153S</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>275 mW</td>
</tr>
</tbody>
</table>

Decrease to 200 mW at the rate of 8 mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>1.4 - 6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;O&lt;/sub&gt;</td>
<td>0 - V&lt;sub&gt;CC&lt;/sub&gt; V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>-40 - 85 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t&lt;sub&gt;TR&lt;/sub&gt;, t&lt;sub&gt;TF&lt;/sub&gt;</td>
<td>2.0 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td></td>
<td></td>
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</table>

### DC Characteristics (GND = 0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;</td>
<td>I&lt;sub&gt;0&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;IH&lt;/sub&gt;</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V&lt;sub&gt;IL&lt;/sub&gt;</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.4</td>
<td>4.5</td>
</tr>
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<td></td>
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<td>6.0</td>
<td>5.9</td>
<td>6.0</td>
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<td>2.0</td>
<td>3.86</td>
<td>3.76</td>
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<td></td>
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<td>4.5</td>
<td>5.36</td>
<td>5.26</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>0.1</td>
<td>0.1</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0</td>
<td>0.0</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0</td>
<td>0.0</td>
<td>±0.1</td>
</tr>
</tbody>
</table>

---

Panasonic
High-Speed CMOS Logic MN74HC Series

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ\text{C}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TH}$</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{TH}$</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
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<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time A, B→Y (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>47</td>
<td>175</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>17</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>Propagation time A, B→Y (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>45</td>
<td>150</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>18</td>
<td>30</td>
<td>38</td>
</tr>
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<td></td>
<td>6.0</td>
<td>14</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time $\overline{G}$→Y (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>38</td>
<td>125</td>
<td>155</td>
</tr>
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<td></td>
<td></td>
<td>4.5</td>
<td>12</td>
<td>21</td>
<td>26</td>
</tr>
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<td></td>
<td>6.0</td>
<td>14</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time $\overline{G}$→Y (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>40</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>17</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>14</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Propagation time C→Y (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>45</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>18</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>15</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Propagation time C→Y (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>44</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>17</td>
<td>30</td>
<td>38</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>14</td>
<td>26</td>
<td>33</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit ($t_{PLH}$-$t_{PHL}$)
  2. Waveforms
MN74HC155/MN74HC155S

Dual 2-to-4 Line Decoders/Demultiplexers

**Description**

MN74HC155/MN74HC155S contain dual 2-bit 2-to-4 line decoders/demultiplexers. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistor and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS.

**Truth table**

### 2-line to 4-line Decoder / 1-line to 4-line Demultiplexer

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>Enable</td>
</tr>
<tr>
<td>B A</td>
<td>1G 1C</td>
</tr>
<tr>
<td>× ×</td>
<td>H ×</td>
</tr>
<tr>
<td>L L</td>
<td>L H</td>
</tr>
<tr>
<td>L H</td>
<td>L H</td>
</tr>
<tr>
<td>H L</td>
<td>L H</td>
</tr>
<tr>
<td>H H</td>
<td>L H</td>
</tr>
<tr>
<td>× ×</td>
<td>× L</td>
</tr>
</tbody>
</table>

### 3-line to 8-line Decoder / 1-line to 8-line Demultiplexer

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>Enable</td>
</tr>
<tr>
<td>C B A</td>
<td>G</td>
</tr>
<tr>
<td>× × ×</td>
<td>H</td>
</tr>
<tr>
<td>L L L</td>
<td>L</td>
</tr>
<tr>
<td>L L H</td>
<td>L</td>
</tr>
<tr>
<td>L H L</td>
<td>L</td>
</tr>
<tr>
<td>L H H</td>
<td>L</td>
</tr>
<tr>
<td>H L L</td>
<td>L</td>
</tr>
<tr>
<td>H L H</td>
<td>L</td>
</tr>
<tr>
<td>H H L</td>
<td>L</td>
</tr>
<tr>
<td>H H H</td>
<td>L</td>
</tr>
</tbody>
</table>

**Note:**
1. H: High level
2. L: Low level
3. X: Either H or L; it doesn’t matter
4. C: 1G/2C inputs connected between them
5. G: 1G/2G inputs connected between them
High-Speed CMOS Logic MN74HC Series

■ Logic Diagram

Enable 1G
Data 1C
Select B
Select A
Data 2C
Enable 2G

Enable 2G
Data 2C
Select A
Select B
Data 1C
Enable 1G

■ Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vi, Vo</td>
<td>−0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IiK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IiO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, IiND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC155</td>
<td>Ta=−40~+60°C</td>
<td>Pd</td>
<td>400 mW</td>
</tr>
<tr>
<td>MN74HC155S</td>
<td>Ta=+60~+85°C</td>
<td>Pd</td>
<td>275 mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td>MN74HC155</td>
<td>Ta=−40~+60°C</td>
<td>Pd</td>
</tr>
<tr>
<td></td>
<td>MN74HC155S</td>
<td>Ta=+60~+85°C</td>
<td>Pd</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

■ Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vi, Vo</td>
<td>0~Vcc</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>Ta</td>
<td>−40~+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
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</table>
### DC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>$V_I$</td>
<td>1.5</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$I_O$</td>
<td>3.15</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>4.2</td>
<td>max.</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>$V_I$</td>
<td>0.3</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$I_O$</td>
<td>0.9</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.2</td>
<td>max.</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_I=V_{IH}$</td>
<td>1.9</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>4.4</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}$</td>
<td>5.9</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>3.86</td>
<td>min.</td>
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<td>6.0</td>
<td>$V_{IL}$</td>
<td>5.36</td>
<td>typ.</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$V_I=V_{IL}$</td>
<td>0.0</td>
<td>min.</td>
</tr>
<tr>
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<td></td>
<td>4.5</td>
<td>$V_{IL}$</td>
<td>0.0</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>0.0</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$</td>
<td>±0.1</td>
<td>typ.</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$</td>
<td>8.0</td>
<td>min.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>$I_O=0$</td>
<td></td>
<td>max.</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

MN74HC155/MN74HC155S

**AC Characteristics (GND=0V, Input transition time ≤6ns, \(C_L=50\text{pF}\))**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>(t_{TLH})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>95 ns</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
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<tr>
<td>Output fall time</td>
<td>(t_{THL})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>95 ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td>7</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time A, B→Y (L→H)</td>
<td>(t_{PLH})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>155 ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time A, B→Y (H→L)</td>
<td>(t_{PHL})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>155 ns</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time 1G, 2C, 2G→Y (L→H)</td>
<td>(t_{PLH})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>155 ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>14</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
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<tr>
<td>Propagation time 1G, 2C, 2G→Y (H→L)</td>
<td>(t_{PHL})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>155 ns</td>
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<td>26</td>
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<tr>
<td>Propagation time 1C→Y (L→H)</td>
<td>(t_{PLH})</td>
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<td>Min. typ. max.</td>
<td>155 ns</td>
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<td>6.0</td>
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<td>21</td>
<td>26</td>
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<tr>
<td>Propagation time 1C→Y (H→Y)</td>
<td>(t_{PHL})</td>
<td>2.0</td>
<td></td>
<td>Min. typ. max.</td>
<td>155 ns</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
</tbody>
</table>

* Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (\(t_{PLH}, t_{PHL}\))

2. Waveforms

---

Panasonic
**MN74HC157/MN74HC157S**

Quad 2-Input Multiplexers

**Description**

MN74HC157/MN74HC157S contain quad 2-input multiplexer circuits which select one of two data. Strobe and select inputs are common to each output of the quad circuits, all outputs become “L”. 1-input data is selected from each of 2-input signals depending on the state of the select input, and is transferred to quad outputs. The selected input data is transferred to output by in-phase. Adoption of a silicon date CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL; and LS TTL 10-inputs can be directly driven.

Resistors and diodes are used in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strobe G</td>
<td>Select S</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VІ, Vо</td>
<td>-0.5 ~ VCC + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IіK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iо</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IГND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th></th>
<th>MN74HC157</th>
<th>Ta=−40~+60°C</th>
<th>P₀</th>
<th>400</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MN74HC157S</td>
<td>Ta=−40~+60°C</td>
<td>P₀</td>
<td>275</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VІ, Vо</td>
<td>0 ~ VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>Ta</td>
<td>-40 ~ +85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>0 ~ 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 ~ 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 ~ 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VІ, Iо</td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>VІH</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
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<td>4.5</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>VІL</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>VОH</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
<td></td>
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</tr>
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<tr>
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<td>6.0</td>
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<td></td>
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</tr>
<tr>
<td>Output LOW voltage</td>
<td>VОL</td>
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<td></td>
<td></td>
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<tr>
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<td>4.5</td>
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<td></td>
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</tr>
<tr>
<td>Input current</td>
<td>IІ</td>
<td>6.0</td>
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<td>Quiescent supply current</td>
<td>IСC</td>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50pF \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = 25^\circ C )</td>
<td>( T_a = -40^\circ C \sim +85^\circ C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
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<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time A, B→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
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<tr>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time A, B→Y (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>11</td>
<td>20</td>
</tr>
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<td></td>
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<td>4.5</td>
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</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time S→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
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<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<tr>
<td>Propagation time S→Y (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
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<td>14</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
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<td>6.0</td>
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</tr>
<tr>
<td>Propagation time ( \bar{G} \rightarrow Y ) (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( \bar{G} \rightarrow Y ) (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (\( t_{PLH}, t_{PHL} \))
  2. Waveforms

![Waveforms Diagram](image-url)
MN74HC158/MN74HC158S
Quad 2-Input Multiplexers (Inverted Output)

- **Description**
  MN74HC158/MN74HC158S contain quad 2-input multiplexer circuits which select one of two data. Strobe and select input is common, and, when it is "H", all output become "H". When strobe input is "L", 1-input data is selected from each of 2-input signals depending on the state of the select input, and is transferred to each of the quad outputs. Then, the selected input data is transferred to output inverted. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL; LS TTL 10-inputs can be directly driven. Resistors and diodes are used in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strobe G</td>
<td>Select S</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note
1 × Either HIGH or LOW, it doesn’t matter

- **Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC158</td>
<td>$P_{D}$</td>
<td>400 mW</td>
<td></td>
</tr>
<tr>
<td>MN74HC158S</td>
<td>$P_{D}$</td>
<td>275 mW</td>
<td></td>
</tr>
</tbody>
</table>

*Decrease to 200mW at the rate of 8mW/°C*

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0 \sim $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{R}, t_{f}$</td>
<td>2.0</td>
<td>0 \sim 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 \sim 500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 \sim 400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>$V_{I}$ &amp; $I_{O}$</td>
<td>$T_{A}=25$°C</td>
<td>$T_{A}=-40 \sim +85$°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.0</td>
<td>1.5</td>
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<tr>
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<td></td>
<td>6.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td></td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>$V_{I}$ &amp; $I_{O}$</td>
<td>$T_{A}=25$°C</td>
<td>$T_{A}=-40 \sim +85$°C</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>3.0</td>
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<td>6.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

| Output HIGH voltage           | $V_{OH}$ | 2.0 | $V_{I}$ & $I_{O}$ | $T_{A}=25$°C | $T_{A}=-40 \sim +85$°C | |
|                               |        | 4.5 | 3.0 | 1.5 | 1.5 | V |
|                               |        | 6.0 | 4.0 | 3.0 | 3.0 | V |
| Output LOW voltage            | $V_{OL}$ | 2.0 | $V_{I}$ & $I_{O}$ | $T_{A}=25$°C | $T_{A}=-40 \sim +85$°C | |
|                               |        | 4.5 | 3.0 | 1.5 | 1.5 | V |
|                               |        | 6.0 | 4.0 | 3.0 | 3.0 | V |
| Input current                 | $I_{I}$ | 6.0 | $V_{I}=V_{CC}$ or GND | 0.0 | 0.1 | V |
| Quiescent supply current      | $I_{CC}$ | 6.0 | $V_{I}=V_{CC}$ or GND, $I_{O}=0$ | 8.0 | 80.0 | μA |
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = 25^\circ C )</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td>Output rise time</td>
<td>t_{PLH}</td>
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<td></td>
<td>75</td>
<td>15</td>
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<tr>
<td></td>
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<td>4.5</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{PLH}</td>
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<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<tr>
<td>Propagation time A, B → \overline{Y} (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
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<td></td>
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<td>4.5</td>
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<td></td>
<td>6.0</td>
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<tr>
<td>Propagation time A, B → \overline{Y} (H→L)</td>
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<td>15</td>
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<td>4.5</td>
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<td>6.0</td>
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</tr>
<tr>
<td>Propagation time S → \overline{Y} (L→H)</td>
<td>t_{PLH}</td>
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<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time S → \overline{Y} (H→L)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
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<td>6.0</td>
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</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit
2. Waveforms
MN74HC160/MN74HC160S

Synchronous Decade Counter with Asynchronous Clear

**Description**

MN74HC160/MN74HC160S are pre-settable synchronous decade counters with an internal carry-look-ahead system which makes possible high-speed counter applications. Outputs of all flip-flop change at the rising edge of clock input. Since this counter is perfectly programmable, the output can be preset to both “H” and “L” by using load input. Four flip-flops are preset synchronously with the rising edge of clock input. When load input is “L”, the counter stops its function, and the data corresponding with input data to be set at next clock pulse, regardless of the enable input level, appears in the output. Even if the load input becomes “H” before the rising edge of clock input, the counter doesn’t operate. Clear operates asynchronously, and, when clear input is “L”, it operates regardless of load or enable input level.

The carry-look-ahead circuit is used for cascade connection of an n bit synchronous counter without additional components. These junctions are performed by the enable input (ENP-ENT) of two active “HIGH” and ripple-carry (RC) outputs. When both enable inputs P and T are “H”, the count can be enabled.

Ripple-carry output becomes almost the same width as output \( Q_n \) “H”.

This “H” overflow ripple-carry pulse is used to enable each connected stage to cascade. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL. Resistors and diodes are used in the \( V_{CC} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>ENP</th>
<th>ENT</th>
<th>LOAD</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Clear</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>Count disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>∫</td>
<td>H</td>
<td>X</td>
<td>X</td>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>∫</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Increment Counter</td>
</tr>
</tbody>
</table>

Note:
1. \( ∫ \): When clock rises from LOW to HIGH, output increments and counts. When the load is LOW, input data is loaded.
2. \( X \): Either HIGH or LOW; it doesn’t matter.
High-Speed CMOS Logic MN74HC Series

MN74HC160/MN74HC160S

- Logic Diagram

- Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 - +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 - V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IP}$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OP}$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$ mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC, I_GND}$</td>
<td>$\pm 50$ mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 - +150$ °C</td>
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</table>

- Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MN74HC160</th>
<th>MN74HC160S</th>
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</thead>
<tbody>
<tr>
<td>Ta=−40−+60°C</td>
<td>PD</td>
<td>400</td>
</tr>
<tr>
<td>Ta=+60−+85°C</td>
<td>PD</td>
<td>275</td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
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</tr>
<tr>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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</tr>
</tbody>
</table>

- Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 - 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>0 - $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 - +85$ °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2.0 - 0 - 1000 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 - 0 - 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 - 0 - 400 ns</td>
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</tbody>
</table>
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature ( T_a=25^\circ C )</th>
<th>( T_a=-40^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_I )</td>
<td>( I_O )</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td></td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>3.15</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td></td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0.9</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.2</td>
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</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>( -20.0 )</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>( -20.0 )</td>
<td>4.4</td>
<td>4.5</td>
<td>4.4</td>
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<td></td>
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<td>6.0</td>
<td>( -20.0 )</td>
<td>5.9</td>
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<td>5.9</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( -4.0 )</td>
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<td>3.76</td>
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<td>( -5.2 )</td>
<td>5.26</td>
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<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
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<td>( 20.0 )</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
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<td>4.5</td>
<td>( 20.0 )</td>
<td>0.1</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>( 20.0 )</td>
<td>0.1</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( 4.0 )</td>
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<td>0.32</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( 5.2 )</td>
<td>0.37</td>
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</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND</td>
<td>±0.1</td>
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<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND, ( I_O=0 )</td>
<td>8.0</td>
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</table>

### AC Characteristics (GND=0V, Input transition time \( \leq 6 \text{ns}, C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature ( T_a=25^\circ C )</th>
<th>( T_a=-40^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<td>Output rise time</td>
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<td>95</td>
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<td>19</td>
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<td>7</td>
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<td>16</td>
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<td>Output fall time</td>
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<td>95</td>
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<td>6.0</td>
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<td>44</td>
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<td>CLK→Q_A→Q_B (L→H)</td>
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<td></td>
<td>18</td>
<td>35</td>
<td>44</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>30</td>
<td>37</td>
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</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
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<td>35</td>
<td>44</td>
</tr>
<tr>
<td>CLK→Q_A→Q_B (H→L)</td>
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<td></td>
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<td>35</td>
<td>44</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>30</td>
<td>37</td>
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</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
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<td>220</td>
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<td>CLK→RC (L→H)</td>
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<td>6.0</td>
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<td>30</td>
<td>37</td>
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<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
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<td>175</td>
<td>220</td>
<td></td>
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<tr>
<td>CLK→RC (H→L)</td>
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<td>6.0</td>
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<td>37</td>
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### AC Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td>Ta=25°C</td>
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</tr>
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<td>min.</td>
<td>typ.</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
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<tr>
<td>ENT→RC (H→L)</td>
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<td>4.5</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>17</td>
<td>35</td>
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<tr>
<td>CLR→QA→QD (H→L)</td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>CLR→RC (H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Minimum Set-up time LOAD</td>
<td>t_{ss}</td>
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<td></td>
<td>9</td>
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</tr>
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<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time A, B, C, D</td>
<td>t_{ss}</td>
<td>2.0</td>
<td></td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{h}</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
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</tr>
<tr>
<td>Minimum pulse width CLR</td>
<td>t_{w}</td>
<td>2.0</td>
<td></td>
<td>7</td>
<td>100</td>
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<td></td>
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<td>4.5</td>
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</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t_{rem}</td>
<td>2.0</td>
<td></td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
- 1. Measuring Circuit
2. Waveforms

Waveforms-1 $t_{PLH}, t_{PHL} (CLK \rightarrow Q_A \sim Q_D, RC)$

Waveforms-2 $t_{PLH}, t_{PHL} (ENT \rightarrow RC)$

Waveforms-3 $t_{PHL} (CLR \rightarrow Q_A \sim Q_D, RC)$

- Timing chart

- Diagram with timing charts and waveforms.
MN74HC161/MN74HC161S
Synchronous Binary Counter

**Description**

MN74HC161/MN74HC161S are presettable synchronous binary counters with an internal carry-look-ahead system which makes possible high-speed counter applications. Outputs of all flip-flops change at the rising edge of the clock input. Since this counter is perfectly programmable, the output can be preset to both “H” and “L” by utilizing the load input. Four flip-flops are preset synchronously with the rising edge of the clock input. When the load input is “L”, the counter stops its function, and the data corresponding with input data to be set at the next clock pulse, regardless of the enable input level, appears in the output. Even if the load input becomes “H” before the rising edge of clock input, the counter doesn’t operate. The clear function operates asynchronously, and, when clear input is “L”, it operates regardless of load or enable input level. The carry-look-ahead circuit is used for cascade connection of an n bit synchronous counter without any additional components. These functions are performed by the enable input (ENP-ENT) of two active “HIGH” and ripple-carry (RC) outputs. When both enable inputs P and T are “H”, the counter can be enabled. Ripple-carry-out becomes almost the same width as output QA “H”.

This “H” overflow ripple-carry pulse is used to enable each stage connected to cascade. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance and an operation speed equivalent to LS TTL. Resistors and diodes are used in the VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>ENP</th>
<th>ENT</th>
<th>LOAD</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Clear</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>Count disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>H</td>
<td>X</td>
<td>X</td>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>![Symbol]</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Increment Counter</td>
</tr>
</tbody>
</table>

Note:
1. ![Symbol]: When clock rises from LOW to HIGH, output increments and counts. When the load is LOW, input data is loaded.
2. X: Either HIGH or LOW; it doesn’t matter.
High-Speed CMOS Logic MN74HC Series

MN74HC161/MN74HC161S

### Logic Diagram

![Logic Diagram](image)

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vl, V0</td>
<td>-0.5 ~ Vcc + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Ipk</td>
<td>± 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>± 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>± 25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IOL</td>
<td>± 50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC161</td>
<td>Pd</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC161S</td>
<td>Pd</td>
<td>275</td>
<td>mW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td>Pd</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td>275</td>
<td></td>
<td>mW</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>1.4 ~ 6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vl, V0</td>
<td>0 ~ Vcc</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T0</td>
<td>-40 ~ +85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tR, tf</td>
<td>2.0</td>
<td>0 ~ 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 ~ 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 ~ 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

Panasonic
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>$-4.0$</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{IH}$</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>-5.2</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
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</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$T_{a=25^\circ C}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td>75</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>61</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>52</td>
<td>46</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>75</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>150</td>
<td>18</td>
</tr>
<tr>
<td>CLK→$Q_A$→$Q_D$ (L→H)</td>
<td></td>
<td>4.5</td>
<td>130</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>116</td>
<td>116</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PFL}$</td>
<td>2.0</td>
<td>150</td>
<td>18</td>
</tr>
<tr>
<td>CLK→$Q_A$→$Q_D$ (H→L)</td>
<td></td>
<td>4.5</td>
<td>130</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>116</td>
<td>116</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>175</td>
<td>17</td>
</tr>
<tr>
<td>CLK→RC (L→H)</td>
<td></td>
<td>4.5</td>
<td>165</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PFL}$</td>
<td>2.0</td>
<td>175</td>
<td>16</td>
</tr>
<tr>
<td>CLK→RC (H→L)</td>
<td></td>
<td>4.5</td>
<td>165</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>150</td>
<td>15</td>
</tr>
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</table>
### AC Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;sup&gt;T&lt;sub&gt;a&lt;/sub&gt;=25°C&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>ENT→RC (L→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>ENT→RC (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>CLR→Q&lt;sub&gt;A&lt;/sub&gt;~Q&lt;sub&gt;D&lt;/sub&gt; (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>CLR→RC (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t&lt;sub&gt;su&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>LOAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t&lt;sub&gt;su&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>A, B, C, D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t&lt;sub&gt;h&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Minimum pulse width</td>
<td>t&lt;sub&gt;W&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>CLR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit
2. Waveforms

Waveforms-1  \( t_{PLH}, t_{PHL} \) (CLK→Q_A→Q_D, RC)

```
<table>
<thead>
<tr>
<th>Event</th>
<th>Time (ns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_{PLH}</td>
<td>≤6</td>
</tr>
<tr>
<td>t_{PHL}</td>
<td>≤6</td>
</tr>
</tbody>
</table>
```

Waveforms-2  \( t_{PLH}, t_{PHL} \) (ENT→RC)

```
<table>
<thead>
<tr>
<th>Event</th>
<th>Time (ns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_{PLH}</td>
<td>≤6</td>
</tr>
<tr>
<td>t_{PHL}</td>
<td>10%</td>
</tr>
</tbody>
</table>
```

Waveforms-3  \( t_{PHL} \) (CLR→Q_A→Q_D, RC)

```
<table>
<thead>
<tr>
<th>Event</th>
<th>Time (ns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_{PLH}</td>
<td>≤6</td>
</tr>
</tbody>
</table>
```

---

**Timing chart**

- **CLR**, **LOAD**, **Data Inputs**: A, B, C, D
- **CLK**, **ENP**, **ENT**, **Outputs**: Q_A, Q_B, Q_C, Q_D, RC
- **Clear**, **Preset (Load)**, **Count**, **Inhibit**
MN74HC162/MN74HC162S

Synchronous Decade Counter with Synchronous Clear

Description
MN74HC162/MN74HC162S are presettable synchronous decade counters with an internal carry-look-ahead system which makes possible high-speed counter applications. Outputs of all flip-flops change at the rising edge of the clock input. Since this counter is perfectly programmable, the output can be preset to both “H” and “L” by utilizing the load input. Four flip-flops are preset synchronously with the rising edge of the clock input. When the load input is “L”, the counter stops its function, and the data corresponding with input data to be set at the next clock pulse, regardless of the enable input level, appears in the output. Even if the load input becomes “H” before the rising edge of clock input, the counter doesn’t operate. The clear function operates with clock synchronously, and, when clear input is “L”, it operates on the rising edge of clock input. The carry-look-ahead circuit is used for cascade connection of an n bit synchronous counter without any additional components. These functions are performed by the enable input (ENP-ENT) of two active “HIGH” and ripple-carry (RC) outputs. When both enable inputs P and T are “H”, the counter can be enabled. Ripple-carry-out becomes almost the same width as output $\bar{Q}_A$ “H”. This “H” overflow ripple-carry pulse is used to enable each stage connected to cascade. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance and an operation speed equivalent to LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are used in the $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

Truth Table

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>ENP</th>
<th>ENT</th>
<th>LOAD</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\uparrow$</td>
<td>L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Clear</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>Count disabled</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>$\uparrow$</td>
<td>H</td>
<td>X</td>
<td>X</td>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>$\uparrow$</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Increment Counter</td>
</tr>
</tbody>
</table>

Note:
1. $\uparrow$: When clock rises from LOW to HIGH, output increments and counts. When the load is LOW, input data is loaded.
2. X: Either HIGH or LOW; it doesn’t matter.
High-Speed CMOS Logic MN74HC Series

**Logic Diagram**

```
CLK
CLR
LOAD
ENP
ENT
A
B
C
D

MN74HC162/MN74HC162S

Qc
Qb
QA
Qd
RC

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5−+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vt,Vo</td>
<td>−0.5−VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIN</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>ION</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC,IGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65−+150</td>
<td>°C</td>
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<table>
<thead>
<tr>
<th>Power dissipation</th>
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<tr>
<td>MN74HC162</td>
<td>Pd</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=−40−+60°C</td>
<td></td>
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</tr>
<tr>
<td>Ta=+60−+85°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
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<tr>
<td>MN74HC162S</td>
<td>PD</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>Ta=−40−+60°C</td>
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<td></td>
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<tr>
<td>Ta=+60−+85°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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**Operating Conditions**

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
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<tr>
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<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vt,Vo</td>
<td>0−VCC</td>
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<td>V</td>
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<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>−40−+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr,tf</td>
<td>2.0−1000</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5−500</td>
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<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>6.0−400</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

Panasonic
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>Temperature</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>$Ta=25{}^\circ C$</td>
<td>$Ta=-40{}^\circ C +85{}^\circ C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
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<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td></td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td></td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
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<td>5.9</td>
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<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>3.86</td>
<td>3.76</td>
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<td>0.32</td>
<td>0.37</td>
<td>0.32</td>
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<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td></td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
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<td></td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
<td>80.0</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time $\leq 6$ns, $C_{L}=50$pf)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>$Ta=25{}^\circ C$</th>
<th>$Ta=-40{}^\circ C +85{}^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TH}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
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<td>7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{FL}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
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<td>15</td>
<td>95</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
<td>13</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PL}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>19</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>CLK→$Q_{A}$→$Q_{B}$ (L→H)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;H&quot;</td>
<td>30</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PH}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>18</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>CLK→$Q_{A}$→$Q_{B}$ (H→L)</td>
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<td>4.5</td>
<td>LOAD=&quot;H&quot;</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>35</td>
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<td></td>
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<tr>
<td>E Propagation time</td>
<td>$t_{PL}$</td>
<td>2.0</td>
<td>LOAD=&quot;L&quot;</td>
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<td>220</td>
</tr>
<tr>
<td>CLK→$Q_{A}$→$Q_{B}$ (L→H)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;L&quot;</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>35</td>
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<td></td>
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<tr>
<td>E Propagation time</td>
<td>$t_{PH}$</td>
<td>2.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>18</td>
<td>35</td>
<td>220</td>
</tr>
<tr>
<td>CLK→$Q_{A}$→$Q_{B}$ (H→L)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;L&quot;</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>35</td>
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</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature Condition</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a=25^\circ \text{C} )</td>
<td>( T_a=-40^\circ \text{C} )</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<td>typ.</td>
</tr>
<tr>
<td>E Propagation time CLK→RC (L→H)</td>
<td>( t_{PLH} )</td>
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<td>200</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>25</td>
<td>40</td>
<td>200</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
<td>25</td>
<td>40</td>
<td>200</td>
</tr>
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<td>200</td>
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<td>6.0</td>
<td>23</td>
<td>40</td>
<td>200</td>
</tr>
<tr>
<td>E Propagation time ENT→RC (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
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<td>30</td>
<td>150</td>
</tr>
<tr>
<td>E Propagation time ENT→RC (H→L)</td>
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<td>35</td>
<td>175</td>
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<td>17</td>
<td>35</td>
<td>175</td>
</tr>
<tr>
<td>Minimum Set-up time LOAD</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td>13</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
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<td>4.5</td>
<td>13</td>
<td>25</td>
<td>125</td>
</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Minimum Set-up time A, B, C, D</td>
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<td>20</td>
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</tr>
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<td>6.0</td>
<td>6</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Minimum Set-up time CLR</td>
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<tr>
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<td>4.5</td>
<td>13</td>
<td>25</td>
<td>125</td>
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<td>6.0</td>
<td>13</td>
<td>25</td>
<td>125</td>
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<td>Minimum Hold time</td>
<td>( t_{h} )</td>
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<tr>
<td>Minimum pulse width CLK</td>
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<td>11</td>
<td>20</td>
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<td>Minimum recovery time</td>
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<td>125</td>
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<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>2.0</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>30</td>
<td>56</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>30</td>
<td>56</td>
<td>5</td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

Waveforms-1 \( t_{PLH}, t_{PHL} \) (CLK → Q_A → Q_D, RC)

Waveforms-2 \( t_{PLH}, t_{PHL} \) (ENT → RC)

Typical Operating Conditions
MN74HC163/MN74HC163S

Synchronous Binary Counter with Synchronous Clear

**Description**
MN74HC163/MN74HC163S are presettable synchronous binary counters with an internal carry-look-ahead system which makes possible high-speed counter applications. Outputs of all flip-flops change at the rising edge of the clock input. Since this counter is perfectly programmable, the output can be preset to both “H” and “L” by utilizing the load input. Four flip-flops are preset synchronously with the rising edge of the clock input. When the load input is “L”, the counter stops its function, and the data corresponding with input data to be set at the next clock pulse, regardless of the enable input level, appears in the output. Even if the load input becomes “H” before the rising edge of clock input, the counter doesn’t operate. The clear function operates with clock synchronously, and, when clear input is “L”, it operates on the rising edge of clock input. The carry-look-ahead circuit is used for cascade connection of an n bit synchronous counter without any additional components. These functions are performed by the enable input (ENP-ENT) of two active “HIGH” and ripple-carry (RC) outputs. When both enable inputs P and T are “H”, the counter can be enabled. Ripple-carry-out becomes almost the same width as output $Q_A$ “H”. This “H” overflow ripple-carry pulse is used to enable each stage connected to cascade. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance and an operation speed equivalent to LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are used in the $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>ENP</th>
<th>ENT</th>
<th>LOAD</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\uparrow$</td>
<td>L</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>Clear</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>Count disabled</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>Count &amp; RC disabled</td>
</tr>
<tr>
<td>$\uparrow$</td>
<td>H</td>
<td>×</td>
<td>×</td>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>$\uparrow$</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Increment Counter</td>
</tr>
</tbody>
</table>

**Note:**
1. When clock rises from LOW to HIGH, output increments and counts. When the load is LOW, input data is loaded.
2. Either HIGH or LOW, it doesn’t matter
### Logic Diagram

- **CLK**
- **CLR**
- **LOAD**
- **ENP**
- **ENT**
- **A**
- **B**
- **C**
- **D**

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>-0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC163</th>
<th>Ta=-40~+60°C</th>
<th>PD</th>
<th>400</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MN74HC163S</td>
<td>Ta=-40~+60°C</td>
<td>PD</td>
<td>275</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>0~VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40~+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$Ta=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or $V_{IH}$</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>-4.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-5.2</td>
<td>mA</td>
<td>5.36</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or 20.0</td>
<td>μA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>4.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>±0.1</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time $\leq 6$ns, $C_L=50$ pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$Ta=25^\circ C$</td>
<td>$Ta=-40\sim +85^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q_A→Q_B (L→H)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;H&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q_A→Q_B (H→L)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q_A→Q_B (L→H)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q_A→Q_B (H→L)</td>
<td></td>
<td>4.5</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>LOAD=&quot;L&quot;</td>
<td>15</td>
<td>25</td>
</tr>
</tbody>
</table>

---

Panasonic
## AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature Condition</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
</tr>
<tr>
<td>E Propagation time CLK→RC (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>24</td>
</tr>
<tr>
<td>E Propagation time CLK→RC (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>20</td>
</tr>
<tr>
<td>E Propagation time ENT→RC (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
</tr>
<tr>
<td>E Propagation time ENT→RC (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>16</td>
</tr>
<tr>
<td>Minimum Set-up time LOAD</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
</tr>
<tr>
<td>Minimum Set-up time A, B, C, D</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Minimum Set-up time CLR</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>11</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_h )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>—</td>
</tr>
<tr>
<td>Minimum CLR pulse width</td>
<td>( t_{w} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>16</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Waveforms-1 t_{PLH}, t_{PHL} (CLK→Q_A→Q_D, RC)

Waveforms-2 t_{PLH}, t_{PHL} (ENL→RC)

Typical Operating Conditions

- CLR
- LOAD
- (Synchronous)
- Data Inputs
- A
- B
- C
- D
- CLK
- ENP
- ENT
- Outputs
- Q_A
- Q_B
- Q_C
- Q_D
- RC
- CLR
- LOAD
- Count
- Inhibit

Panasonic
Description

MN74HC164/MN74HC164S is 8-bit shift register with gated serial input and asynchronous clear input. Gated serial input (A, B) control data input. When a LOW is applied to either or both, data input stops and the initial flip-flop is reset to "L" by the next clock pulse. When one input is "H", other inputs become enabled, and data is input to the initial flip-flop by the next clock pulse. Serial input data is not input, when clock is "H" or "L". But, data satisfying the set-up conditions clock rise at all times. Clear functions, when clear input is "L" regardless of clock.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLR</td>
<td>CLK</td>
</tr>
<tr>
<td>L</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

Logic Diagram
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5～+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vᵢ, Vₒ</td>
<td>−0.5～VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Iᵢₚ</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iₒₚ</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Iₒ</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Iground</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65～+150</td>
<td>℃</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC164</th>
<th>MN74HC164S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tᵢ=−40~+60℃</td>
<td>PD</td>
<td>400</td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 8mW/℃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tᵢ=+60~+85℃</td>
<td>PD</td>
<td>275</td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 3.8mW/℃</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>1.4～6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vᵢ, Vₒ</td>
<td>0～Vcc</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>Tᵢ</td>
<td>−40～+85</td>
<td>℃</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tᵣ, tᵣ</td>
<td>2.0</td>
<td>0～1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0～500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
<td>0～400</td>
<td>ns</td>
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### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vᵢ</td>
<td>Iₒ</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V₉H</td>
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<td>6.0</td>
<td>4.2</td>
<td>min.</td>
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<td>Input LOW voltage</td>
<td>V₉L</td>
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<td>0.3</td>
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<td>1.2</td>
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<td>μA</td>
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<td>4.5</td>
<td>−20.0</td>
<td>μA</td>
</tr>
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<td></td>
<td>or</td>
<td>6.0</td>
<td>−20.0</td>
<td>μA</td>
</tr>
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<td></td>
<td>4.5</td>
<td>−4.0</td>
<td>mA</td>
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<td>−5.2</td>
<td>mA</td>
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<td>Output LOW voltage</td>
<td>V₀₉L</td>
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<td>20.0</td>
<td>μA</td>
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<td>20.0</td>
<td>μA</td>
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<td>5.2</td>
<td>mA</td>
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<td>Input current</td>
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<td>Quiescent supply current</td>
<td>Icc</td>
<td>6.0</td>
<td>Vᵢ=Vcc or GND, Iₒ=0</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<td>Ta=25°C</td>
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<td>typ.</td>
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<td>15</td>
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<td>7</td>
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<tr>
<td>Output fall time</td>
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<td>16</td>
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<tr>
<td>E Propagation time CLK→Q(L→H)</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
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<td>150</td>
<td>30</td>
<td>38</td>
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<td>4.5</td>
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<td>15</td>
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<tr>
<td>E Propagation time CLK→Q(H→K)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
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<td>150</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>26</td>
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<tr>
<td>E Propagation time CLR→Q(L→H)</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
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<td>150</td>
<td>30</td>
<td>38</td>
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<tr>
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<td>4.5</td>
<td>26</td>
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<td>6.0</td>
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<tr>
<td>E Propagation time CLR→Q(H→L)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>150</td>
<td>30</td>
<td>38</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>26</td>
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<tr>
<td>Minimum pulse width CLR</td>
<td>t&lt;sub&gt;W&lt;/sub&gt;</td>
<td>2.0</td>
<td>100</td>
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<td></td>
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<td>4.5</td>
<td>17</td>
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<tr>
<td>Minimum Set-up time</td>
<td>t&lt;sub&gt;SU&lt;/sub&gt;</td>
<td>2.0</td>
<td>100</td>
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<td>4.5</td>
<td>17</td>
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<tr>
<td>Hold time minimum</td>
<td>t&lt;sub&gt;H&lt;/sub&gt;</td>
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<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td></td>
<td>6.0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
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<td>75</td>
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<td>4.5</td>
<td>13</td>
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<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>30</td>
<td>24</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>35</td>
<td>28</td>
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</table>

Panasonic
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit

![Diagram of Measuring Circuit]

2. Waveforms

Waveforms-1 \(t_{TLH}, t_{THL}, t_{PLH}/t_{PHL} (CLK \rightarrow Q), t_{SU}, f_{MAX}, t_{REM}, t_{TH}\)

Waveforms-2 \(t_{PLH}/t_{PHL} (CLR \rightarrow Q), t_{W}\)

- Typical Operating Conditions

![Waveform Diagram]

Panasonic
MN74HC165/MN74HC165S
8-Bit Parallel-Input Serial-Output Shift Register

Description
MN74HC165/MH74HC165S are high-speed 8-bit parallel-input/serial output shift register. The data is shifted from QA to QH by the clock. Parallel input at each stages works, when shift/load input is "L". These has gated clock input and complementary output from the 8th bit. When clock inhibit input is "L", the clock generates through 2 inputs NOR gate. When one of two clock inputs is "H", the internal clock stops. When shift/load input is "H", the other clock input works, if one of two clock input is maintained at LOW. The data is transferred by the rising edge of clock pulse. Parallel loading stops as long as shift/load input is "H". When shift/load input is "L", parallel input data is directly loaded to the register regardless of clock.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic Diagram

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Internal Stages</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>S/L</td>
<td>CINH CLK SI A...H</td>
<td>QA Q B QH</td>
</tr>
<tr>
<td>L</td>
<td>X X X a...h a b h</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>L L L X X QAO QBO QHO</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>L L H X H QAn QGn</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>H H X X QAO QBO QHO</td>
<td></td>
</tr>
</tbody>
</table>
# High-Speed CMOS Logic MN74HC Series

## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>¥0.5–+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_I, V_O</td>
<td>¥0.5–V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{PK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OB}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_O</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{CC,H}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{STG}</td>
<td>-65–+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation | MN74HC165 | Ta=−40–+60°C | P_D | 400 | mW | Decrease to 200mW at the rate of 8mW/°C |
|                  | MN74HC165S | Ta=+60–+85°C | P_D | 275 | mW | Decrease to 200mW at the rate of 3.8mW/°C |

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4–6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_I, V_O</td>
<td>0–V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_A</td>
<td>-40–+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>2.0</td>
<td>0–1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0–500</td>
<td>ns</td>
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<td></td>
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<td>6.0</td>
<td>0–400</td>
<td>ns</td>
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## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>min.</th>
<th>max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td>V_{IH}</td>
<td>2.0</td>
<td>V_1 = 1.5</td>
<td>T_A=25°C</td>
<td>V</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
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<tr>
<td></td>
<td>V_{IL}</td>
<td>2.0</td>
<td>V_1 = -20.0</td>
<td>T_A=−40–+85°C</td>
<td>V</td>
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<td>0.9</td>
<td>1.2</td>
<td>0.3</td>
<td>0.9</td>
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<td>V_{OH}</td>
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<tr>
<td>Input current</td>
<td>I_I</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND</td>
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<td>μA</td>
<td>±1.0</td>
<td>±1.0</td>
<td>μA</td>
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</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_O=0</td>
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<td>μA</td>
<td>80.0</td>
<td>80.0</td>
<td>μA</td>
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Panasonic
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( \text{Vcc} (\text{V}) )</th>
<th>2.0</th>
<th>4.5</th>
<th>6.0</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Ta=25°C</th>
<th>Ta=−40~+85°C</th>
<th>Unit</th>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
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<td>( t_{TLH} )</td>
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<td>6.0</td>
<td>6</td>
<td>15</td>
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<td>16</td>
<td>ns</td>
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<tr>
<td>E Propagation time</td>
<td>( t_{PLH} )</td>
<td>( \text{CLK} \rightarrow \overline{Q}, \overline{\overline{Q}} (\text{L} \rightarrow \text{H}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PHL} )</td>
<td>( \text{CLK} \rightarrow Q, \overline{Q} (\text{H} \rightarrow \text{L}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PLH} )</td>
<td>( S/L \rightarrow Q, \overline{Q} (\text{L} \rightarrow \text{H}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PHL} )</td>
<td>( S/L \rightarrow Q, \overline{Q} (\text{H} \rightarrow \text{L}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PLH} )</td>
<td>( \text{H} \rightarrow \overline{Q} (\text{L} \rightarrow \text{H}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PHL} )</td>
<td>( \text{H} \rightarrow \overline{Q} (\text{H} \rightarrow \text{L}) )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>150</td>
<td>30</td>
<td>190</td>
<td>38</td>
<td>ns</td>
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<tr>
<td>Minimum Set-up time</td>
<td>( t_{SU} )</td>
<td></td>
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<td>4.5</td>
<td>6.0</td>
<td>100</td>
<td>20</td>
<td>125</td>
<td>25</td>
<td>ns</td>
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<tr>
<td>Minimum Hold time</td>
<td>( t_{H} )</td>
<td></td>
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<td>4.5</td>
<td>6.0</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
<td>30</td>
<td>4</td>
<td>24</td>
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</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

![Switching Time Measuring Circuit](image)

2. Waveforms

![Waveforms](image)

- Typical Operating Conditions

![Typical Operating Conditions](image)
MN74HC166/MN74HC166S

Parallel-load 8-bit shift Registers

**Description**
MN74HC166/MN74HC166S are high-speed, parallel-load 8-bit shift registers. The parallel-input or serial-input mode can be selected by the serial/load input.
When this input is HIGH, the serial-data input functions, and data are shifted from $Q_A$ to $Q_H$ by clock pulse.
When this input is LOW, however, the parallel-data input functions, and data are loaded by clock pulse.
When the input used as the clock pulse inhibit function is LOW, the internal clock pulses are generated through the two-input NOR gate.
Internal clock pulses are inhibited when either one of the clock inputs is held at HIGH. Data transmission is made at the positive going edge of the clock pulse.
A buffer has been added to the gate output, thus improving the input/output transmission characteristics; fluctuations of the transmission time resulting from increasing the load capacity are suppressed to the minimum and, Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{cc}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLR</th>
<th>S/L</th>
<th>CINH</th>
<th>CLK</th>
<th>SI</th>
<th>Parallel A ... H</th>
<th>QA</th>
<th>QB</th>
<th>QH</th>
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</thead>
<tbody>
<tr>
<td>L</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>L</td>
<td>L</td>
<td>×</td>
<td>×</td>
<td>QA0</td>
<td>QB0</td>
<td>QH0</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>×</td>
<td>a . h</td>
<td>a</td>
<td>b</td>
<td>h</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>×</td>
<td>H</td>
<td>QAan</td>
<td>QGn</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>×</td>
<td>L</td>
<td>QAan</td>
<td>QGn</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>H</td>
<td>×</td>
<td>×</td>
<td>QA0</td>
<td>QB0</td>
<td>QH0</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. ×: Either HIGH or Low; it doesn’t matter

**Logic Diagram**

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5~+7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>$-0.5~V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65~+150$</td>
<td>°C</td>
</tr>
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</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>MN74HC166</th>
<th>Symbol</th>
<th>$P_{D}$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a=-40~+60°C$</td>
<td></td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a=+60~+85°C$</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC166S</th>
<th>Symbol</th>
<th>$P_{D}$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a=-40~+60°C$</td>
<td></td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a=+60~+85°C$</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4~6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$</td>
<td>$0~V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40~+85$°C</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>$V_{CC}=2.0V$</td>
<td>0~1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=4.5V$</td>
<td>0~500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=6.0V$</td>
<td>0~400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_a=25°C$</td>
<td>$T_a=-40~+85°C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or</td>
<td>$-4.0$</td>
<td>mA</td>
<td>4.4</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>V</td>
</tr>
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<td></td>
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<td>4.5</td>
<td>4.4</td>
<td>4.4</td>
<td>V</td>
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<tr>
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<td>6.0</td>
<td>5.9</td>
<td>5.9</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>$-4.0$</td>
<td>mA</td>
<td>3.96</td>
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<td></td>
<td></td>
<td>or</td>
<td>$-5.2$</td>
<td>mA</td>
<td>5.36</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
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<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>V</td>
</tr>
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<td>0.1</td>
<td>0.1</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>$V_{IH}$</td>
<td>$20.0$</td>
<td>$\mu A$</td>
<td>0.0</td>
</tr>
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<td></td>
<td></td>
<td>or</td>
<td>$4.0$</td>
<td>mA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>$5.2$</td>
<td>mA</td>
<td>0.32</td>
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<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_G=0$</td>
<td>8.0</td>
<td>80.0</td>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤ 6ns, $C_L=50\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
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<td></td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Propagation time CLK→QH (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>53</td>
<td>17</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td>20</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Propagation time CLK→QH (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Propagation time CLR→QH (H→L)</td>
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<td>2.0</td>
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<td>49</td>
<td>18</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td>21</td>
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<td></td>
<td>6.0</td>
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<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Minimum pulse width CLR</td>
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<td>16</td>
<td>8</td>
</tr>
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<td>4.5</td>
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<td>8</td>
<td>14</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>$t_{su}$</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>3</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>$t_h$</td>
<td>2.0</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
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<td></td>
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<td>4.5</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>$T_{rem}$</td>
<td>2.0</td>
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<td>5</td>
<td>3</td>
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<td>4.5</td>
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<td></td>
<td>6.0</td>
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<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>$f_{max}$</td>
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<td>6</td>
<td>30</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td>35</td>
<td>80</td>
</tr>
</tbody>
</table>

**Panasonic**
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Waveforms-1 \( \left( t_{TLH}, t_{THL}, t_{su}, f_{max}, t_{PLH}/t_{PHL}(\text{CLR} \rightarrow Q, Q), t_{rem}, t_{h} \right) \)

Waveforms-2 \( \left( t_{PLH}/t_{PHL}(\text{CLR} \rightarrow Q, Q), t_{w} \right) \)

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Panasonic
MN74HC173/MN74HC173S
Quad TRI-STATE D-Type Flip-Flops

Description
MN74HC173/MN74HC173S are TRI-STATE quad D-type flip-flops. Quad D-type flip-flops are synchronously operated by common clock. When one or either of output control (M, N) become “H”, output turns to be tri-state mode and become ineffective. But, it doesn’t effect the continuous operation of flip-flops. When one of data enable input (G1, G2) becomes “H”, output Q is transferred to input and remain flip-flops at the same condition. Clear operates, when clear input is “H”. Data output operates on the rising edge of clock. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Logic Diagram

Truth Table

<table>
<thead>
<tr>
<th>CLR</th>
<th>CLK</th>
<th>Data Enable</th>
<th>Data</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
<td>X</td>
<td>Q0</td>
</tr>
<tr>
<td>L</td>
<td>✓</td>
<td>H</td>
<td>X</td>
<td>Q0</td>
</tr>
<tr>
<td>L</td>
<td>✓</td>
<td>X</td>
<td>H</td>
<td>Q0</td>
</tr>
<tr>
<td>L</td>
<td>✓</td>
<td>L</td>
<td>L</td>
<td>Q0</td>
</tr>
<tr>
<td>L</td>
<td>✓</td>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. ✓: Rise of positive direction
3. Q0: Q level prior to determination of input condition shown in table
4. When one or either of M, N is “H”, output turns to high impedance and becomes ineffective. But, it doesn’t effect the continuous operation of flip-flops.
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 - +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>$-0.5 - V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>MN74HC173</th>
<th>$P_D$</th>
<th>400</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40 - +60 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_a = +60 - +85 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC173S</th>
<th>$P_D$</th>
<th>275</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40 - +60 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_a = +60 - +85 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of 8mW/°C

Decrease to 200mW at the rate of 3.8mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 - 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>0 - $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 - +85 \degree C$</td>
<td>\degree C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>2.0 - 1000 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 - 500 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 - 400 ns</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$, $I_O$</td>
<td>$T_a = 25 \degree C$</td>
<td>$T_a = -40 - +85 \degree C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>min. typ. max. min. max.</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>$\mu A$</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>5.9</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_{IH}$ -20.0</td>
<td>$\mu A$</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>5.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$ -6.0</td>
<td>$mA$</td>
<td>0.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$V_{IH}$ -20.0</td>
<td>$\mu A$</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$ 6.0</td>
<td>$mA$</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I = V_{CC}$ or GND</td>
<td>$\mu A$</td>
<td>0.1</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_I = V_{IH}$ or $V_{IL}$</td>
<td>$V_O = V_{CC}$ or GND</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I = V_{CC}$ or GND, $I_O = 0$</td>
<td>$\mu A$</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Panasonic
# AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\, \text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \text{Ta}=25^\circ\text{C} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \text{Ta}=-40^\circ\text{C} +85^\circ\text{C} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Propagation time ( \text{CLK→Q} (L→H) )</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>75</td>
</tr>
<tr>
<td>Propagation time ( \text{CLK→Q} (H→L) )</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>75</td>
</tr>
<tr>
<td>Minimum pulse width ( \text{CLR} )</td>
<td>t_{w}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>100</td>
</tr>
<tr>
<td>3-state propagation time ( (H→Z) )</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>100</td>
</tr>
<tr>
<td>3-state propagation time ( (L→Z) )</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>125</td>
</tr>
<tr>
<td>3-state propagation time ( (Z→H) )</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>100</td>
</tr>
<tr>
<td>3-state propagation time ( (Z→L) )</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>125</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t_{su}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>100</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{h}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>—</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t_{rem}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>100</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
</tbody>
</table>

---

Panasonic
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Switching Waveforms

Waveforms-1

Waveforms-2

[2] tPHZ, tPZH

1. Measuring Circuit

2. Switching Waveforms

[3] tPLZ, tPZL

1. Measuring Circuit

2. Switching Waveforms

High-Speed CMOS Logic MN74HC Series

MN74HC174/MN74HC174S

Hex D-Type Flip-Flops with Clear

Description
MN74HC174/MN74HC174S contain six D-type flip-flop circuits with clear in one chip, and this master/slave flip-flop has common clock and clear. D-input data to be met to set-up time is transferred to output Q at the positive going edge of the clock pulse. When the clear input is “L”, all outputs are set to “L”. Adoption of a silicon gate CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL; LS TTL 10-inputs can be directly driven. Resistors and diodes are used in the Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>CLR</td>
<td>CLK</td>
</tr>
<tr>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. ×: Data input is transferred to output on the positive going edge from LOW to HIGH of the clock
2. ×: Either HIGH or LOW; it doesn’t matter
3. Qo: Q level prior to determination of input condition shown in table

Logic Diagram
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V&lt;sub&gt;cc&lt;/sub&gt;</td>
<td>−0.5~+7.0 V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;o&lt;/sub&gt;</td>
<td>−0.5~V&lt;sub&gt;cc&lt;/sub&gt;+0.5 V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I&lt;sub&gt;K&lt;/sub&gt;</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I&lt;sub&gt;OK&lt;/sub&gt;</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>±25 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;, I&lt;sub&gt;GD&lt;/sub&gt;</td>
<td>±50 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>−65~+150 ℃</td>
<td></td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th></th>
<th>MN74HC174</th>
<th></th>
<th>MN74HC174S</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=−40~+60℃</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>400 mW</td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>275 mW</td>
</tr>
<tr>
<td>Ta=+60~+85℃</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/℃</td>
<td>Decrease to 200mW at the rate of 3.8mW/℃</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;cc&lt;/sub&gt; (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V&lt;sub&gt;cc&lt;/sub&gt;</td>
<td>1.4~6.0 V</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;o&lt;/sub&gt;</td>
<td>0~V&lt;sub&gt;cc&lt;/sub&gt;</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;a&lt;/sub&gt;</td>
<td>−40~+85 ℃</td>
<td></td>
<td>℃</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t&lt;sub&gt;r&lt;/sub&gt;, t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>2.0 ns, 4.5 ns, 6.0 ns</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;cc&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V&lt;sub&gt;I&lt;/sub&gt;</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td>1.5, 3.15, 4.2</td>
<td>1.5, 3.15, 4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V&lt;sub&gt;L&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td>0.3, 0.9, 1.2</td>
<td>0.3, 0.9, 1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td>−20.0, 5.9, 6.0</td>
<td>1.9, 4.4, 5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
<td>μA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td>20.0, 4.0, 5.2</td>
<td>0.0, 0.0, 0.0</td>
</tr>
<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0 V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;cc&lt;/sub&gt; or GND</td>
<td>±0.1</td>
<td>±1.0 μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0 V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;cc&lt;/sub&gt; or GND, I&lt;sub&gt;O&lt;/sub&gt;=0</td>
<td>8.0</td>
<td>80.0 μA</td>
</tr>
</tbody>
</table>
## AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>125</td>
</tr>
<tr>
<td>CLK→Q (L→H)</td>
<td></td>
<td>2.0</td>
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<td>4.5</td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
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<td>125</td>
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<tr>
<td>CLK→Q (H→L)</td>
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<td>4.5</td>
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<tr>
<td>Propagation time</td>
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</tr>
<tr>
<td>CLR→Q (H→L)</td>
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<td>Minimum Set-up time</td>
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<tr>
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<td>t_{H}</td>
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<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>—</td>
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<tr>
<td>Minimum pulse width</td>
<td>t_{W}</td>
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<td>100</td>
</tr>
<tr>
<td>C L R</td>
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<td>6.0</td>
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<td>4.5</td>
<td>6.0</td>
<td>17</td>
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<tr>
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<td>Maximum clock frequency</td>
<td>f_{max}</td>
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• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit \((t_{PLH}, t_{PHL})\)

2. Waveforms

Waveforms—1 \((t_{TLH}, t_{THL}, t_{SU}, f_{MAX},\) \(t_{PLH}/t_{PHL}(CLK\rightarrow Q), t_{REM}, t_{H}\))

Waveforms—2 \((t_{PHL}(CLR\rightarrow Q), t_{W})\)
MN74HC175/MN74HC175S

Quad D-Type Flip-Flops with Clear

- **Description**

MN74HC175/MN74HC175S contain four quad D-type flip-flop circuits with clear, and this circuit has common clock and clear, and complementary outputs Q and Q. D-input data is transferred to outputs Q and Q at the rising edge of the clock pulse. The output from each flip-flop circuit is a reversed phase output of the other. All flip-flops are controlled by a common clock and clear; the clear function operates when the clear input is "L", and all Q and Q outputs become “L” and “H” respectively. Adoption of the silicon gate CMOS process makes possible low power consumption and a high noise allowance; LS TTL 10-inputs can be directly driven. Resistors and diodes are used in the VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLR</td>
<td>CLK</td>
</tr>
<tr>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. ×: Data input is transferred to output on the negative-going edge from HIGH to LOW of the clock
2. ×: Either HIGH or LOW; it doesn’t matter
3. Qo: (Qo): Q (Q) level prior to determination of input condition shown in table

- **Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>MN74HC175</th>
<th>MN74HC175S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>$P_{D}$</td>
<td>$400$</td>
<td>$275$</td>
</tr>
<tr>
<td>dissipation</td>
<td></td>
<td>$mW$</td>
<td>$mW$</td>
</tr>
</tbody>
</table>

*Decrease to 200mW at the rate of 8mW/°C*

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>$2.0$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 1000$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 500$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 400$</td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_{I}$</td>
<td>$V_{O}$</td>
<td>$T_{A}=25,^\circ C$</td>
<td>$T_{A}=40 \sim +85,^\circ C$</td>
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</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$1.9$</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$4.4$</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>6.0</td>
<td>$-20.0$</td>
<td>$5.9$</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>$3.86$</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>$5.36$</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>$20.0$</td>
<td>0.0</td>
<td>μA</td>
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<td>4.5</td>
<td>$20.0$</td>
<td>0.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>6.0</td>
<td>$20.0$</td>
<td>0.0</td>
<td>μA</td>
</tr>
<tr>
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<td>$4.0$</td>
<td>0.32</td>
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<td>$5.2$</td>
<td>0.32</td>
<td>mA</td>
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<tr>
<td>Input current</td>
<td>$I_{I}$</td>
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<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
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<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
<td>μA</td>
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</table>
## AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>( T_a = +25^\circ \text{C} )</th>
<th>( T_a = -40^\circ +85^\circ \text{C} )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
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<td>Output rise time</td>
<td>( t_{TLH} )</td>
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<td>4.5</td>
<td>6.0</td>
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<td>75</td>
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<tr>
<td></td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
<td>7</td>
<td>13</td>
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<td>Output fall time</td>
<td>( t_{THL} )</td>
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<td>4.5</td>
<td>6.0</td>
<td>20</td>
<td>75</td>
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<tr>
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<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time ( \text{CLK} \rightarrow Q, \overline{Q} \ (\text{L} \rightarrow \text{H}) )</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
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<td>25</td>
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<td>6</td>
<td>21</td>
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<tr>
<td>Propagation time ( \text{CLK} \rightarrow Q, \overline{Q} \ (\text{H} \rightarrow \text{L}) )</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
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<td>15</td>
<td>25</td>
<td>31</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Propagation time ( \text{CLR} \rightarrow Q \ (\text{L} \rightarrow \text{H}) )</td>
<td>( t_{PLH} )</td>
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<td>4.5</td>
<td>6.0</td>
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<td>35</td>
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<tr>
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<td>35</td>
<td>44</td>
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<td>30</td>
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<tr>
<td>Propagation time ( \text{CLR} \rightarrow Q \ (\text{H} \rightarrow \text{L}) )</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
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<td>30</td>
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<td>17</td>
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<td>38</td>
<td>6</td>
<td>26</td>
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<tr>
<td>Minimum Set-up time</td>
<td>( t_{SU} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
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<td>3</td>
<td>20</td>
<td>25</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_h )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>---</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>---</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>0</td>
</tr>
<tr>
<td>Minimum pulse width ( \text{CLR} )</td>
<td>( t_w )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>20</td>
<td>25</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>15</td>
<td>19</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{\text{max}} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
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<td>30</td>
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<td>30</td>
<td>66</td>
<td>24</td>
<td>4</td>
<td>35</td>
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</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Waveforms-1 \( (t_{THL}, t_{TTL}, t_{SU}, f_{max}, f_{PLH}/f_{PHL}(CLK \rightarrow Q, \bar{Q}), t_{REM}, t_h) \)

Waveforms-2 \( (t_{PLH}/t_{PHL}(CLR \rightarrow Q, \bar{Q}), t_w) \)
MN74HC183/MN74HC183S

Dual Carry-Save Full Adders

- **Description**

  MN74HC183/MN74HC183S are dual carry-save full adders. \( \Sigma \) output is obtained by the sum of each bit, and the digit-carry signal from the 2nd bit's output is obtained in \( C_{n+1} \) output. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>( C_n )</th>
<th>B</th>
<th>A</th>
<th>( \Sigma )</th>
<th>( C_{n+1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
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</tr>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

  **Note:**
  1. H: High level
  2. L: Low level

- **Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{ih}$, $V_{o}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{ih}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{oh}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{o}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC183</td>
<td>TD</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>MN74HC183S</td>
<td>TD</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC183 Taus</td>
<td>$V_{CC}$</td>
<td>$-40 \sim +60$°C</td>
<td></td>
</tr>
<tr>
<td>MN74HC183 PD</td>
<td>$T_{a}$</td>
<td>$-40 \sim +60$°C</td>
<td></td>
</tr>
<tr>
<td>MN74HC183S PD</td>
<td>$V_{CC}$</td>
<td>$-40 \sim +60$°C</td>
<td></td>
</tr>
<tr>
<td>MN74HC183S PD</td>
<td>$T_{a}$</td>
<td>$-40 \sim +60$°C</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

| Parameter                                | Symbol | $V_{CC}$ ($V$) | Rating | Unit   |
|-----------------------------------------|--------|----------------|--------|
| Operating supply voltage                | $V_{CC}$ | $1.4 \sim 6.0$ | $V$    |
| Input/output                            | $V_{ih}$, $V_{o}$ | $0 \sim V_{CC}$ | $V$    |
| Operating temperature range             | $T_{a}$ | $-40 \sim +85$°C | °C     |
| Input rise and fall time                | $t_{r}, t_{f}$ | $0 \sim 1000$ | ns     |
|                                        | $V_{CC}$ | $4.5 \sim 6.0$ | ns     |
|                                        | $V_{CC}$ | $4.0 \sim 6.0$ | ns     |

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ ($V$)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{i}$</td>
<td>$I_{o}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td>Input HIGH voltage</td>
<td>$V_{ih}$</td>
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<td>1.5</td>
<td>3.15</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<tr>
<td>Input LOW voltage</td>
<td>$V_{il}$</td>
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<td>0.3</td>
<td>0.9</td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
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<td>Output HIGH voltage</td>
<td>$V_{oh}$</td>
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<td>$-20.0$</td>
<td>$\mu A$</td>
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<td>4.5</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
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<td></td>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{ol}$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td></td>
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<td>4.5</td>
<td>4.0</td>
<td>mA</td>
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<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{i}$</td>
<td>6.0</td>
<td>$V_{i}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{i}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
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High-Speed CMOS Logic MN74HC Series

MN74HC183/MN74HC183S

AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_CC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

-50% 50% 90% 10%

Input

Positive Output

Negative Output

≤6ns ≤6ns
4-Bit Bidirectional Universal Shift Register

- **Description**

MN74HC194/MN74HC194S is bidirectional shift register composed of parallel input, parallel output, right shift/left shift serial input, operating mode control, and direct clear input. This register has four operating modes: parallel load, right shift (from $Q_A$ to $Q_D$), left shift (from $Q_D$ to $Q_A$), and clock stop. Synchronized parallel load is executed by applying four-bit data to the parallel input, when both mode control inputs $S_0$ and $S_1$ is "H". Data is loaded to the respective flip-flops, and transferred to the output on the rising edge of the clock. The serial shift stops during parallel loading. Right shift synchronizes with the clock pulse rise, when mode control input $S_0$ is "H" and $S_1$ is "L". When $S_0$ is "L" and $S_1$ is "H", left shift is executed by applying new data to the left shift serial input. The flip-flop clock stops when both mode control inputs are "L". Mode control input changes only when clock input is "H".

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Pin Configuration (top view)**

<table>
<thead>
<tr>
<th>CLR</th>
<th>Mode</th>
<th>Input: CLK SLSI SRSI</th>
<th>Parallel: A B C D</th>
<th>Output: QA QB QC QD</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
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<td>$Q_A$</td>
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<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
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<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
</tbody>
</table>

- **Truth Table**

<table>
<thead>
<tr>
<th>CLR</th>
<th>Mode</th>
<th>Input: CLK SLSI SRSI</th>
<th>Parallel: A B C D</th>
<th>Output: QA QB QC QD</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
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<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td>$Q_A$</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH 2. L: LOW 3. x: Either H or L, it doesn't matter 4. $\nearrow$: Rise from "L" to "H" 5. a, b, c, d: Input level of A, B, C, D on the normal condition 6. $Q_{A0}$, $Q_{B0}$, $Q_{C0}$, $Q_{D0}$: $Q_A$, $Q_B$, $Q_C$, $Q_D$ level prior to the determination of input conditions shown in table. 7. $Q_{A0}$, $Q_{B0}$, $Q_{C0}$, $Q_{D0}$: $Q_A$, $Q_B$, $Q_C$, $Q_D$ level before transition
High-Speed CMOS Logic MN74HC Series

■ Logic Diagram

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,VO}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{LOAD}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

| MN74HC194 | $P_{D}$ | 400 | mW | Decrease to 200mW at the rate of 8mW/°C |
| MN74HC194S | $P_{D}$ | 275 | mW | Decrease to 200mW at the rate of 3.8mW/°C |

| MN74HC194 | $T_a = -40 \sim +60°C$ | $T_a = +60 \sim +85°C$ |
| MN74HC194S | $T_a = -40 \sim +60°C$ | $T_a = +60 \sim +85°C$ |

■ Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,VO}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r,tf}$</td>
<td>2.0 &amp; 4.5 &amp; 6.0</td>
<td>ns &amp; ns &amp; ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0<del>1000 &amp; 0</del>500 &amp; 0~400</td>
<td>ns &amp; ns &amp; ns</td>
<td></td>
</tr>
</tbody>
</table>

Panasonic
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_I$</th>
<th>$I_O$</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
<td>µA</td>
<td>$T_a=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
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<td>1.5</td>
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<td>1.5</td>
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<tr>
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<td>4.5</td>
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<td>3.15</td>
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</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
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<td>0.3</td>
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<td>0.3</td>
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<td>6.0</td>
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<td>1.2</td>
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<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
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<td>$V_{IH}=-20.0$</td>
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<td>6.0</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>8.0</td>
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<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>80.0</td>
<td></td>
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</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_I$</th>
<th>$I_O$</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>$T_a=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
<td>19</td>
</tr>
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<td></td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
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<td>75</td>
<td>25</td>
<td>31</td>
</tr>
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<td>CLK→Q (L→H)</td>
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<td>21</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
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<td>125</td>
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<td>31</td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
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<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{PIL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>25</td>
<td>31</td>
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<tr>
<td>CLR→Q (H→L)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Minimum pulse width</td>
<td>$t_{w}$</td>
<td>2.0</td>
<td></td>
<td>100</td>
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<td>25</td>
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<tr>
<td>CLK, CLR</td>
<td></td>
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Panasonic
### AC Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a = 25^\circ C$</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>$t_{su}$</td>
<td>2.0</td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td>100</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>125</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>$t_h$</td>
<td>2.0</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td>-</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>$t_{rem}$</td>
<td>2.0</td>
<td></td>
<td>125</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>$f_{max}$</td>
<td>2.0</td>
<td></td>
<td>min.</td>
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<tr>
<td></td>
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</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

![Measuring Circuit Diagram]

2. Switching Waveforms

![Switching Waveforms Diagram]
Typical Operating Conditions
MN74HC195/MN74HC195S

4-Bit Parallel Shift Register

Description
MN74HC195/MH74HC195S are four-bit parallel shift registers composed of parallel input, parallel output, J-K serial input, shift/load control input, and direct clear input. This shift register operates in two modes, parallel load and Q_A to Q_D. Parallel loading is executed by putting in four-bit data to a parallel input, and setting “L” to the shift/load control input. Data is loaded to the respective flip-flop; output appears on the rising edge of clock pulse. The serial shift function stops between parallel loads. Serial shift is executed by the rising edge of clock pulse, when shift/load control input is “H” and data is input to the J-K.

As shown in the truth table, the first stage represents to function as a J-K, D, or toggle flip-flop.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLR</td>
<td>SLC</td>
</tr>
<tr>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note: 1. H: HIGH 2. L: LOW 3. X: Either H or L, it doesn’t matter 4. ⊖: Rise from “L” to “H” 5. a, b, c, d: Input level of A, B, C, D on the normal condition 6. Q_A0, Q_B0, Q_C0, Q_D0: Q_A, Q_B, Q_C, Q_D level prior to the determination of input conditions shown in table. 7. Q_A0, Q_B0, Q_C0, Q_D0: Q_A, Q_B, Q_C, Q_D level before transmission
High-Speed CMOS Logic MN74HC Series

### Logic Diagram

![Logic Diagram]

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5~+7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5~V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CL, I_{LOAD}}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65~+150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>MN74HC195</th>
<th>$P_D$</th>
<th>$400$</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40~+60^\circ C$</td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td>$T_a = +60~+85^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC195S</th>
<th>$P_D$</th>
<th>$275$</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40~+60^\circ C$</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
<tr>
<td>$T_a = +60~+85^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4~6.0$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$0~V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40~+85$</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$2.0$</td>
<td>$0~1000$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>$0~500$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>$0~400$</td>
<td>ns</td>
</tr>
</tbody>
</table>

Panasonic
## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>$V_I$</th>
<th>$I_O$</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
<td>$1.9$</td>
<td>$2.0$</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$-5.2$</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
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<td></td>
<td>6.0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$0.1$</td>
<td>$0.1$</td>
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</tr>
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<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>$8.0$</td>
<td>$80.0$</td>
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</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$0.1$</td>
<td>$0.1$</td>
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<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td>8</td>
<td>75</td>
<td>95</td>
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<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>15</td>
<td>19</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>125</td>
<td>155</td>
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</tr>
<tr>
<td>CLK→Q (L→H)</td>
<td></td>
<td>4.5</td>
<td>25</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
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</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>125</td>
<td>155</td>
<td></td>
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<tr>
<td>CLK→Q (H→L)</td>
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<td>4.5</td>
<td>25</td>
<td>31</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PLH}$</td>
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<td>150</td>
<td>190</td>
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<tr>
<td>CLK→Q (L→H)</td>
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<td>4.5</td>
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<td>38</td>
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</tr>
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<td></td>
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<td>6.0</td>
<td>26</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>150</td>
<td>190</td>
<td></td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
<td></td>
<td>4.5</td>
<td>30</td>
<td>38</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>26</td>
<td>33</td>
<td></td>
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<tr>
<td>E Propagation time</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>125</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>CLR→Q (H→L)</td>
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<td>4.5</td>
<td>25</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
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</table>

Panasonic
### AC/Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{cc}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Minimum pulse width CLK, CLR</td>
<td>$t_w$</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
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<tr>
<td></td>
<td>4.5</td>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>17</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>$t_{su}$</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>20</td>
<td>25</td>
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</tr>
<tr>
<td></td>
<td>6.0</td>
<td>17</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>$t_h$</td>
<td>2.0</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>—</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>—</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>$t_{rem}$</td>
<td>2.0</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
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</tr>
<tr>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>$f_{max}$</td>
<td>2.0</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
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<tr>
<td></td>
<td>6.0</td>
<td>35</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

#### Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit
2. Waveforms

---

Panasonic
Typical Operating Conditions
**MN74HC221/MN74HC221S**

Dual Monostable Multivibrators with Clear

**Description**
MN74HC221/MN74HC221S are dual monostable multivibrator. Trigger input is triggered on falling edge of A input and rising edge of B input/CLR input. Once input is triggered, the monostable mode is sustained by a resistor and capacitor mounted externally, unless CLR input is “L”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>A</th>
<th>B</th>
<th>Q</th>
<th>( \overline{Q} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAR</td>
<td>L</td>
<td>X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>H</td>
<td>L</td>
<td>H</td>
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<td>X</td>
<td>L</td>
<td>L H</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
H : High level
L : Low level
X : Either H or L, it doesn’t matter
\( \overline{\text{x}} \) : fall from H to L
\( \checkmark \) : use from L to H
\( \text{\textcircled{1}} \) : one High level pulse
\( \text{\textcircled{L}} \) : one Low level pulse

**Logic Diagram**

![Logic Diagram](image_url)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CL}</td>
<td>-0.5～7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5～V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{HK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CL}, I_{GND}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65～+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>MN74HC221</td>
<td></td>
<td>P_{D}</td>
<td>400 mW</td>
</tr>
<tr>
<td>MN74HC221S</td>
<td></td>
<td>P_{D}</td>
<td>275 mW</td>
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</table>

Decrease to 200mW at the rate of 8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>2.0～6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0～V_{CC}</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>-40～+85</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>0～1000 ns</td>
<td>ns</td>
</tr>
<tr>
<td>A, CLR</td>
<td></td>
<td>5～1000 kΩ</td>
<td>kΩ</td>
</tr>
<tr>
<td>external timing resistance</td>
<td>R_{ext}</td>
<td>no limit</td>
<td>pF</td>
</tr>
<tr>
<td>external timing capacitance</td>
<td>C_{ext}</td>
<td>no limit</td>
<td>pF</td>
</tr>
<tr>
<td>wiring capacitance</td>
<td>R_{ext}/C_{ext}</td>
<td>0～50 pF</td>
<td>pF</td>
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### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V_{I} I_{O}</td>
<td>T_{A}=25°C</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td>min. max.</td>
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<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
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<td>1.5</td>
<td>1.5</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
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<td>-20.0</td>
<td>1.9</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0 μA</td>
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<td></td>
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<td>-20.0 μA</td>
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<td>-20.0</td>
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<td>-20.0 mA</td>
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<td>-5.2 mA</td>
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<td>Input current</td>
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<td>V_{I}=V_{CC} or GND</td>
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<tr>
<td>Rext/Cext pin leak current</td>
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<td>±0.1</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>V_{O}=V_{CC} or GND</td>
<td>±0.5</td>
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<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>$T_a=25^\circ C$</td>
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<td>Output rise time</td>
<td>$t_{TLH}$</td>
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<td>10</td>
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<td>Output fall time</td>
<td>$t_{THL}$</td>
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<td>20</td>
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<td></td>
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<td>8</td>
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<tr>
<td></td>
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<td>6.0</td>
<td></td>
<td>6</td>
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<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>76</td>
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<td>A, B, CLR→Q, (L→H)</td>
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<td>83</td>
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<tr>
<td>A, B, CLR→Q, (H→L)</td>
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<td></td>
<td>6.0</td>
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<td>22</td>
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<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>47</td>
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<tr>
<td>CLR→Q, Q (L→H)</td>
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<td>16</td>
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<td>6.0</td>
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<td>15</td>
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<td>Propagation time</td>
<td>$t_{PHL}$</td>
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<td>44</td>
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<tr>
<td>CLR→Q, Q (H→L)</td>
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<td>4.5</td>
<td></td>
<td>16</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{W(OUT)}$</td>
<td>2.0</td>
<td>$C_{ext} = 0$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$R_{ext} = 5 , k\Omega$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{W(OUT)}$</td>
<td>2.0</td>
<td>$C_{ext} = 1000 , pF$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$R_{ext} = 10 , k\Omega$</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Minimum pulse width</td>
<td>$t_{W(IN)}$</td>
<td>2.0</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>A, B</td>
<td></td>
<td>4.5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>34</td>
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<tr>
<td>Minimum pulse width</td>
<td>$t_{W(IN)}$</td>
<td>2.0</td>
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<tr>
<td>CLR</td>
<td></td>
<td>4.5</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>34</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

![Measuring Circuit Diagram](image)

2. Waveforms

![Waveforms Diagram](image)
**MN74HC237/MN74HC237S**

3-to-8 Line Decoder with Address Latches

**Description**

MN74HC237/MN74HC237S are high-speed 3-to-8 line decoders with three address latches. Address are stored, when GL input is “H”. When enable input G1 is “H” and G2 is “L”, the output depending on A, B and C inputs become “H”, and all other outputs become “L”. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistor and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable</th>
<th>Select</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL</td>
<td>G1</td>
<td>G2</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>×</td>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
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<tr>
<td>L</td>
<td>H</td>
<td>L</td>
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<tr>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level
3. ×: Either HIGH or LOW; doesn’t matter

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Voltage (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IP}$</td>
<td>$\pm 20$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OP}$</td>
<td>$\pm 20$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>Model</th>
<th>$T_a$</th>
<th>PD (mW)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC237</td>
<td>$-40 \sim +60$°C</td>
<td>400</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>MN74HC237S</td>
<td>$-40 \sim +60$°C</td>
<td>275</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 $\sim$ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>$V_{CC}=2.0$V</td>
<td>0 $\sim$ 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=4.5$V</td>
<td>0 $\sim$ 500 ns</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=6.0$V</td>
<td>0 $\sim$ 400 ns</td>
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</tr>
</tbody>
</table>

## DC Characteristics (GND = 0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_a = 25$°C</td>
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<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>1.5</td>
<td>1.5</td>
<td>3.15</td>
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<td>6.0</td>
<td>1.5</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
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<td>4.5</td>
<td>0.9</td>
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<td>6.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>4.4</td>
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<td>4.4</td>
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<td>4.4</td>
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<td>4.4</td>
<td>4.4</td>
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<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>4.4</td>
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<td>6.0</td>
<td>4.4</td>
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<td>Input current</td>
<td>$I_I$</td>
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<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>μA</td>
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<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>8.0</td>
<td>80.0</td>
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</table>
**AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_{ee} ) Test Conditions</th>
<th>( T_a = 25^\circ C )</th>
<th>( T_a = -40^\circ C ) to ( +85^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>19</td>
<td>75</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>19</td>
<td>75</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>48</td>
<td>150</td>
</tr>
<tr>
<td>Propagation time A, B, C→Y</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>40</td>
<td>150</td>
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<tr>
<td>Propagation time G1→Y</td>
<td>( t_{PLH} )</td>
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<td>Minimum pulse width</td>
<td>( t_w )</td>
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<td>6.0</td>
<td>≥6</td>
<td>100</td>
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<td>Minimum setup time A, B, C</td>
<td>( t_{ss} )</td>
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<td>Minimum hold time</td>
<td>( t_h )</td>
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<td>4.5</td>
<td>6.0</td>
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</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

![Measuring Circuit Diagram]

2. Waveforms

![Waveforms Diagram]
**MN74HC238/MN74HC238S**

3-to-8 Line Decoder/Demultiplexer

- **Description**

MN74HC238/MN74HC238S are high-speed 3-to-8 decoder/demultiplexer decoding one of eight output lines depending on the condition of three select inputs (A0, A1 and A2) and three enable inputs (E1, E2 and E3). The enable input consists of an active LOW of 2 inputs and active HIGH of 1-input which makes the subsidiary connection easy. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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<tbody>
<tr>
<td>E1</td>
<td>E2</td>
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<td>H</td>
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Note: 1. H: HIGH level  2. L: LOW level

- **Logic Diagram**
### Absolute Maximum Ratings

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
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<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
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<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power Dissipation**

| MN74HC238                  | $V_{CC}=2.0\text{V}$ | $0 \sim 1000$ | ns  |
| MN74HC238S                 | $V_{CC}=4.5\text{V}$ | $0 \sim 500$  | ns  |
| MN74HC238                 | $V_{CC}=6.0\text{V}$ | $0 \sim 400$  | ns  |

### Operating Conditions

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
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<tr>
<td>Input/output</td>
<td>$V_I$, $V_O$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
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<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
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**Input rise and fall time**

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<th>Temperature</th>
<th>$V_{CC}=2.0\text{V}$</th>
<th>$V_{CC}=4.5\text{V}$</th>
<th>$V_{CC}=6.0\text{V}$</th>
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<tr>
<td>$V_I$, $t_r$, $t_f$</td>
<td>$T_a=25^\circ\text{C}$</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
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<td>$V_I$, $t_r$, $t_f$</td>
<td>$T_a=-40\sim+85^\circ\text{C}$</td>
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<td>0.9</td>
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### DC Characteristics (GND=0V)

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<th>Parameter</th>
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<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_I$, $I_O$</th>
<th>Temperature</th>
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<tr>
<td></td>
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<td>$V_I$, $I_O$</td>
<td>$T_a=25^\circ\text{C}$</td>
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<td>$V_I$</td>
<td>$I_O$</td>
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<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
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<td>$\mu A$</td>
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<td>$V_{IH}$</td>
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<td>6.0</td>
<td>$V_{IL}$</td>
<td>$-20.0$</td>
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<td>6.0</td>
<td>$V_{IL}$</td>
<td>$-5.2$</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>$V_{IH}$</td>
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<td>6.0</td>
<td>$V_{IL}$</td>
<td>$5.2$</td>
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</table>

**Input current**

| $I_I$ | $V_I=V_{CC}$ or GND | $\pm 0.1$ | $\pm 1.0$ | $\mu A$ |

**Quiescent supply current**

| $I_{CC}$ | $V_I=V_{CC}$ or GND, $I_O=0$ | 8.0 | 80.0 | $\mu A$ |
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50\text{pF} \))

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature (Unit)</th>
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<td></td>
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<td>( T_a = 25^\circ \text{C} )</td>
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<td>Propagation time E1, E2→Y</td>
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<td>Min. Typ. Max.</td>
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<td>( (L→H) )</td>
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<td>Propagation time E1, E2→Y</td>
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</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (\( t_{PLH}, t_{PHL} \))
  2. Waveforms

![Switching Time Measuring Circuit and Waveforms](image)
MN74HCT238/MN74HCT238S
3-to-8 Decoder/Demultiplexer (TTL Input)

**Description**

MN74HCT238/MN74HCT238S are high-speed 3-to-8 decoder/demultiplexer (TTL input) decoding one of eight output lines depending on the condition of three select inputs (A0, A1 and A2) and three enable inputs (E1, E2 and E3). The input consists of an active LOW of 2 inputs and active HIGH of 1-input which makes the subsidiary connection easy. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2V or more is logic “1”. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>A2</th>
<th>A1</th>
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Note: 1. H: HIGH level 2. L: LOW level

**Logic Diagram**

![Logic Diagram of MN74HCT238/MN74HCT238S](image-url)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I$, $V_O$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IH}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th>Temperature</th>
<th>PD</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{a}= -40 \sim +60°C$</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{a}= +60 \sim +85°C$</td>
<td>275</td>
<td>mW</td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of $8mW/°C$ for $T_{a}= +60 \sim +85°C$

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>4.5 $\sim$ 5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output</td>
<td>$V_I$, $V_O$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>4.5V</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>4.5 $\sim$ 5.5</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>4.5 $\sim$ 5.5</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>4.5 $\sim$ 5.5</td>
<td>$V_{IH}$</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or $V_{IL}$</td>
<td>-4.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>4.5 $\sim$ 5.5</td>
<td>$V_{IH}$</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or $V_{IL}$</td>
<td>4.0</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>5.5</td>
<td>$V_I$ $= V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>5.5</td>
<td>$V_I$ $= V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Panasonic
## AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature Ta=25°C</th>
<th>Temperature Ta=-40°C~+85°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>4.5</td>
<td></td>
<td>5</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>4.5</td>
<td></td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Propagation time A→Y (L→H)</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>18</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>Propagation time A→Y (H→L)</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>13</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time E1, E2→Y (L→H)</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>20</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Propagation time E1, E2→Y (H→L)</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>16</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time E3→Y (L→H)</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time E3→Y (H→L)</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>21</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms
MN74HC240/MN74HC240S

Inverting Octal TRI-STATE Buffers

**Description**
MN74HC240/MN74HC240S are high-speed inverting buffers constructed with octal tri-state outputs. High-speed operation can be obtained for driving a large capacity bus line, because these ICs have large current output. When the output is “L”, inputs 1G and 2G are available, where output becomes enable and each of the four buffers is independently controlled. Adoption of the silicon gate CMOS process makes possible low power consumption and a high noise allowance; LS TTL 15-inputs can be directly driven. Resistors and diodes are used in the Vcc and GND in order to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>1A</td>
<td>1Y</td>
<td>2G</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>Hi-Z</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>Hi-Z</td>
<td>H</td>
</tr>
</tbody>
</table>

**Logic Diagram**

```
A1   A2   A3   A4   G
    ▼    ▼    ▼    ▼
    ▼    ▼    ▼    ▼
    ▼    ▼    ▼    ▼
    ▼    ▼    ▼    ▼
Y1   Y2   Y3   Y4
```

**Note:**
Hi-Z: High impedance
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 \sim +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IN}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{C\text{L, } I_{OMI}}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

| MN74HC240 | $P_D$ | 400 mW |
| MN74HC240S| $P_D$ | 275 mW |

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, tf}$</td>
<td>2.0 $\sim$ 1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 $\sim$ 500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 $\sim$ 400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_i$</td>
<td>$I_o$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0 $\sim$ 4.5 $\sim$ 6.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0 $\sim$ 4.5 $\sim$ 6.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0 $\sim$ 4.5 $\sim$ 6.0</td>
<td>$-20.0$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0 $\sim$ 4.5 $\sim$ 6.0</td>
<td>$-6.0$</td>
<td>$-6.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>6.0 $\sim V_{CC}$</td>
<td>$V_i$</td>
<td>$= V_{CC}$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0 $\sim V_{IH}$</td>
<td>$V_i$</td>
<td>$= V_{IL}$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0 $\sim V_{CC}$</td>
<td>$V_i$</td>
<td>$= V_{CC}$</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>RL = 1 kΩ</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>(H→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>RL = 1 kΩ</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>RL = 1 kΩ</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>RL = 1 kΩ</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Switching Time Measuring Circuit and Waveforms**

1. Measuring Circuit (t_{PLH}, t_{PHL})
2. Waveforms

![Switching Time Measuring Circuit](image)

![Waveforms](image)
[2] $t_{PHZ}, t_{PZH}$
1. Measuring Circuit

2. Waveforms

[3] $t_{PLZ}, t_{PZL}$
1. Measuring Circuit

2. Waveforms

**MN74HC241/MN74HC241S**

Octal TRI-STATE Buffer

**Description**
MN74HC241/MN74HC241S are high-speed non-inverted buffers constructed with octal tri-state outputs. High-speed operation can be obtained for driving a large capacity bus line, because these ICs have large current outputs. Also, these ICs have input IG where output becomes enable at “L” output, and input 2G where output becomes enable at “H” output, and each of the four buffers is independently controlled. Adoption of the silicon gate CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL; LS TTL 15-inputs can be directly drive. Resistors and diodes are used in the VCC and GND in order to protect the input/output from damage by static electricity. Same pin configuration and function as standard 45LS/74LS Logic Family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>1A</td>
</tr>
<tr>
<td>1Y</td>
<td>2G</td>
</tr>
<tr>
<td>2A</td>
<td>2Y</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>Hi-Z</td>
</tr>
<tr>
<td>L</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. Hi-Z: High impedance

**Logic Diagram**

---

*Panasonic*
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>( -0.5 \sim +7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>( -0.5 \sim V_{CC} +0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{PB} )</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{PB} )</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{O(NAND)} )</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>( -65 \sim +150 )</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC241</th>
<th>MN74HC241S</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{a}=-40 \sim +60°C )</td>
<td>( P_{D} )</td>
<td>400</td>
</tr>
<tr>
<td>( T_{a}=-40 \sim +85°C )</td>
<td>( P_{D} )</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>( T_{a}=+40 \sim +60°C )</td>
<td>( P_{H} )</td>
<td>275</td>
</tr>
<tr>
<td>( T_{a}=+40 \sim +85°C )</td>
<td>( P_{H} )</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>0~( V_{CC} )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{a} )</td>
<td>( -40 \sim +85 )</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0~1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5~500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0~400</td>
<td>ns</td>
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</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_{I} ), ( I_{O} )</td>
<td>( T_{a}=25°C )</td>
<td>( T_{a}=-40\sim+85°C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
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<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-0.0</td>
<td>-0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-0.0</td>
<td>-0.0</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>-0.0</td>
<td>-0.0</td>
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<tr>
<td></td>
<td></td>
<td>( V_{IL} )</td>
<td>-6.0</td>
<td>3.86</td>
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<td></td>
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<td>4.5</td>
<td>-7.8</td>
<td>5.36</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>20.0</td>
<td>20.0</td>
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<td></td>
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<td>6.0</td>
<td>20.0</td>
<td>20.0</td>
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<td></td>
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<td>4.5</td>
<td>6.0</td>
<td>6.0</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_{I} )</td>
<td>6.0</td>
<td>( V_{I}=V_{CC} ) or ( GND )</td>
<td>±0.1</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>( I_{OZ} )</td>
<td>6.0</td>
<td>( V_{I}=V_{IH} ) or ( V_{IL} ), ( V_{O}=V_{CC} ) or ( GND )</td>
<td>±0.5</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I}=V_{CC} ) or ( GND ), ( I_{O}=0 )</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics

**GND=0V, Input transition time ≤6ns, C\textsubscript{L}=50pF**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}) (V)</th>
<th>Test Conditions</th>
<th>(T_a=25,^\circ\text{C})</th>
<th>(T_a=-40\sim+85,^\circ\text{C})</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=-40~+85°C</td>
<td></td>
</tr>
<tr>
<td>Output rise time</td>
<td>(t_{\text{TLH}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>(t_{\text{THL}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>(t_{\text{PLH}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>(t_{\text{PHL}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>(t_{\text{PHZ}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>(t_{\text{PLZ}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>(t_{\text{PZH}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>(t_{\text{PZL}})</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>11</td>
<td>20</td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. tTLH, tTHL, tPLH, tPHL

2. Waveforms

3. tPHZ, tPZH

4. tPLZ, tPZL

---

Panasonic
**MN74HC242/MN74HC242S**

Inverting Quad TRI-STATE Transceivers

**Description**

MN74HC242/MN74HC242S are high-speed tri-state output, inverting buffers which asynchronously transfer the input bidirectionally through the data bus line. Large current output makes possible high-speed operation for driving a large capacity bus line. These ICs have input GBA where output A becomes enable at “H” level, and input GAB where output B becomes enabled at “L” level. Adoption of the silicon gate CMOS process makes possible low power consumption, a high noise allowance, and an operation speed equivalent to LS TTL; LS TTL 15-pints can be directly driven. Resistors and diodes are used in the 

Resistors and diodes are used in the VCC and GND in order to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS Logic Family.

**Truth Table**

<table>
<thead>
<tr>
<th>Control Input</th>
<th>Data Port Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAB</td>
<td>GBA</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:

1. *: When the transceiver operates bi-directionally at the same time, destructive oscillation might occur.
2. Hi-Z: High impedance

**Logic Diagram**

![Logic Diagram](image-url)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC242</td>
</tr>
<tr>
<td>$T_a = -40 \sim +85°C$</td>
</tr>
<tr>
<td>$P_{D}$</td>
</tr>
<tr>
<td>$400$ mW</td>
</tr>
<tr>
<td>Decrease to $200$ mW at the rate of $8$ mW/°C</td>
</tr>
<tr>
<td>MN74HC242S</td>
</tr>
<tr>
<td>$T_a = -40 \sim +85°C$</td>
</tr>
<tr>
<td>$P_{D}$</td>
</tr>
<tr>
<td>$275$ mW</td>
</tr>
<tr>
<td>Decrease to $200$ mW at the rate of $3.8$ mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, tf}$</td>
<td>$2.0$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 1000$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 500$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 400$</td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>$V_{I}$</th>
<th>$V_{O}$</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a=25°C$</td>
<td>$T_a=-40\sim+85°C$</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>$2.0$</td>
<td>$V_{II}$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td></td>
<td></td>
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<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td></td>
<td></td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>$2.0$</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
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<td></td>
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<td>$4.5$</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
</tr>
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<td></td>
<td>$6.0$</td>
<td></td>
<td></td>
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<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>$2.0$</td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>4.4</td>
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<td>$4.5$</td>
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<td></td>
<td></td>
<td>$6.0$</td>
<td></td>
<td>$V_{IL}$</td>
<td>$-6.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
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<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>$-6.0$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>$2.0$</td>
<td>$V_{IH}$</td>
<td>$20.0$</td>
<td>$\mu A$</td>
<td>5.36</td>
</tr>
<tr>
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<td>5.36</td>
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<td>$6.0$</td>
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<td>$V_{IL}$</td>
<td>$6.0$</td>
<td>$\mu A$</td>
</tr>
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<td>$V_{IH}$</td>
<td>$20.0$</td>
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<td></td>
<td></td>
<td></td>
<td>$V_{IL}$</td>
<td>$6.0$</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>$6.0$</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>$6.0$</td>
<td>$V_{I}=V_{IH}$ or $V_{IL}$</td>
<td>$\pm 0.5$</td>
<td>$\pm 5.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>$6.0$</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
<td>80.0</td>
<td>$\mu A$</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td></td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>8</td>
<td>75</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>19</td>
<td>19</td>
<td>ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>6</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>10</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>11</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Propagation time A→B (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>8</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>95</td>
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</tr>
<tr>
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<td>6.0</td>
<td>16</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time A→B (H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>16</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Propagation time B→A (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>8</td>
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<td>3-state propagation time (H→Z)</td>
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<td></td>
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<td>3-state propagation time (L→Z)</td>
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<td>125</td>
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<td>26</td>
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<td>3-state propagation time (Z→H)</td>
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<td>100</td>
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<td></td>
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<td>4.5</td>
<td>25</td>
<td>31</td>
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<td>6.0</td>
<td>26</td>
<td>31</td>
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High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms


Panasonic
MN74HC243/MN74HC243S
Quad TRI-STATE Transceivers

Description
MN74HC243/MN74HC243S are high-speed tri-state output and non-inverted buffer transferring input bi-directionally and asynchronously through a data bus line. High-speed operation can be obtained for driving a large-capacity bus line due to large current output. It has input GBA where output A becomes enabled at HIGH, and input GAB where output B becomes enabled at LOW. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Control Inputs</th>
<th>Data Port Status</th>
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<td>A</td>
</tr>
<tr>
<td>GAB</td>
<td>H</td>
</tr>
<tr>
<td>GBA</td>
<td>Output</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Hi-Z</td>
</tr>
<tr>
<td>L</td>
<td>Input</td>
</tr>
<tr>
<td>Note:</td>
<td></td>
</tr>
<tr>
<td>1. *: If transceiver is bi-directionally at the same time, destructive oscillation may be generated.</td>
<td></td>
</tr>
<tr>
<td>2. Hi-Z: High impedance</td>
<td></td>
</tr>
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</table>

Logic Diagram

Pin configuration (top view)

14-pin plastic DIL package

14-pin Panafit package (SO-14D)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC243</th>
<th>$P_{D}$</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Ta=-40 \sim +60 \degree C$</td>
<td>400 mW</td>
<td></td>
</tr>
<tr>
<td>$T_{a}=+60 \sim +85 \degree C$</td>
<td>400 mW</td>
<td></td>
</tr>
<tr>
<td>MN74HC243S</td>
<td>$P_{D}$</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
<tr>
<td>$Ta=-40 \sim +60 \degree C$</td>
<td>275 mW</td>
<td></td>
</tr>
<tr>
<td>$T_{a}=+60 \sim +85 \degree C$</td>
<td>275 mW</td>
<td></td>
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</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC} (V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{a}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>$2.0 \sim 0 \sim 1000$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$4.5 \sim 0 \sim 500$</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$6.0 \sim 0 \sim 400$</td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC} (V)$</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{CC}$ (V)</td>
<td>$V_{I}, I_{O}$</td>
<td>$T_{a}=25 \degree C$</td>
<td>$T_{a}=-40 \sim +85 \degree C$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{HH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
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<td>$-20.0$</td>
<td>$\mu A$</td>
<td>1.9</td>
<td>2.0</td>
</tr>
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<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>4.4</td>
<td>4.5</td>
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<td>6.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>5.9</td>
<td>6.0</td>
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<td>$\mu A$</td>
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<td>Output LOW voltage</td>
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<td>$20.0$</td>
<td>$\mu A$</td>
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<td>$\mu A$</td>
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<td>$7.8$</td>
<td>$\mu A$</td>
<td>0.32</td>
<td>0.37</td>
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<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\mu A$</td>
<td>$\pm 0.1$</td>
<td>1.0</td>
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<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_{I}=V_{HH}$ or $V_{IL}$</td>
<td>$V_{O}=V_{CC}$ or GND</td>
<td>$\mu A$</td>
<td>$\pm 0.5$</td>
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<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
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<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
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## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\,\text{pF}$)

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<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>$T_a=25^\circ\text{C}$</td>
<td>$T_a=-40^\circ\text{C}+85^\circ\text{C}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
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<td></td>
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<td>6.0</td>
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<td>Output fall time</td>
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<td></td>
<td>6.0</td>
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<tr>
<td>Propagation time A→B (L→H)</td>
<td>$t_{\text{PLH}}$</td>
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<td>8</td>
<td>20</td>
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<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
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<tr>
<td>Propagation time A→B (H→L)</td>
<td>$t_{\text{PHL}}$</td>
<td>2.0</td>
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<td>6</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Propagation time B→A (L→H)</td>
<td>$t_{\text{PLH}}$</td>
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<td>8</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Propagation time B→A (H→L)</td>
<td>$t_{\text{PHL}}$</td>
<td>2.0</td>
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<td>7</td>
<td>20</td>
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<td></td>
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<td>4.5</td>
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<td></td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time (H→Z)</td>
<td>$t_{\text{PHZ}}$</td>
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<td>$R_L=1,\text{k}\Omega$</td>
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<td>25</td>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time (L→Z)</td>
<td>$t_{\text{PLZ}}$</td>
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<td>$R_L=1,\text{k}\Omega$</td>
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<td>6.0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>$t_{\text{PHZ}}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
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<td>20</td>
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<td></td>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time (Z→L)</td>
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<td>$R_L=1,\text{k}\Omega$</td>
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<td>20</td>
</tr>
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</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. tPLZ, tPZL

1. Measuring Circuit
MN74HC244/MN74HC244S

Octal TRI-STATE Buffers

**Description**

MN74HC244/MN74HC244S are high-speed non-inverted buffers consisting of octal tri-state outputs. High-speed operation is possible for driving a large capacitance bus line owing to large current output. Inputs $1\bar{G}$ and $2\bar{G}$ are available where output becomes enabled at LOW, and each input controls 4 buffers. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1\bar{G}$</td>
<td>$1A$</td>
</tr>
<tr>
<td>$2\bar{G}$</td>
<td>$2A$</td>
</tr>
<tr>
<td>$L$</td>
<td>$L$</td>
</tr>
<tr>
<td>$L$</td>
<td>$H$</td>
</tr>
<tr>
<td>$H$</td>
<td>$L$</td>
</tr>
<tr>
<td>$H$</td>
<td>$H$</td>
</tr>
</tbody>
</table>

Note:
1. Hi-Z: High impedance

**Logic Diagram**

![Logic Diagram](image-url)
<table>
<thead>
<tr>
<th>Absolute Maximum Ratings</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
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<td>V</td>
</tr>
<tr>
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<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-5 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation        | MN74HC244 | $P_{D}$ | 400 | mW |
|                         | Mn74HC244S | $P_{D}$ | 275 | mW |
|                         |           | Decrease to 200mW at the rate of 8mW/°C |     |
|                         |           | Decrease to 200mW at the rate of 3.8mW/°C |     |

<table>
<thead>
<tr>
<th>Operating Conditions</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 - 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
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</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0</td>
<td>0 - 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 - 500</td>
<td>ns</td>
</tr>
<tr>
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<td>6.0</td>
<td>0 - 400</td>
<td>ns</td>
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<table>
<thead>
<tr>
<th>DC Characteristics (GND=0V)</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td>$T_{A}=25$ °C</td>
<td>$T_{A}=-40 \sim +85$ °C</td>
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<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
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<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
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<td>4.2</td>
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<td></td>
<td></td>
<td>6.0</td>
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<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
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<td>1.9</td>
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<td>$V_{IH}$</td>
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<td>$\mu A$</td>
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<td>6.0</td>
<td></td>
<td>$V_{IL}$</td>
<td>-6.0</td>
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<td>4.5</td>
<td></td>
<td>$V_{IL}$</td>
<td>-6.0</td>
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<td>$V_{IH}$</td>
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<td>$\mu A$</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>$V_{IL}$</td>
<td>6.0</td>
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<td>Output LOW voltage</td>
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<td>$V_{I}=V_{CC}$ or GND</td>
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<td>$V_{O}=V_{CC}$ or GND</td>
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### AC Characteristics (GND=0V, Input transition time ≤ 6ns, $C_L$=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
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<td>$Ta=25^\circ C$</td>
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<td>typ.</td>
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<td></td>
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<td>4.5</td>
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<td>9</td>
<td>15</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>18</td>
<td>15</td>
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<td>Output fall time</td>
<td>$t_{THL}$</td>
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<td></td>
<td>8</td>
<td>15</td>
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<td></td>
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<td>6.0</td>
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<td>17</td>
<td>15</td>
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<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
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<td>15</td>
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<td>4.5</td>
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<td>8</td>
<td>15</td>
</tr>
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<td></td>
<td>6.0</td>
<td></td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
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<td>18</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td>8</td>
<td>15</td>
</tr>
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<td></td>
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<td>6.0</td>
<td></td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>$t_{PHZ}$</td>
<td>2.0</td>
<td>$R_L=1,k\Omega$</td>
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<td>125</td>
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<tr>
<td>(H→Z)</td>
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<td>4.5</td>
<td></td>
<td>13</td>
<td>25</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>125</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>$t_{PLZ}$</td>
<td>2.0</td>
<td>$R_L=1,k\Omega$</td>
<td>28</td>
<td>125</td>
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<tr>
<td>(L→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>28</td>
<td>125</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>$t_{PZH}$</td>
<td>2.0</td>
<td>$R_L=1,k\Omega$</td>
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<td>100</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>12</td>
<td>20</td>
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<tr>
<td></td>
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<td>6.0</td>
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<td>25</td>
<td>100</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>$t_{PZH}$</td>
<td>2.0</td>
<td>$R_L=1,k\Omega$</td>
<td>33</td>
<td>125</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>125</td>
</tr>
</tbody>
</table>

**Switching Time Measuring Circuit and Waveforms**

1. Measuring Circuit

2. Waveforms

---

Panasonic
[2] \( t_{PHZ}, t_{PZH} \)
1. Measuring Circuit

2. Waveforms

[3] \( t_{PLZ}, t_{PZL} \)
1. Measuring Circuit

2. Waveforms

MN74HC245/MN74HC245S

Octal TRI-STATE Transceivers

**Description**

MN74HC245/MN74HC245S are high-speed non-inverted bi-directional buffers consisting of octal tri-state output. Input is transferred bi-directionally asynchronously through a data bus line. Large current output enables high-speed operation for driving a large capacitance bus line. It has input G where output becomes enabled at LOW, and direction control input DIR. When DIR input is HIGH, data is transferred from input A to B, and, when DIR input is LOW, data is transferred from input B to output A. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs are directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable G</th>
<th>Direction Control DIR</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>B data to A bus</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>A data to B bus</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. Hi-Z: High impedance
2. X: Either HIGH OR LOW; it doesn't matter

**Logic Diagram**

![Logic Diagram](image_url)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{ih}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{oK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$</td>
<td>$I_{OAD}$</td>
<td>$\pm 70$</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC245</th>
<th>MN74HC245S</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC} = -40 \sim +60$°C</td>
<td>$P_D$ 400 mW</td>
</tr>
<tr>
<td>$Ta = +60 \sim 85$°C</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>$V_{CC} = -40 \sim +60$°C</td>
<td>$P_D$ 275 mW</td>
</tr>
<tr>
<td>$T_{stg} = +60 \sim 85$°C</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

| Parameter                          | Symbol | $V_{CC}$ (V) | Rating | Unit   |
|------------------------------------|--------|--------------|--------|
| Operating supply voltage           | $V_{CC}$ | 1.4 \sim 6.0 | V      |
| Input/output voltage               | $V_i, V_o$ | $0 \sim V_{CC}$ | V      |
| Operating temperature range        | $T_A$  | $-40 \sim 85$°C | °C     |
| Input rise and fall time           | $t_{r}, t_f$ | 2.0        | ns     |
|                                   |        | 4.5          | ns     |
|                                   |        | 6.0          | ns     |
|                                   |        | 0 \sim 1000  | ns     |
|                                   |        | 0 \sim 500   | ns     |
|                                   |        | 0 \sim 400   | ns     |

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_i$</td>
<td>$I_O$</td>
<td>$T_A = 25$°C</td>
<td>$T_A = -40 \sim 85$°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_iH$</td>
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<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>$V_iL$</td>
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<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_oH$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>1.9</td>
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<td>4.5</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>4.4</td>
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<td>$\mu A$</td>
<td>5.9</td>
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<td>$-7.8$</td>
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<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td>$V_i = V_{CC}$ or GND</td>
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<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_i = V_{IH}$ or $V_{IL}$</td>
<td>$\pm 0.5$</td>
<td>$\pm 5.0$</td>
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<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
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<td>$V_i = V_{CC}$ or GND, $I_O = 0$</td>
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<td>80.0</td>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tr>
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<td>typ.</td>
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<td>6.0</td>
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<td>Output fall time</td>
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<td>15</td>
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<td>6.0</td>
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<td>Propagation time (H→L)</td>
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<td>6.0</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>R_L = 1 kΩ</td>
<td>18</td>
<td>30</td>
</tr>
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<td></td>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_L = 1 kΩ</td>
<td>12</td>
<td>20</td>
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<td>4.5</td>
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<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>R_L = 1 kΩ</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

2. Waveforms (tPHZ, tPZH, tPLZ, tPZL)
MN74HC251/MN74HC251S
8-Channel TRI-STATE Multiplexer

**Description**
MN74HC251/MN74HC251S are 8-channel tri-state multiplexer selecting one input from eight channel data input; each multiplexer has a reverse phase output Y, W, and strobe input. When strobe input is “L”, the circuit becomes enabled; when strobe input is “H”, status. Accordingly, when strobe input is “L”, one input is selected according to the select input A, B, C combination, and data is transferred to outputs Y, W.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic Diagram**

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
3. D0, D1, ...... D7: Related D input level
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>–0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>–0.5~V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IN}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OH}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{CM}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{STG}</td>
<td>–65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC251</th>
<th>Ta=–40 ~+60°C</th>
<th>P_{D}</th>
<th>400</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MN74HC251S</td>
<td>Ta=+60 ~+85°C</td>
<td>P_{D}</td>
<td>275</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>–40~+85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{R}, t_{L}</td>
<td>2.0</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V_{I}</td>
<td>I_{O}</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>2.0</td>
<td>–20.0</td>
<td>ΜA</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>–20.0</td>
<td>ΜA</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>–20.0</td>
<td>ΜA</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>–6.0</td>
<td>mA</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>–7.8</td>
<td>mA</td>
<td>5.36</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>2.0</td>
<td>20.0</td>
<td>ΜA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>ΜA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>ΜA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>mA</td>
<td>0.32</td>
</tr>
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<td>6.0</td>
<td>7.8</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>I_{OZ}</td>
<td>6.0</td>
<td>V_{I}=V_{IH} or V_{IL}, V_{O}=V_{CC} or GND</td>
<td>±0.5</td>
<td>±5.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{Q}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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<tr>
<td></td>
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<td>min. typ. max.</td>
<td>min. typ. max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>8 15 95</td>
<td>6 13 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>6 75 95</td>
<td>13 19 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time D→Y, W(L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>150 190</td>
<td>26 33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time D→Y, W(H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>150 190</td>
<td>26 33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time A,B,C→Y, W(L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>150 190</td>
<td>26 33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time A,B,C→Y, W(H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>150 190</td>
<td>26 33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_1=1kΩ 100 125 25</td>
<td>17 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>R_1=1kΩ 100 125 25</td>
<td>17 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_1=1kΩ 100 125 25</td>
<td>17 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_1=1kΩ 100 125 25</td>
<td>17 21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

---

[1] \( t_{TLH}, t_{THL}, t_{PLH}, t_{PHL} \)

---

[2] \( t_{PHZ}, t_{PZH} \)

---

[3] \( t_{PLZ}, t_{PZL} \)

---

MN74HC253/MN74HC253S

Dual 4-Channel TRI-STATE Multiplexers

**Description**
MN74HC253/MN74HC253S contain two tri-state multiplexers selecting one input from 4-channel data inputs in one chip. Output control input controls dual 4 lines respectively. When output control input is “H”, output becomes high impedance regardless of bus line. When output control input is “L”, data is transferred to the output by selecting output channel suited for data input signal from select input A and B.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic Diagram**

![Logic Diagram](image)

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>Data</td>
</tr>
<tr>
<td>B A</td>
<td>C0 C1 C2 C3</td>
</tr>
<tr>
<td>× ×</td>
<td>× × × ×</td>
</tr>
<tr>
<td>L L</td>
<td>L × × ×</td>
</tr>
<tr>
<td>L L</td>
<td>H × × ×</td>
</tr>
<tr>
<td>L H</td>
<td>× L × ×</td>
</tr>
<tr>
<td>L H</td>
<td>× H × ×</td>
</tr>
<tr>
<td>H L</td>
<td>× × L ×</td>
</tr>
<tr>
<td>H L</td>
<td>× × H ×</td>
</tr>
<tr>
<td>H H</td>
<td>× × × L</td>
</tr>
<tr>
<td>H H</td>
<td>× × × H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PD}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OD}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{OL}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{O}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC253</th>
<th>$P_{D}$</th>
<th>Decrease to $200$ mW at the rate of $8$ mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC253S</td>
<td>$P_{D}$</td>
<td>Decrease to $200$ mW at the rate of $3.8$ mW/°C</td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}$, $t_{f}$</td>
<td>$2.0$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{r}$, $t_{f}$</td>
<td>$4.5$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{r}$, $t_{f}$</td>
<td>$6.0$</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td>$T_{A}=25$ °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit</td>
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<td>$V_{O}$ $V_{CC}$ or GND</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

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<th>$T$ Test Conditions</th>
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<th>Temperature Ta=−40~+85°C</th>
<th>Unit</th>
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<td>3-state propagation time (L→Z)</td>
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Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

High-Speed CMOS Logic MN74HC Series

MN74HC257/MN74HC257S

Quad 2-Channel TRI-STATE Multiplexers

■ Description
MN74HC257/MN74HC257S contain four tri-state multiplexers selecting one input from two data inputs in one chip. Input is composed of two data inputs A, B each determining the output, output control, and select input common to four output groups. When output control is “H”, quad multiplexer outputs become high impedance. If select input is “H” at LOW level, data B status is output; if select input is “L”, data A status is output. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Truth Table

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<th>Input</th>
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<th>B</th>
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<td>A</td>
<td>B</td>
<td>Y</td>
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<tr>
<td>H</td>
<td>×</td>
<td>X</td>
<td>X</td>
<td>Hi-Z</td>
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<tr>
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Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance

■ Logic Diagram

[Logic Diagram Image]

Panasonic
### Absolute Maximum Ratings

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<th>Parameter</th>
<th>Symbol</th>
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<th>Unit</th>
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<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
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<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
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<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
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<td>Output current</td>
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<tr>
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<td>mA</td>
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<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
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### Operating Conditions

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<td>V</td>
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<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
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<td>V</td>
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<td>$4.5 \sim 500$</td>
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### DC Characteristics (GND=0V)

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## AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

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<tr>
<td>3-state propagation time (H→Z)</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>R_{L}=1kΩ</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
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<td></td>
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<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
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<td>R_{L}=1kΩ</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_{L}=1kΩ</td>
<td>10</td>
<td>20</td>
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<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>R_{L}=1kΩ</td>
<td>10</td>
<td>20</td>
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<td>4.5</td>
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<td>6.0</td>
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</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

(1) \( t_{\text{TLH}}, t_{\text{THL}}, t_{\text{PLH}}, t_{\text{PHL}} \)

1. Measuring Circuit

2. Waveforms

(2) \( t_{\text{PHZ}}, t_{\text{PZH}} \)

1. Measuring Circuit

2. Waveforms

(3) \( t_{\text{PILZ}}, t_{\text{PZL}} \)

1. Measuring Circuit

2. Waveforms

MN74HC258/MN74HC258S
Quad 2-Channel TRI-STATE Multiplexers (Inverted Output)

Description
MN74HC258/MN74HC258S contain four tri-state multiplexers selecting one input from two data inputs in one chip. Input is composed of two data inputs A, B each determining the output, output control, and select input common to four output groups. When output control is “H”, quad multiplexer outputs become high impedance. If select input is “H” inverted data B is output; if select inputs is “L”, inverted data A is output. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Select</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance

Logic Diagram

Pin configuration (top view)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>(-0.5 \sim V_{CC} +0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{PK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>( \pm 25 )</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{CCO} )</td>
<td>( \pm 50 )</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150 )</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>MN74HC258</th>
<th>( P_{D} )</th>
<th>400</th>
<th>( \text{mW} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{A} = -40 \sim +60 ) °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( T_{A} = +60 \sim +85 ) °C</td>
<td></td>
<td></td>
<td>Decrease to 200( \text{mW} ) at the rate of 8( \text{mW/°C} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MN74HC258S</th>
<th>( P_{D} )</th>
<th>275</th>
<th>( \text{mW} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{A} = -40 \sim +60 ) °C</td>
<td></td>
<td></td>
<td>Decrease to 200( \text{mW} ) at the rate of 3.8( \text{mW/°C} )</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>0 \sim V_{CC}</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>(-40 \sim +85 ) °C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0 \sim 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 \sim 500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 \sim 400 ns</td>
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</tr>
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</table>

### DC Characteristics (\( \text{GND}=0V \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_{I} )</td>
<td>( I_{O} )</td>
<td>( T_{A} = 25 ) °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
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<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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</tr>
<tr>
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<td>6.0</td>
<td></td>
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<td>4.5</td>
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<td></td>
</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>( I_{I} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or ( \text{GND} )</td>
<td>( \pm 0.1 )</td>
</tr>
<tr>
<td>3-state output off state</td>
<td>( I_{OZ} )</td>
<td>6.0</td>
<td>( V_{I} = V_{IH} ) or ( V_{IL} )</td>
<td>( V_{O} = V_{CC} ) or ( \text{GND} )</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or ( \text{GND} ), ( I_{O} = 0 )</td>
<td>8.0</td>
</tr>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ C$</td>
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<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td></td>
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<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
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</tr>
<tr>
<td>Output fall time</td>
<td>$t_{TIL}$</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Propagation time $A,B\rightarrow Y$ ($L\rightarrow H$)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
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<tr>
<td>Propagation time $A,B\rightarrow Y$ ($H\rightarrow L$)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>11</td>
<td>30</td>
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<tr>
<td></td>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>Propagation time $S\rightarrow Y$ ($L\rightarrow H$)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>14</td>
<td>30</td>
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<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time $S\rightarrow Y$ ($H\rightarrow L$)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td></td>
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</tr>
<tr>
<td>3-state propagation time ($H\rightarrow Z$)</td>
<td>$t_{PHZ}$</td>
<td>2.0</td>
<td>$R_i=1\text{k}\Omega$</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time ($L\rightarrow Z$)</td>
<td>$t_{PLZ}$</td>
<td>2.0</td>
<td>$R_i=1\text{k}\Omega$</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time ($Z\rightarrow H$)</td>
<td>$t_{PZH}$</td>
<td>2.0</td>
<td>$R_i=1\text{k}\Omega$</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time ($Z\rightarrow L$)</td>
<td>$t_{PZL}$</td>
<td>2.0</td>
<td>$R_i=1\text{k}\Omega$</td>
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<td>20</td>
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<td>4.5</td>
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<td></td>
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<td>6.0</td>
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</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

MN74HC266/MN74HC266S

Quad 2-Input Exclusive NOR (XNOR) Gates

- **Description**

MN74HC266/MN74HC266S contain quad 2-input exclusive NOR gates. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Logic Diagram (1 gate)**

- **Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>−0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I1K</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGD</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC266</td>
<td>Ta=−40~+60°C</td>
<td>Pb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta=+60~+85°C</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>MN74HC266S</td>
<td>Ta=−40~+60°C</td>
<td>Pb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta=+60~+85°C</td>
<td>275</td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of 8mW/°C

Decrease to 200mW at the rate of 3.8mW/°C
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40~+85$</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics ($GND=0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_0$</th>
<th>Temperature</th>
<th>$T_a=25°C$</th>
<th>$T_a=-40~+85°C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
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</tr>
<tr>
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<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>V</td>
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<td></td>
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<td>4.5</td>
<td>-20.0</td>
<td>4.4</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>5.9</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>2.0</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>4.5</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>6.0</td>
<td>V</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>3.86</td>
<td>V</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>5.96</td>
<td>V</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>6.0</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_0$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>μA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_0=0$</td>
<td>2.0</td>
<td>μA</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

## AC Characteristics ($GND=0V$, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_a=25°C$</th>
<th>$T_a=-40~+85°C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td>20.0</td>
<td>25</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>20</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>7</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>6</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (L → H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>20.0</td>
<td>25</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (H → L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>25</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

MN74HC273/MN74HC273S

Quad D-Type Flip-Flops with Clear

■ Description

MN74HC273/MN74HC273S contain eight D-type flip-flops with clear. This is a master/slave flip-flop with common clock and clear. D input data satisfying set-up time is transferred to output Q on the positive-going edge of the clock pulse. When the clear input is low, all outputs are set to low. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs are directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLR</td>
<td>CLK</td>
</tr>
<tr>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. ×: Data Input is transmitted to output during the rise of clock from “L” to “H”.
2. X: Either of “H” and “L” will do.
3. Q_L: Q level before establishment of input conditions shown in the table.

■ Logic Diagram
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IN}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{CCND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

- **MN74HC273**
  - $T_a = -40 \sim +60 °C$: $P_0 = 400$ mW
  - $T_a = +60 \sim +85 °C$: Decrease to 200mW at the rate of 8mW/°C
- **MN74HC273S**
  - $T_a = -40 \sim +60 °C$: $P_0 = 275$ mW
  - $T_a = +60 \sim +85 °C$: Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0 ~ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, tf}$</td>
<td>2.0</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>$-4.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>$-4.0$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>$20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>$20.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>$20.0$</td>
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<td></td>
<td></td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>$4.0$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$V_{IH}$</td>
<td>$4.0$</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IL}$</td>
<td>$5.2$</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
</tr>
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</table>
### AC Characteristics (GND=0V, Input transition time \( \leq 6\text{ns}, C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td>CLK( \rightarrow )Q (L( \rightarrow )H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td>CLK( \rightarrow )Q (H( \rightarrow )L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td>CLR( \rightarrow )Q (H( \rightarrow )L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td></td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_{h} )</td>
<td>2.0</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Minimum CLR pulse</td>
<td>( t_{w} )</td>
<td>2.0</td>
<td></td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>width</td>
<td></td>
<td>4.5</td>
<td></td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td></td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>35</td>
<td>28</td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Waveforms-1 \( (t_{\text{TLH}}, t_{\text{THL}}, t_{\text{su}}, f_{\text{max}}, t_{\text{PLH}}/t_{\text{PFL}}(\text{CLK} \rightarrow \text{Q}), t_{\text{rem}}, t_{\text{h}}) \)

Waveforms-2 \( (t_{\text{PFL}}(\text{CLR} \rightarrow \text{Q}), t_{w}) \)

---

Panasonic
MN74HC280/MN74HC280S

9-Bit Odd/Even Parity Generator/Checker

**Description**
MN74HC280/280S are 9-bit odd/even parity generator/checker, which have odd/even outputs to follow odd/even parity. Word length can be easily expanded by cascade connection. All inputs are compatible with TTL logic level: 0.8V or less is logic "0" and 2V or more is logic "1". Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input signal at HIGH level from data input (I₀～I₉)</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 2, 4, 6, 8</td>
<td>H</td>
</tr>
<tr>
<td>1, 3, 5, 7, 9</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level

**Logic Diagram**

![Logic Diagram](image)

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$P_D$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC280</td>
<td>$T_a = -40 \sim +60°C$</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC280S</td>
<td>$T_a = +60 \sim +85°C$</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td>mW</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>0 $\sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>$V_{CC}=2.0V$</td>
<td>0 $\sim$ 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=4.5V$</td>
<td>0 $\sim$ 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC}=6.0V$</td>
<td>0 $\sim$ 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_i$, $I_o$</td>
<td>$T_a=25°C$; $T_a=-40\sim+85°C$</td>
<td></td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>mA</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>mA</td>
<td>V</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>mA</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
<td>8.0</td>
<td>μA</td>
</tr>
</tbody>
</table>

---

Panasonic
# AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{\text{FLH}}$</td>
<td>2.0</td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{\text{FHL}}$</td>
<td>2.0</td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{\text{P LH}}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$I \rightarrow \Sigma E$</td>
<td></td>
<td></td>
<td>(L→H)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{\text{P HL}}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$I \rightarrow \Sigma O$</td>
<td></td>
<td></td>
<td>(H→L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{\text{P LH}}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$I \rightarrow \Sigma O$</td>
<td></td>
<td></td>
<td>(L→H)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time</td>
<td>$t_{\text{P HL}}$</td>
<td>2.0</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>$I \rightarrow \Sigma O$</td>
<td></td>
<td></td>
<td>(H→L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit ($t_{\text{P LH}}, t_{\text{PHL}}$)
  2. Waveforms
MN74HCT280/MN74HCT280S
9-Bit Odd/Even Parity Generator/Checker (TTL Input)

- **Description**
  MN74HCT280/MN74HCT280S are 9-bit odd/even parity generator/checker, which have odd/even outputs to follow odd/even parity. Word length can be easily expanded by cascade connection.
  All inputs are compatible with TTL logic level: 0.8V or less is logic "0" and 2V or more is logic "1". Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.
  Resistors and diodes are provided in \( V_{CC} \) and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input signal at HIGH level from data input ((I_0 \sim I_9))</th>
<th>Output (\Sigma E)</th>
<th>(\Sigma O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 2, 4, 6, 8</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>1, 3, 5, 7, 9</td>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. H: HIGH level
2. L: LOW level

- **Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>(V_{CC})</td>
<td>(-0.5 \sim +7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>(V_{I}, V_{O})</td>
<td>(-0.5 \sim V_{CC}+0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>(I_{IK})</td>
<td>(\pm 20)</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>(I_{OK})</td>
<td>(\pm 20)</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>(I_{O})</td>
<td>(\pm 25)</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>(I_{CC}, I_{GND})</td>
<td>(\pm 50)</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td></td>
<td>(-65 \sim +150)</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

- **MN74HCT280**
  - \(T_a=+60 \sim +85°C\)
  - \(P_D\) = 400 mW
  - Decrease to 200 mW at the rate of 8 mW/°C

- **MN74HCT280S**
  - \(T_a=+60 \sim +85°C\)
  - \(P_D\) = 275 mW
  - Decrease to 200 mW at the rate of 3.8 mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}(V))</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>(V_{CC})</td>
<td></td>
<td>4.5 ～ 5.5</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>(V_{I}, V_{O})</td>
<td></td>
<td>0 ～ (V_{CC})</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>(T_a)</td>
<td></td>
<td>(-40 \sim +85) °C</td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>(t_{r}, t_{f})</td>
<td>(V_{CC}=4.5) V</td>
<td>0 ～ 500</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}(V))</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(V_{I})</td>
<td>(I_{O})</td>
<td>(T_a=25°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>(V_{IH})</td>
<td>4.5 ～ 5.5</td>
<td>2.0</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ～ 5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>(V_{IL})</td>
<td>4.5 ～ 5.5</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ～ 5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>(V_{OH})</td>
<td>4.5 ～ 5.5</td>
<td>(V_{IH})</td>
<td>(-20.0) (\mu A)</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ～ 5.5</td>
<td>(V_{IL})</td>
<td>(-4.0) (mA)</td>
<td>3.86</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>(V_{OL})</td>
<td>4.5 ～ 5.5</td>
<td>(V_{IH})</td>
<td>20.0 (\mu A)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ～ 5.5</td>
<td>(V_{IL})</td>
<td>4.0 (mA)</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>(I_{I})</td>
<td>5.5</td>
<td>(V_{I}=V_{CC}) or GND</td>
<td>(\pm 0.1)</td>
<td>(\pm 1.0)</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>(I_{CC})</td>
<td>5.5</td>
<td>(V_{I}=V_{CC}) or GND, (I_{O}=0)</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \(C_L=50\text{pF}\))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(T_a=25^\circ\text{C})</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>(t_{TLH})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>(t_{THL})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PLH})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(I\rightarrow\Sigma E)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PHL})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(I\rightarrow\Sigma O)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PLH})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(I\rightarrow\Sigma E)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PHL})</td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(I\rightarrow\Sigma O)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (\(t_{PLH}, t_{PHL}\))
  2. Waveforms

---

**Panasonic**
MN74HC352/MN74HC352S

Dual 4-Input Multiplexers (Inverted Output)

**Description**

MN74HC352/352S are dual 4-input multiplexers which transfer one of four inverted data to output Y according to the common select input (A, B). Each multiplexer has a respective strobe input. Multiplexer functions at LOW level. At HIGH level, output is fixed LOW.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Select Inputs</th>
<th>Data Inputs</th>
<th>Enable</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>B  A</td>
<td>C0 C1 C2 C3</td>
<td>G</td>
<td>Y</td>
</tr>
<tr>
<td>X  X</td>
<td>X X X X</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L  L</td>
<td>L X X X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L  L</td>
<td>H X X X</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L  H</td>
<td>X L X X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L  H</td>
<td>H H X X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H  L</td>
<td>X X H X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H  L</td>
<td>H H X X</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H  H</td>
<td>X X X H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H  H</td>
<td>H H X X</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:

1. X: Either HIGH or LOW; it doesn’t matter

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>$-0.5 \sim V_{CC}$, $+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{CND}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC352</th>
<th>$P_{D}$</th>
<th>400</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC352S</td>
<td>$P_{D}$</td>
<td>275</td>
<td>mW</td>
</tr>
</tbody>
</table>

- Decrease to 200mW at the rate of 8mW/°C
- Decrease to 200mW at the rate of 3.8mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>0 $\sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0 $\sim$ 1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 $\sim$ 500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 $\sim$ 400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>$\mu A$</td>
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<tr>
<td></td>
<td>4.5</td>
<td>$-40$</td>
<td>$m A$</td>
<td>3.86</td>
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<td>6.0</td>
<td>$-5.2$</td>
<td>$m A$</td>
<td>5.36</td>
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<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td>4.5</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
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<td></td>
<td>4.5</td>
<td>4.0</td>
<td>$m A$</td>
<td>0.32</td>
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<td></td>
<td>6.0</td>
<td>5.2</td>
<td>$m A$</td>
<td>0.32</td>
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<tr>
<td>Input current</td>
<td>$I_{I}$</td>
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<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{O}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
</tr>
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</table>
**AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_{EE} ) Test Conditions</th>
<th>( T_a=25^\circ C )</th>
<th>( T_a=-40~+85^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td>8</td>
<td>15</td>
<td>19</td>
<td>75</td>
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<tr>
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<td>4.5</td>
<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>6</td>
<td>15</td>
<td>19</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Propagation time A, B→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>18</td>
<td>30</td>
<td>38</td>
<td>150</td>
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<td>4.5</td>
<td>26</td>
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<td></td>
<td>6.0</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Propagation time A, B→Y (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>26</td>
<td></td>
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<td></td>
<td>6.0</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Propagation time G→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>26</td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time G→Y (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>26</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time C→Y (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>19</td>
<td>35</td>
<td>44</td>
<td>175</td>
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<td>4.5</td>
<td>30</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Propagation time C→Y (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>20</td>
<td>35</td>
<td>44</td>
<td>175</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>30</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit
  2. Switching Waveforms

---

Panasonic
High-Speed CMOS Logic MN74HC Series

MN74HC353/MN74HC353S

Dual 4-Channel TRI-STATE Multiplexers (Inverted Output)

- Description
MN74HC353/MH74HC353S contain dual 4-channel tri-state multiplexers (Inverted Output) in one chip, selecting one input from four channel data input. The output control input controls two sets of four lines respectively. When output control is “H”, output becomes high impedance regardless of bus line. When output control input is “L”, the output channel suited to the data input signal from select input A or B is selected, the data is inverted and transferred to the output.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- Logic Diagram

- Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Select</th>
<th>Data</th>
<th>Output Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>A</td>
<td>C0</td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>×</td>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>×</td>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>×</td>
<td>×</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>×</td>
<td>×</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>×</td>
<td>×</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>×</td>
<td>×</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_i, V_o )</td>
<td>-0.5 \sim ( V_{CC} +0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_o )</td>
<td>( \pm 25 )</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{ND} )</td>
<td>( \pm 50 )</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC353</td>
<td></td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150 )</td>
</tr>
<tr>
<td>MN74HC353S</td>
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<td>( P_{D} )</td>
<td>400</td>
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<td>Power dissipation</td>
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<td>MN74HC353</td>
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<tr>
<td>MN74HC353S</td>
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</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_i, V_o )</td>
<td>0 \sim ( V_{CC} )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>(-40 \sim +85 )</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r, t_f )</td>
<td>2.0</td>
<td>0 \sim 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 \sim 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 \sim 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V)</td>
<td>( I)</td>
<td>( T_a=25^\circ C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>(-20.0 )</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>(-20.0 )</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( V_{IH} )</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>(-6.0 )</td>
<td>( V_{IL} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>(-7.8 )</td>
<td>( V_{IH} )</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( V_{IH} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( V_{IL} )</td>
</tr>
<tr>
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<td>6.0</td>
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<td>( V_{IL} )</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>7.8</td>
<td>( V_{IH} )</td>
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<td>Input current</td>
<td>( I_i )</td>
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<td>( V_i=V_{CC} ) or GND</td>
<td>( \pm 0.1 )</td>
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<tr>
<td>3-state output off state current</td>
<td>( I_{OZ} )</td>
<td>6.0</td>
<td>( V_{ih} ) or GND</td>
<td>( V_{il} )</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{IL} ) or GND, ( I_o=0 )</td>
<td>8.0</td>
</tr>
</tbody>
</table>

---
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td></td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>8 15 13</td>
<td>75 19 ns</td>
</tr>
<tr>
<td></td>
<td>t_{TLH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>6 15 13</td>
<td>75 19 ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>2.0 75 95</td>
<td>6 15 16 ns</td>
</tr>
<tr>
<td></td>
<td>t_{THL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>6 15 13</td>
<td>75 19 ns</td>
</tr>
<tr>
<td>Propagation time A,B→Y (L→H)</td>
<td>t_{PLH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>18 30 26</td>
<td>150 38 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PHL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>17 30 26</td>
<td>150 38 ns</td>
</tr>
<tr>
<td>Propagation time C→Y (L→H)</td>
<td>t_{PLH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>19 35 30</td>
<td>175 44 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PHL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>18 30 26</td>
<td>150 38 ns</td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>t_{PZH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>15 25 21</td>
<td>125 31 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PZH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>15 25 21</td>
<td>125 31 ns</td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>15 25 21</td>
<td>125 31 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PLZ}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>15 25 21</td>
<td>125 31 ns</td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>11 20 17</td>
<td>100 25 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PZH}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>11 20 17</td>
<td>100 25 ns</td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>19 35 30</td>
<td>175 44 ns</td>
</tr>
<tr>
<td></td>
<td>t_{PZL}</td>
<td></td>
<td>2.0</td>
<td>4.5 6.0</td>
<td>19 35 30</td>
<td>175 44 ns</td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

---

2. Waveforms

High-Speed CMOS Logic MN74HC Series

MN74HC365/MN74HC365S

Hex TRI-STATE Buffers

**Description**
MN74HC365/MN74HC365S are high-speed non-inverted buffers consisting of six tri-state outputs. Large current output makes possible high-speed operation for driving a large capacity bus line. The hex gate can be simultaneously controlled by two tri-state control inputs (G₁ and G₂) when output becomes enabled at LOW level.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G₁</td>
<td>Y</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn't matter
2. Hi-Z: High impedance

**Logic Diagram**

---
# High-Speed CMOS Logic MN74HC Series

## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>Condition</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40 \sim +60 \degree C$</td>
<td>$P_d$</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a = +60 \sim +85 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of $8 \mbox{mW/}^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a = -40 \sim +60 \degree C$</td>
<td>$P_d$</td>
<td>275</td>
<td>mW</td>
</tr>
<tr>
<td>$T_a = +60 \sim +85 \degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of $3.8 \mbox{mW/}^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, tf}$</td>
<td>$2.0$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 1000$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$4.5$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 500$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$6.0$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0 \sim 400$</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics ($GND=0V$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{I}$, $I_{O}$</td>
<td>$T_a=25 \degree C$</td>
<td>$T_a=-40 \sim +85 \degree C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-V_{IH}$</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-V_{IH}$</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-V_{IH}$</td>
<td>4.4</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>$-V_{IL}$</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-V_{IL}$</td>
<td>0.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>6.0</td>
<td>$-V_{IL}$</td>
<td>0.0</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or $GND$</td>
<td>±0.1</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_{I}=V_{IH}$ or $V_{IL}$</td>
<td>±0.5</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or $GND$, $I_{O}=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

· Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = 25^\circ C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Propagation time (L\rightarrow H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Propagation time (H\rightarrow L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>3-state propagation time (H\rightarrow Z)</td>
<td>( t_{PHZ} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>3-state propagation time (L\rightarrow Z)</td>
<td>( t_{PLZ} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>3-state propagation time (Z\rightarrow H)</td>
<td>( t_{PZH} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>3-state propagation time (Z\rightarrow L)</td>
<td>( t_{PZL} )</td>
<td>2.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

\( R_L = 1 \, \Omega \)
[2] $t_{PHZ}, t_{PZH}$
1. Measuring Circuit

2. Waveforms


[3] $t_{PLZ}, t_{PZL}$
1. Measuring Circuit

2. Waveforms
High-Speed CMOS Logic MN74HC Series

MN74HC366/MN74HC366S

Inverting Hex TRI-STATE Buffers

**Description**

MN74HC366/MN74HC366S are high-speed inverting buffers consisting of six tri-state outputs. Large current output makes possible high-speed operation for driving a large capacity bus line. Six gates can be simultaneously controlled by two tri-state control inputs ($G_1$ and $G_2$) where output becomes enable at LOW. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and family as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_1$</td>
<td>$G_2$</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,VO}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CL, I_{OL}}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC366</th>
<th>$T_a=−40 \sim +60$ °C</th>
<th>$P_{D}$</th>
<th>400 mA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_a=+60 \sim +85$ °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74HC366S</td>
<td>$T_a=−40 \sim +60$ °C</td>
<td>$P_{D}$</td>
<td>275 mW</td>
</tr>
<tr>
<td></td>
<td>$T_a=+60 \sim +85$ °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,VO}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$−40 \sim +85$ °C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r,tf}$</td>
<td>2.0</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td>$T_a=+25$ °C</td>
<td>$T_a=−40 \sim +85$ °C</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
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<td>1.5 V</td>
</tr>
<tr>
<td></td>
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<td>3.15 V</td>
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<td>4.2 V</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$ μA</td>
<td>1.9</td>
<td>1.9 V</td>
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<td></td>
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<td>4.4 V</td>
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<td></td>
<td>6.0</td>
<td>$-20.0$ μA</td>
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<td>5.9 V</td>
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<td></td>
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<td>4.5</td>
<td>$-6.0$ mA</td>
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<td>3.86 V</td>
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<td>6.0</td>
<td>$-7.8$ mA</td>
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<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>20.0 μA</td>
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<td></td>
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<td>4.5</td>
<td>20.0 μA</td>
<td>0.0</td>
<td>0.1 V</td>
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<td>6.0</td>
<td>20.0 μA</td>
<td>0.0</td>
<td>0.1 V</td>
</tr>
<tr>
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<td></td>
<td>4.5</td>
<td>6.0 mA</td>
<td>0.32</td>
<td>0.37 V</td>
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<td>7.8 mA</td>
<td>0.32</td>
<td>0.37 V</td>
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<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I} = V_{CC}$ or GND</td>
<td>±0.1 μA</td>
<td>±1.0 μA</td>
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<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
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<td>$V_{I} = V_{IH}$ or $V_{IL}$</td>
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<td>±5.0 μA</td>
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<td></td>
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<td>Quiescent supply current</td>
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<td>$V_{I} = V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0 μA</td>
<td>80.0 μA</td>
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</table>
High-Speed CMOS Logic MN74HC Series

MN74HC366/MN74HC366S

**AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
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<td>typ.</td>
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<tr>
<td>Output rise time</td>
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<td>4.5</td>
<td></td>
<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td>16</td>
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<td>Output fall time</td>
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<td>15</td>
</tr>
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<td></td>
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<td>4.5</td>
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<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>16</td>
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<tr>
<td>Propagation time (L→H)</td>
<td>t_{PLH}</td>
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<td></td>
<td>9</td>
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<td>4.5</td>
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<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td>16</td>
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<td>Propagation time (H→L)</td>
<td>t_{PHL}</td>
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<td>4.5</td>
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<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
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<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (H→Z)</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
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<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td>6.0</td>
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<td>21</td>
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<td>3-state propagation time (L→Z)</td>
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<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
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<td>R_L=1 kΩ</td>
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<td>20</td>
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<td>4.5</td>
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<td>17</td>
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<td>6.0</td>
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<td>21</td>
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</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
<td>13</td>
<td>20</td>
</tr>
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<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
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<td>6.0</td>
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<td>21</td>
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</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (t_{PLH}, t_{PHL})
  2. Waveforms

![Switching Time Measuring Circuit](image)

![Waveforms](image)
[2] $t_{PHZ}$, $t_{PZH}$

1. Measuring Circuit

2. Waveforms

![Waveform Diagram](image)

[3] $t_{PLZ}$, $t_{PZL}$

1. Measuring Circuit

2. Waveforms

See above [2]. 2. for waveforms.

![Waveform Diagram](image)
MN74HC367/MN74HC367S
Hex TRI-STATE Buffers

■ Description
MN74HC367/MN74HC367S are high-speed non-inverted buffers consisting of six tri-state outputs. Large current output makes possible high-speed operation for driving a large bus line. Two inputs (G1 and G2) are available where output becomes enable at LOW, and G1 controls four gates and G2 controls two gates respectively.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

■ Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance

■ Logic Diagram

Panasonic
# Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5~+7.0 V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5~V_{CC}+0.5 V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±35 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±70 mA</td>
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</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65~+150 °C</td>
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</tbody>
</table>

### Power dissipation

| MN74HC367                      | P_D | 400 mW         |
| MN74HC367S                     | P_D | Decrease to 200 mW at the rate of 8 mW/°C |

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0 V</td>
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</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>-40~+85 °C</td>
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</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>2.0 0~1000 ns</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 0~500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 0~400 ns</td>
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</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ta=25 °C</td>
<td>Ta=-40~+85 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
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<td>1.5</td>
<td>3.15</td>
</tr>
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<td>4.5 0.9</td>
<td>3.15</td>
<td>3.15</td>
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<td></td>
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<td>6.0 -20.0</td>
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<td>4.5</td>
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<td>Output HIGH voltage</td>
<td>V_{OH}</td>
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<td>-20.0</td>
<td>1.9</td>
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<td>4.5 0.9</td>
<td>-20.0</td>
<td>4.4</td>
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<td>6.0 -6.0</td>
<td>5.9</td>
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<td></td>
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<td>4.5 7.8</td>
<td>3.86</td>
<td>3.86</td>
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<td>6.0 -7.8</td>
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<td>V_{IH} 20.0</td>
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<td>4.5 0.9</td>
<td>V_{IH} 20.0</td>
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<td>6.0 0.3</td>
<td>V_{IH} 20.0</td>
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<td>4.5 0.3</td>
<td>V_{IL} 6.0</td>
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<td>V_{IL} 7.8</td>
<td>0.32</td>
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<td>I_{I}</td>
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<td>3-state output off state current</td>
<td>I_{O2}</td>
<td>6.0 V_{IH} or V_{IL}</td>
<td>±0.5</td>
<td>±5.0</td>
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<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>6.0 V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
<td>80.0</td>
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## AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>Ta=25°C</td>
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<td>min.  typ.  max.</td>
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<td>min.  max.</td>
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<td>6.0</td>
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<tr>
<td>Output fall time</td>
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<tr>
<td>Propagation time (L→H)</td>
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<td>Propagation time (H→L)</td>
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<tr>
<td>3-state propagation time</td>
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<td>R_L = 1 kΩ</td>
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<td>20</td>
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<td>6.0</td>
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<td></td>
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<tr>
<td>3-state propagation time</td>
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<td>R_L = 1 kΩ</td>
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<td>15</td>
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<td>4.5</td>
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<td>R_L = 1 kΩ</td>
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<td>15</td>
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<td>4.5</td>
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<td>6.0</td>
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</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit
2. Waveforms
[2] $t_{PHZ}, t_{PZH}$
1. Measuring Circuit

![Measuring Circuit Diagram]

2. Waveforms

![Waveforms Diagram]

[3] $t_{PLZ}, t_{PZL}$
1. Measuring Circuit

![Measuring Circuit Diagram]

2. Waveforms

MN74HC368/MN74HC368S

Inverting Hex TRI-STATE Buffers

**Description**

MN74HC368/MN74HC368S are high-speed inverting buffers consisting of six tri-state outputs. Large current output makes possible high-speed operating for driving a large capacitance bus line. Two inputs (G1 and G2) are available where output becomes enable at LOW, and G1 controls four gates and G2 controls two gates respectively.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

**Logic Diagram**
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>(-0.5 \sim V_{CC} +0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_O )</td>
<td>( \pm 35 )</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{OL} )</td>
<td>( \pm 70 )</td>
<td>mA</td>
</tr>
</tbody>
</table>

Storage temperature range \( T_{stg} \): 
- For MN74HC368: \( -65 \sim +150 \) °C
- For MN74HC368S: \( -40 \sim +85 \) °C

Power dissipation:
- MN74HC368: \( P_{D} = 400 \) mW
  - Decrease to 200 mW at the rate of 8 mW/°C
- MN74HC368S: \( P_{D} = 275 \) mW
  - Decrease to 200 mW at the rate of 3.8 mW/°C

**Operating Conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>0 \sim V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>0 \sim +1000</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r, t_f )</td>
<td>0 \sim 500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 \sim 400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

**DC Characteristics (GND = 0V)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>( T_a = 25^\circ C )</th>
<th>( T_a = -40 \sim +85^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( -20.0 ) ( \mu A )</td>
<td>4.4</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( -20.0 ) ( \mu A )</td>
<td>5.9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( -6.0 ) ( mA )</td>
<td>3.86</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( -7.8 ) ( mA )</td>
<td>5.36</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0 ( \mu A )</td>
<td>0.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0 ( \mu A )</td>
<td>0.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0 ( \mu A )</td>
<td>0.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>6.0 ( mA )</td>
<td>0.32</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7.8 ( mA )</td>
<td>0.32</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>( I_i )</td>
<td>6.0</td>
<td>( V_I = V_{CC} ) or GND</td>
<td>( \pm 0.1 )</td>
<td>( \pm 1.0 ) ( \mu A )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>( I_{OZ} )</td>
<td>6.0</td>
<td>( V_I = V_{IH} ) or ( V_{IL} )</td>
<td>( \pm 0.5 )</td>
<td>( \pm 5.0 ) ( \mu A )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I = V_{CC} ) or GND, ( I_0 = 0 )</td>
<td>8.0</td>
<td>80.0 ( \mu A )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>( T_a = 25^\circ C )</th>
<th>( T_a = -40^\circ C \sim +85^\circ C )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( (L \rightarrow H) )</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( (H \rightarrow L) )</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PHZ} )</td>
<td>2.0</td>
<td>( R_L = 1\text{k}\Omega )</td>
<td>13</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>21</td>
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</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PLZ} )</td>
<td>2.0</td>
<td>( R_L = 1\text{k}\Omega )</td>
<td>12</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PZH} )</td>
<td>2.0</td>
<td>( R_L = 1\text{k}\Omega )</td>
<td>9</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PZL} )</td>
<td>2.0</td>
<td>( R_L = 1\text{k}\Omega )</td>
<td>10</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
[2] \(t_{PHZ}, t_{PZH}\)
1. Measuring Circuit

2. Waveforms

[3] \(t_{PLZ}, t_{PZL}\)
1. Measuring Circuit

2. Waveforms

MN74HC373/MN74HC373S

Octal TRI-STATE D-Type Latches

**Description**

MN74HC373/MN74HC373S contain octal tri-state D-type latches. High output driving capacity and tri-state outputs are suited for the use of a common bus line in the bus utilized system. When output disable input is “L” and latch enable input is “H”, the output outputs the data input. When latch enable is “L”, data input is maintained as is until when latch enable input becomes “H” again. Output disable input is “H”, all inputs become high impedance state, regardless of other inputs and data-hold circuit.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Output Control</th>
<th>Enable G</th>
<th>D</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>×</td>
<td>$Q_0$</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
3. $Q_0$: 0 level prior to determination of input condition shown in table

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_K$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 35$ mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{ON}$</td>
<td>$\pm 70$ mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$ °C</td>
<td></td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th></th>
<th>MN74HC373</th>
<th>MN74HC373S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta $= -40 \sim +60$ °C</td>
<td>$P_D$</td>
<td>400 mW</td>
</tr>
<tr>
<td>Ta $= +60 \sim +85$ °C</td>
<td>$P_D$</td>
<td>275 mW</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 $\sim V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$ °C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2,0 ns $\sim$ 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5 ns $\sim$ 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,0 ns $\sim$ 400 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_I, I_O$</td>
<td>$T_a=25 °C$</td>
<td>$T_a=-40 \sim +85$ °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_a=25 °C$</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0, 4.5, 6.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0, 4.5, 6.0</td>
<td>-20.0</td>
<td>$V_{IH}$</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0, 4.5, 6.0</td>
<td>-20.0</td>
<td>$V_{IH}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0, 4.5, 6.0</td>
<td>$V_{IL}$</td>
<td>-6.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0, 4.5, 6.0</td>
<td>20.0</td>
<td>$V_{IH}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0, 4.5, 6.0</td>
<td>$V_{IL}$</td>
<td>-7.8</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_I=V_{IH}$ or $V_{IL}$</td>
<td>$\pm 0.5$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_O=V_{CC}$ or GND</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time \( \leq 6 \text{ns} \), \( C_L=50 \text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Propagation time D( \rightarrow )Q (L( \rightarrow )H)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time D( \rightarrow )Q (H( \rightarrow )L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
</tr>
<tr>
<td>Propagation time Enable G( \rightarrow )Q(L( \rightarrow )H)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>19</td>
</tr>
<tr>
<td>Propagation time Enable G( \rightarrow )Q(H( \rightarrow )L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
</tr>
<tr>
<td>3-state propagation time (H( \rightarrow )Z)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>17</td>
</tr>
<tr>
<td>3-state propagation time (L( \rightarrow )Z)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>18</td>
</tr>
<tr>
<td>3-state propagation time (Z( \rightarrow )H)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
</tr>
<tr>
<td>3-state propagation time (Z( \rightarrow )L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{SU} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>2</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_{H} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>—</td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

2. Waveforms

4. Measuring Circuit

2. Waveforms

MN74HC374/MN74HC374S
Octal TRI-STATE D-Type Flip-Flops

Description
MN74HC374/MN74HC374S contain eight high speed D-type flip-flops with tri-state outputs. High output driving capability and tri-state outputs are suited for the use of a common bus line in the bus utilized system. D input data satisfying set-up time is transferred to the output on the positive-going edge of clock input. When output disable input is HIGH, all outputs become high impedance state regardless of other input data and the data-hold circuit.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output Control</th>
<th>CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L, L, L</td>
<td>L</td>
<td>L</td>
<td>X</td>
<td>Q_0</td>
</tr>
<tr>
<td>H, L, X</td>
<td>L</td>
<td></td>
<td></td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. $\rightarrow$ : Data input is transferred to output on the positive-going edge from LOW to HIGH
2. $\times$ : Either HIGH or LOW; it doesn’t matter
3. Q_0: Q level prior to determination of input condition shown in table
4. Hi-Z: High impedance

Logic Diagram (1 gate)

[Diagram showing logic configuration]
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5\sim+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5\sim V_{CC} + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_K</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_OK</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_O</td>
<td>\pm 35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{O,H}</td>
<td>\pm 70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{STG}</td>
<td>-65\sim+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>MN74HC374</th>
<th>MN74HC374S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation</td>
<td>P_D</td>
<td>Ta=+-40\sim+60°C</td>
<td>Ta=+60\sim+85°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>V_{EE} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{EE}</td>
<td>1.4\sim6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0\sim V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_A</td>
<td>-40\sim+85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>2.0 \sim 8.0 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
<td>V_{I}</td>
<td>I_{O}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>2.0</td>
<td>V_{IH}</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>or -20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>V_{IH}</td>
<td>-6.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-7.8</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>2.0</td>
<td>V_{IH}</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>or 20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>V_{IH}</td>
<td>6.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7.8</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>3-state output off state</td>
<td>I_{OZ}</td>
<td>6.0</td>
<td>V_{I}=V_{OH} or V_{IL}</td>
<td>V_{O}=V_{CC} or GND</td>
</tr>
<tr>
<td>Quescent supply current</td>
<td>I_{CC}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td></td>
<td></td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td></td>
<td></td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>CLK→Q (L→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>R_L = 1kΩ</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>(H→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>R_L = 1kΩ</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_L = 1kΩ</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_L = 1kΩ</td>
<td>125</td>
<td>155</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Minimum pulse width</td>
<td>t_{su}</td>
<td>2.0</td>
<td></td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{h}</td>
<td>2.0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>64</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

(1) \( t_{\text{fLH}}, t_{\text{fHL}}, t_{\text{fPHL}}, t_{\text{fPHD}} (D \rightarrow Q) \)

2. Waveforms

(2) \( t_{\text{fPLH}}, t_{\text{fPHL}} (E_{\text{NG}} \rightarrow Q) \)

3. \( t_{\text{fPHZ}}, t_{\text{fPZH}} \)

4. \( t_{\text{fPLZ}}, t_{\text{fPZL}} \)
MN74HC375/MN74HC375S

4-Bit Bistable Latches

**Description**
MN74HC375/MH74HC375S are bistable latches with four bit Q, Q output. These are suited for temporary binary data memory circuits between the data processing unit and the I/O, or between display units. Data at data input (D) are transferred to output Q when enable pin (G) is “H”; output Q follows the data input state so long as the enable is “H”. When enable becomes “L”, output Q is maintained as is until when the enable becomes “H”. Output Q indicates the data input state when the enable changes from “H” to “L”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL IO-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>G</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>x</td>
<td>L</td>
</tr>
</tbody>
</table>

Note:
1. x: Either HIGH or LOW; it doesn’t matter
2. Qo: Q level prior to determination of input condition shown in table
3. Qo: Q level prior to determination of input condition shown in table

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 ~ +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 ~ V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{NAD}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td></td>
<td>$T_{stg}$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

- **MN74HC375**
  - $T_a = -40 ~ +85 ^\circ C$
  - $P_{DI} = 400 mW$
  - Decrease to 200mW at the rate of 8mW/°C
- **MN74HC375S**
  - $T_a = -40 ~ +85 ^\circ C$
  - $P_{DI} = 275 mW$
  - Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>0 ~ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 ~ +85 ^\circ C$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, t_f}$</td>
<td>2.0</td>
<td>0 ~ 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 ~ 500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 ~ 400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_i$</td>
<td>$I_o$</td>
<td>$T_a=25 ^\circ C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td>max.</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.9</td>
<td>max.</td>
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<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>4.5</td>
<td>$-4.0$</td>
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<td>$-5.2$</td>
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<td>Input current</td>
<td>$I_i$</td>
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<td>$V_i=V_{CC}$ or GND</td>
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<td>Quiescent supply current</td>
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<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
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# AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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• Switching Time Measuring Circuit and Waveforms

(1) \( t_{\text{TTLH}}, t_{\text{THL}}, t_{\text{PLH}} / t_{\text{PHL}} (D \rightarrow Q, \overline{Q}) \)

1. Measuring Circuit

![Measuring Circuit Diagram]

2. Waveforms

![Waveform Diagram]

(2) \( t_{\text{PLH}} / t_{\text{PHL}} (G \rightarrow Q, \overline{Q}), t_w, t_{su}, t_h \)

1. Measuring Circuit

![Measuring Circuit Diagram]

2. Waveforms

![Waveform Diagram]
**MN74HC377/MN74HC377S**

Octal D-Type Flip-Flop with Enable Data

**Description**

MN74HC377/377S contain eight high-speed D-type flip-flops with enable data. D input data satisfying set-up time is transferred to the output Q on the rising edge of clock input, when enable data input CE is “L”. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Input</th>
<th>Output</th>
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<tbody>
<tr>
<td></td>
<td>CLK</td>
<td>CE</td>
</tr>
<tr>
<td>Load “1”</td>
<td>√</td>
<td>L</td>
</tr>
<tr>
<td>Load “0”</td>
<td>√</td>
<td>L</td>
</tr>
<tr>
<td>Hold (Do nothing)</td>
<td>H</td>
<td>×</td>
</tr>
</tbody>
</table>

Note:
1. √: Data input is transferred to output on the positive-going edge from LOW to HIGH.
2. ×: Either HIGH or LOW; it doesn’t matter.

**Logic Diagram**

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5) to (+7.0 ) V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_i, V_o )</td>
<td>(-0.5) to (+V_{CC}+0.5 ) V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_K )</td>
<td>( \pm20 ) mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_O )</td>
<td>( \pm20 ) mA</td>
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</tr>
<tr>
<td>Output current</td>
<td>( I_O )</td>
<td>( \pm25 ) mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC, \text{GND}} )</td>
<td>( \pm50 ) mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65) to (+150 ) °C</td>
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</table>

#### Power Dissipation

<table>
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<th>Power Dissipation</th>
<th>Symbol</th>
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<th>Unit</th>
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<tbody>
<tr>
<td>MN74HC377</td>
<td>( P_D )</td>
<td>400 mW</td>
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</tr>
<tr>
<td>Ta=(-40) to (+60 ) °C</td>
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<tr>
<td>Ta=(+60) to (+85 ) °C</td>
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<tr>
<td>MN74HC377S</td>
<td>( P_D )</td>
<td>275 mW</td>
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<tr>
<td>Ta=(-40) to (+60 ) °C</td>
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<td>Ta=(+60) to (+85 ) °C</td>
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Decrease to 200mW at the rate of 8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 to 6.0 V</td>
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<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_i, V_o )</td>
<td>0 (-V_{CC} )</td>
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<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>(-40) to (+85 ) °C</td>
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<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r, t_f )</td>
<td>( V_{CC}=2.0 ) V</td>
<td>( 0) to ( 1000 ) ns</td>
<td>ns</td>
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<td>( V_{CC}=4.5 ) V</td>
<td>( 0) to ( 500 ) ns</td>
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<td>( V_{CC}=6.0 ) V</td>
<td>( 0) to ( 400 ) ns</td>
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### DC Characteristics (GND=0V)

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<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tr>
<td></td>
<td></td>
<td>( V_i ) ( I_O )</td>
<td>( V_{Hi} )</td>
<td>( V_{Lo} )</td>
<td>( T_A=25°C )</td>
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<tr>
<td>Input HIGH voltage</td>
<td>( V_{Hi} )</td>
<td>2.0 4.5 6.0</td>
<td>1.5 3.15 4.2</td>
<td>( \mu A )</td>
<td>1.9 4.4 5.9 6.0</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{Oh} )</td>
<td>2.0 4.5 6.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>1.9 4.4 5.9 6.0</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>6.0 4.5 6.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>1.9 4.4 5.9 6.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{Il} )</td>
<td>2.0 4.5 6.0</td>
<td>0.3 0.9 1.2</td>
<td>( \mu A )</td>
<td>0.3 0.9 1.2</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{Ol} )</td>
<td>2.0 4.5 6.0</td>
<td>( 20.0 )</td>
<td>( \mu A )</td>
<td>0.0 0.1 0.1</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>6.0 4.5 6.0</td>
<td>( 20.0 )</td>
<td>( \mu A )</td>
<td>0.0 0.1 0.1</td>
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<td>Input current</td>
<td>( I_i )</td>
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<td>( V_i=V_{CC} ) or GND</td>
<td>( \pm0.1 )</td>
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<td>Quiescent supply current</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
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<td>Ta=25°C</td>
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<td></td>
<td>Ta=−40~+85°C</td>
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<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
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<td>75</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>75</td>
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<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
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<td>6.0</td>
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</tr>
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<td>CLK→D (L→H)</td>
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<td>4.5</td>
<td>6.0</td>
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<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
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<td>CLK→D (H→L)</td>
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<td>6.0</td>
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<tr>
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<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
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<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
</tbody>
</table>

---

Panasonic
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms
**MN74HCT377/MN74HCT377S**

Octal D-Type Flip-Flop with Enable Data (TTL Input)

**Description**

MN74HCT377/MN74HCT377S contain eight high-speed D-type flip-flops with enable data. D input data satisfying set-up time is transferred to the output Q on the positive-going edge of clock input, when enable data input \( \overline{CE} \) is "L".

All inputs are compatible with TTL logic level: 0.8V or less is logic "0" and 2V or more is logic "1". Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven.

Resistors and diodes are provided in \( V_{CC} \) and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CLK</td>
<td>CE</td>
</tr>
<tr>
<td>Load &quot;1&quot;</td>
<td>( \nearrow )</td>
<td>L</td>
</tr>
<tr>
<td>Load &quot;0&quot;</td>
<td>( \nearrow )</td>
<td>L</td>
</tr>
<tr>
<td>Hold (Do nothing)</td>
<td>( \nearrow )</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:

1. \( \nearrow \): Data input is transferred to output on the positive-going edge from LOW to HIGH.
2. \( \times \): Either HIGH or LOW; it doesn't matter.

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5~+7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{IH}, V_{OL}</td>
<td>-0.5~V_{CC}+0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IP}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OP}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65~+150 °C</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>MN74HCT377</th>
<th>MN74HCT377S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=−40~+60°C</td>
<td>P_{D}</td>
<td>400 mW</td>
<td>275 mW</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td>P_{D}</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC}(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>4.5~5.5 V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{IH}, V_{OL}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>−40~+85 °C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>V_{CC}=4.5V</td>
<td>0~500 ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>4.5</td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>V_{V}</td>
<td>V_{T}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>4.5</td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>V_{V}</td>
<td>V_{T}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>4.5</td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>V_{V} or V_{IL}</td>
<td>V_{T}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−20.0</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−4.0</td>
<td>3.86</td>
<td>3.76</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>4.5</td>
<td>min. typ. max.</td>
<td>min. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>V_{V} or V_{IL}</td>
<td>V_{T}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>5.5</td>
<td>V_{V}=V_{CC} or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>5.5</td>
<td>V_{V}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a=25^\circ C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>4.5</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>4.5</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Propagation time CLK→D</td>
<td>( t_{P LH} )</td>
<td>4.5</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(L→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time CLK→D</td>
<td>( t_{PHL} )</td>
<td>4.5</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time D</td>
<td>( t_{su} )</td>
<td>4.5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Minimum Set-up time CE</td>
<td>( t_{su} )</td>
<td>4.5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Minimum Hold time D</td>
<td>( t_{h} )</td>
<td>4.5</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Minimum Hold time CE</td>
<td>( t_{h} )</td>
<td>4.5</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Minimum pulse width CLK</td>
<td>( t_{w} )</td>
<td>4.5</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>4.5</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (\(t_{\text{PLH}}, t_{\text{PHL}}\))

2. Waveforms
High-Speed CMOS Logic MN74HC Series

MN74HC386/MN74HC386S

Quad 2-Input Exclusive OR Gates

**Description**

MN74HC386/MN74HC386S contain quad 2-input exclusive OR gates.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>(-0.5 \sim V_{CC} +0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{DI} )</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{DO} )</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>\pm 25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{GND} )</td>
<td>\pm 50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150)</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC386</td>
<td>( P_{D} ) ( T_{a} = -40 \sim +60)</td>
<td>400 mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MN74HC386S</td>
<td>( P_{D} ) ( T_{a} = -40 \sim +60)</td>
<td>275 mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
</tr>
</tbody>
</table>
# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}$, $V_{O}$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40~+85$</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{l}$</td>
<td>2.0</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>Temperature</th>
<th>$T_{A}=25^\circ C$</th>
<th>$T_{A}=-40~+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td></td>
<td>1.5</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>3.15</td>
<td>3.15</td>
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<td>V</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>4.2</td>
<td>4.2</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>μA</td>
<td>4.4</td>
<td>4.5</td>
<td>4.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>μA</td>
<td>5.9</td>
<td>6.0</td>
<td>5.9</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-4.0</td>
<td>mA</td>
<td>3.86</td>
<td>3.76</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>μA</td>
<td>4.4</td>
<td>4.5</td>
<td>4.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-5.2</td>
<td>mA</td>
<td>5.36</td>
<td>5.26</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>mA</td>
<td>0.32</td>
<td>0.37</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
<td>0.37</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td></td>
<td>±1.0</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>2.0</td>
<td></td>
<td>20.0</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_{L}=50$pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>$T_{A}=25^\circ C$</th>
<th>$T_{A}=-40~+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{I}$</td>
<td>$I_{O}$</td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
<td></td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
<td>ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td></td>
<td>20</td>
<td>75</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>6</td>
<td>13</td>
<td>16</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
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<td></td>
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<td>4.5</td>
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<td>8</td>
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<td></td>
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<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
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<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
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<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
<td>ns</td>
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<td>4.5</td>
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<td></td>
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<td>15</td>
<td>19</td>
<td>ns</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
<td>ns</td>
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</table>
MN74HC390/MN74HC390S
Dual 4-Bit Decade Counters

**Description**
MN74HC390/MN74HC390S are independent ripple-carry counters consisting of two decade counters. The decade counter consists of divide-by-two and divide-by-five counters. Divide-by-two and divide-by-five counters can have a maximum of divide-by-100 counters by using two decade counters or combinations. This counter provides increments on the negative-going edge of clock input, and each has independent clear input. When the clear input is HIGH, all of the four outputs of each counter become LOW. The clear input decreases the count number and functions to make this counter a Modulo-N counter. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Logic Diagram**
### Truth Table

<table>
<thead>
<tr>
<th>A or B</th>
<th>CLR</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>L</td>
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</table>

* Output QA to be connected to input B

<table>
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<th>Output</th>
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<td>0</td>
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<tr>
<td>1</td>
<td>L</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>L</td>
</tr>
<tr>
<td>5</td>
<td>L</td>
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<tr>
<td>6</td>
<td>L</td>
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<td>7</td>
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<tr>
<td>8</td>
<td>L</td>
</tr>
<tr>
<td>9</td>
<td>H</td>
</tr>
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</table>

* Output QD to be connected to input A

<table>
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<tr>
<td>1</td>
<td>L</td>
</tr>
<tr>
<td>2</td>
<td>L</td>
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<tr>
<td>3</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>L</td>
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<td>5</td>
<td>H</td>
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<tr>
<td>8</td>
<td>H</td>
</tr>
<tr>
<td>9</td>
<td>H</td>
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</tbody>
</table>

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I},V_{O}</td>
<td>-0.5~V_{CC} +0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{CM}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

- MN74HC390: $T_{a}=-40~+60°C$  
  - $P_{T1} = 400$ mW  
  - Decrease to 200mW at the rate of 8mW/°C
- MN74HC390S: $T_{a}=-40~+60°C$  
  - $P_{T1} = 275$ mW  
  - Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I},V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>-40~+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r},t_{f}$</td>
<td>2.0~1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5~500</td>
<td>ns</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0~400</td>
<td>ns</td>
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</tbody>
</table>
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>$V_I$</th>
<th>$I_O$</th>
<th>$T_a=25^\circ C$</th>
<th>$T_a=-40\sim+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
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<td></td>
<td>V</td>
</tr>
<tr>
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<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
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<td></td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
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<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
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<td>4.5</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
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<td></td>
<td>V</td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$V_{IH}$</td>
<td>-20.0</td>
<td>$V_{OH}$</td>
<td>-20.0</td>
<td>1.9</td>
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<tr>
<td></td>
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<td>4.5</td>
<td>$V_{IH}$</td>
<td>-20.0</td>
<td>$V_{OH}$</td>
<td>-20.0</td>
<td>4.4</td>
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<td>6.0</td>
<td>$V_{IH}$</td>
<td>-4.0</td>
<td>$V_{OH}$</td>
<td>-20.0</td>
<td>3.86</td>
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<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
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<td>$V_{IH}$</td>
<td>20.0</td>
<td>$V_{OL}$</td>
<td>20.0</td>
<td>0.0</td>
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<td>4.5</td>
<td>$V_{IH}$</td>
<td>20.0</td>
<td>$V_{OL}$</td>
<td>20.0</td>
<td>0.0</td>
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<td>6.0</td>
<td>$V_{IH}$</td>
<td>4.0</td>
<td>$V_{OL}$</td>
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<td>6.0</td>
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<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>$\pm 1.0$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
<td>8.0</td>
<td>80.0</td>
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### AC Characteristics (GND=0V, Input transition time $\leqslant 6$ns, $C_L=50\mu F$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_a=25^\circ C$</th>
<th>$T_a=-40\sim+85^\circ C$</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<td>Output fall time</td>
<td>$t_{THL}$</td>
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<td>19</td>
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<td>6.0</td>
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<td>13</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>65</td>
<td>81</td>
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<td>55</td>
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<td>$A\rightarrow Q_C$ (L→H)</td>
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<td>325</td>
<td>65</td>
<td>81</td>
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<td>$A\rightarrow Q_C$ (H→L)</td>
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<td>325</td>
<td>65</td>
<td>81</td>
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<td>6.0</td>
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### AC Characteristics (Cont'd)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Typ.</td>
<td>Max.</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_B ) (L→H)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_B ) (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_C ) (L→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_C ) (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_D ) (L→H)</td>
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<td></td>
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</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>( B\rightarrow Q_D ) (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{FLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
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<tr>
<td>CLR→Q (H→L)</td>
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<td></td>
</tr>
<tr>
<td>Minimum pulse width</td>
<td>( t_w )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>CLK(A),CLK(B),CLR</td>
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</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

- **Switching Time Measuring Circuit and Waveforms**

1. Measuring Circuit

2. Waveforms

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Panasonic
MN74HC393/MN74HC393S
Dual 4-Bit Binary Counters

Description
MN74HC393/MN74HC393S are independent ripple-carry counters consisting of two independent 4-bit ripple-carry binary counters which can be subsidiarily connected to one divide-by-256 counter. This counter provides increments on the negative-going edge of clock input, and each has independent clear input. When the clear input is HIGH, all of the four outputs of each counter become LOW. The clear input decrease the count number and functions to make this counter a Modulo-N counter. Adoption of a silicon gate CMOS process has realized a low power dissipation, high noise margin equivalent to a standard CMOS and operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

Logic Diagram

Pin Configuration (top view)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
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<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{O(N)}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Power Dissipation

<table>
<thead>
<tr>
<th></th>
<th>MN74HC393</th>
<th></th>
<th></th>
<th>MN74HC393S</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>$P_{D}$</td>
<td>$400$</td>
<td>mW</td>
<td></td>
<td>$275$</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>Ta $=-40 \sim +60$ °C</td>
<td></td>
<td></td>
<td></td>
<td>Ta $=-40 \sim +60$ °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
<td></td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 $\sim$ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>0 $\sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0 $\sim$ 0 $\sim$ 1000 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 $\sim$ 0 $\sim$ 500 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 $\sim$ 0 $\sim$ 400 ns</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0 $\sim$ 6.0</td>
<td>$V_{I}, I_{O}$</td>
<td>$T_{A}=25$ °C $T_{A}=-40 \sim +85$ °C</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.5 $\mu A$</td>
<td>1.9</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>3.15 $\mu A$</td>
<td>4.4</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>4.2 $\mu A$</td>
<td>5.9</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0 $\sim$ 6.0</td>
<td>$V_{I}, I_{O}$</td>
<td>$T_{A}=25$ °C $T_{A}=-40 \sim +85$ °C</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>0.3 $\mu A$</td>
<td>0.9</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>0.9 $\mu A$</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0 $\sim$ 6.0</td>
<td>$V_{I}, I_{O}$</td>
<td>$T_{A}=25$ °C $T_{A}=-40 \sim +85$ °C</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.9 $\mu A$</td>
<td>4.4</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>5.9 $\mu A$</td>
<td>6.0</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0 $\sim$ 6.0</td>
<td>$V_{I}, I_{O}$</td>
<td>$T_{A}=25$ °C $T_{A}=-40 \sim +85$ °C</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>0.0 $\mu A$</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>0.0 $\mu A$</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0 $V_{I}=V_{CC}$ or GND</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0 $\sim$ 80.0</td>
<td>µA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0 $V_{I}=V_{CC}$ or GND</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0 $\sim$ 80.0</td>
<td>µA</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L = 50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Condition</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( T_a = 25^\circ C )</td>
<td>( T_a = -40^\circ C ) to ( +85^\circ C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{TLH} )</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td></td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( A \Rightarrow Q_A ) (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>27</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( A \Rightarrow Q_A ) (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>24</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( A \Rightarrow Q_D ) (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td></td>
<td>53</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( A \Rightarrow Q_D ) (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>53</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time ( CLR \Rightarrow Q ) (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td></td>
<td>33</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum pulse width ( CLK, \ CLR )</td>
<td>( t_w )</td>
<td>2.0</td>
<td></td>
<td>16</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum set-up time</td>
<td>( t_{rem} )</td>
<td>2.0</td>
<td></td>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>35</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms

![Waveforms Diagram]

### Truth Table

<table>
<thead>
<tr>
<th>A</th>
<th>CLR</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Count</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn't matter
2. \_\_\_: count on the negative-going edge from HIGH to LOW of A
**MN74HC533/MN74HC533S**

Octal TRI-STATE D-Type Latches with Inverting Outputs

**Description**

MN74HC533/MN74HC533S contain eight high-speed D-type latches with inverting tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system.

When output disable input is LOW and latch enable input is HIGH, the output outputs the inverting data input state.

When latch enable is LOW, the data input data is held in the output until when latch enable input becomes HIGH.

When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in V<sub>CC</sub> and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Output Control</th>
<th>Enable G</th>
<th>D</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn't matter
2. Hi-Z: High impedance
3. Q<sub>0</sub>: Q level prior to determination of input condition shown in table

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>-0.5--+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;O&lt;/sub&gt;</td>
<td>-0.5--V&lt;sub&gt;CC&lt;/sub&gt;+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I&lt;sub&gt;IK&lt;/sub&gt;</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I&lt;sub&gt;OK&lt;/sub&gt;</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;, I&lt;sub&gt;AND&lt;/sub&gt;</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>-65--+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt;</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC533</td>
<td></td>
<td></td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>400  mW</td>
</tr>
<tr>
<td>MN74HC533S</td>
<td></td>
<td></td>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>275  mW</td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of 8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>1.4--6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;I&lt;/sub&gt;, V&lt;sub&gt;O&lt;/sub&gt;</td>
<td>0--V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>-40--+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t&lt;sub&gt;r&lt;/sub&gt;, t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>2.0</td>
<td>0--1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0--500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0--400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V&lt;sub&gt;L&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0, 4.5, 6.0</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>2.0, 4.5, 6.0, 4.5, 6.0</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>I&lt;sub&gt;OZ&lt;/sub&gt;</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;=25°C</td>
<td>T&lt;sub&gt;A&lt;/sub&gt;=−40--+85°C</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>-20.0, -7.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>-20.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0 V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>I&lt;sub&gt;OZ&lt;/sub&gt;</td>
<td>6.0 V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;H&lt;/sub&gt; or V&lt;sub&gt;L&lt;/sub&gt; V&lt;sub&gt;O&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.5</td>
<td>±5.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0 V&lt;sub&gt;I&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND, I&lt;sub&gt;O&lt;/sub&gt;=0</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_a=25^\circ\text{C}$</th>
<th>$T_a=-40\sim+85^\circ\text{C}$</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<tr>
<td>Output rise time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
<td>95</td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time D→$\overline{Q}$ (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>13</td>
<td>20</td>
<td>125</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td>6.0</td>
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<tr>
<td>Propagation time D→$\overline{Q}$ (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>12</td>
<td>20</td>
<td>125</td>
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<td></td>
<td>6.0</td>
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</tr>
<tr>
<td>Propagation time Enable G→$\overline{Q}$ (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
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<td>14</td>
<td>25</td>
<td>155</td>
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<td>6.0</td>
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<tr>
<td>Propagation time Enable G→$\overline{Q}$ (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>15</td>
<td>25</td>
<td>155</td>
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<td></td>
<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>$t_{PHZ}$</td>
<td>2.0</td>
<td>$R_L=1\text{k}\Omega$</td>
<td>14</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
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</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>$t_{PLZ}$</td>
<td>2.0</td>
<td>$R_L=1\text{k}\Omega$</td>
<td>10</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>$t_{PZH}$</td>
<td>2.0</td>
<td>$R_L=1\text{k}\Omega$</td>
<td>10</td>
<td>20</td>
<td>125</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>$t_{PZL}$</td>
<td>2.0</td>
<td>$R_L=1\text{k}\Omega$</td>
<td>12</td>
<td>20</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>$t_{su}$</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
<td>19</td>
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</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>$t_{h}$</td>
<td>2.0</td>
<td></td>
<td>—</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>—</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>—</td>
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<td>0</td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

4. Waveforms

MN74HC534/MN74HC534S
Octal TRI-STATE D-Type Flip-Flops with Inverting Outputs

**Description**

MN74HC534/MN74HC534S contain eight high-speed D-type flip-flops with inverting tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system. D input data satisfying set-up time is inverted and transferred to the output on the positive going edge of clock input. When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in \( V_{cc} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Output Control</th>
<th>CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ×: Data input is transferred to output on the negative-going edge from LOW to HIGH of the clock.
2. ×: Either HIGH or LOW; it doesn’t matter.
3. \( Q_0 \): \( O \) level prior to determination of input condition shown in table.

**Logic Diagram**

[Diagram of Octal TRI-STATE D-Type Flip-Flops with Inverting Outputs]
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>-0.5~VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIN</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOUT</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGN</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>TSTL</td>
<td>-65~+150</td>
<td>℃</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Dissipation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC534</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>MN74HC534S</td>
</tr>
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<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>0~VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40~+85</td>
<td>℃</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0~1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0~500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>ns</td>
<td></td>
</tr>
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<td></td>
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<td>0~400</td>
<td>ns</td>
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### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vl</td>
<td>Io</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>VIH</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
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<td></td>
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<td>4.5</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>VOH</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 V</td>
<td>4.4</td>
<td>4.5</td>
</tr>
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<td></td>
<td>or</td>
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<td>5.9</td>
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<td></td>
<td>6.0</td>
<td>-7.8</td>
<td>3.86</td>
<td>3.76</td>
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<td>Output LOW voltage</td>
<td>VOL</td>
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<td>0.0</td>
<td>0.1</td>
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<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>6.0</td>
<td>0.32</td>
<td>0.37</td>
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<td></td>
<td>6.0</td>
<td>7.8</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0 VCC</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>IiO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0 VCC</td>
<td>±0.5</td>
<td>±5.0</td>
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</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature Condition</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>8</td>
</tr>
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<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>17</td>
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<tr>
<td>Propagation time CLK→\overline{Q} (L→H)</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>17</td>
</tr>
<tr>
<td>Propagation time CLK→\overline{Q} (H→L)</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>13</td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>13</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t_{su}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>2</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{h}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>2</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
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</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

![Circuit Diagram](image1)

2. Waveforms

![Waveform Graph](image2)

2. Waveforms

**MN74HC540/MN74HC540S**

Inverting Octal TRI-STATE Buffers Line Drivers

**Description**
MN74HC540/MN74HC540S are inverting octal tri-state buffers line drivers. Large current output make possible high-speed operation for driving a large capacity bus line. When one of 3-state control input (G1, G2) operated as 2 inputs NOR is “H”, 8 outputs become high impedance.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI</td>
<td>G2</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
</tbody>
</table>

**Note:**
1. ×: Either HIGH or LOW; doesn’t matter
2. Hi-Z: Hi-Impedance

**Logic Diagram**

---

**Pin Configuration (top view)**

---
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>Vih, Vo</td>
<td>-0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IiK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IoK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, In</td>
<td>±70</td>
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</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65~+150</td>
<td>°C</td>
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#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc(V)</th>
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<th>Unit</th>
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<tbody>
<tr>
<td>MN74HC540</td>
<td>Pd</td>
<td>400</td>
<td>kW</td>
<td></td>
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<tr>
<td>MN74HC540S</td>
<td>Pd</td>
<td>275</td>
<td>kW</td>
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Decrease to 200mW at the rate of 8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Vcc(V)</th>
<th>Rating</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output</td>
<td>Vih, Voi</td>
<td>0~Vcc</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
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<td>-40~+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tio, tif</td>
<td>Vcc=2.0V</td>
<td>0~1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vcc=4.5V</td>
<td>0~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vcc=6.0V</td>
<td>0~400</td>
<td>ns</td>
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### DC Characteristics (GND=0V)

<table>
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<tr>
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<th>Symbol</th>
<th>Vcc(V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vih (V)</td>
<td>Ii</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
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<td>Input HIGH voltage</td>
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<td>1.5</td>
<td>1.5</td>
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<td>3.15</td>
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<td>4.2</td>
<td>4.2</td>
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<td>Input LOW voltage</td>
<td>ViL</td>
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<td>0.3</td>
<td>0.3</td>
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<td>0.9</td>
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<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>VoH</td>
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<td>-20.0</td>
<td>µA</td>
<td>1.9</td>
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<td>-20.0</td>
<td>µA</td>
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<td>-20.0</td>
<td>µA</td>
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<td>µA</td>
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<td>20.0</td>
<td>µA</td>
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<td>mA</td>
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<td>7.8</td>
<td>mA</td>
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</table>

Input current                            | Ii     | 6.0  | Vi=Vcc or GND | ±0.1  | ±1.0 | µA |

3-state output off state current          | Ioz    | 0.6  | Vi=Vih or ViL, Vo=Vcc or GND | ±0.5  | ±5.0 | µA |

Quiescent supply current                 | Icc    | 6.0  | Vi=Vcc or GND, Io=0 | 8.0   | 80.0 | µA |
### AC Characteristics (GND=0V, Input transistion time = 6ns, C_L = 50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_CC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Ta=25°C</td>
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<td></td>
<td>Ta=-40~+85°C</td>
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<td></td>
<td></td>
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<td>min.</td>
<td>typ.</td>
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<td>12</td>
<td>15</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_THL</td>
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<td></td>
<td>22</td>
<td>75</td>
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<td>6.0</td>
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<td>7</td>
<td>13</td>
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<td>Propagation time (L→H)</td>
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<td>39</td>
<td>90</td>
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<td>4.5</td>
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<td>14</td>
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<td>12</td>
<td>15</td>
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<td>Propagation time (H→L)</td>
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<td>90</td>
</tr>
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<td>14</td>
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<td>11</td>
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<td>3-stage output off</td>
<td>t_PHZ</td>
<td>2.0</td>
<td></td>
<td>46</td>
<td>140</td>
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<tr>
<td>leakage current (H→Z)</td>
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<td>4.5</td>
<td>R_L = 1kΩ</td>
<td>22</td>
<td>28</td>
</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>3-stage output off</td>
<td>t_PLZ</td>
<td>2.0</td>
<td></td>
<td>44</td>
<td>140</td>
</tr>
<tr>
<td>leakage current (L→Z)</td>
<td></td>
<td>4.5</td>
<td>R_L = 1kΩ</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>3-stage output off</td>
<td>t_PZH</td>
<td>2.0</td>
<td></td>
<td>62</td>
<td>140</td>
</tr>
<tr>
<td>leakage current (Z→H)</td>
<td></td>
<td>4.5</td>
<td>R_L = 1kΩ</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>3-stage output off</td>
<td>t_PZL</td>
<td>2.0</td>
<td></td>
<td>62</td>
<td>140</td>
</tr>
<tr>
<td>leakage current (Z→L)</td>
<td></td>
<td>4.5</td>
<td>R_L = 1kΩ</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>18</td>
<td>24</td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

4. Waveforms (t_{PHZ}, t_{PZH}, t_{PLZ}, t_{PZL})
MN74HC541/MN74HC541S

Octal TRI-STATE Buffers Line Drivers

■ Description
MN74HC541/MN74HC541S are octal tri-state buffers line drivers. Large current output make possible high-speed operation for driving a large capacity bus line. When one of 3-state control input (G1, G2) operated as inputs NOR is “H”. 8 outputs become high impedance

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

■ Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>G2</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; doesn’t matter
2. Hi-Z: Hi-Impedance

■ Logic Diagram
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>(V_{CC})</td>
<td>(-0.5\text{~}+7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>(V_i, V_o)</td>
<td>(-0.5\text{~}V_{CC}+0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>(I_{IK})</td>
<td>\pm20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>(I_{OK})</td>
<td>\pm20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>(I_o)</td>
<td>\pm35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>(I_{CC}, I_{GND})</td>
<td>\pm70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>(T_{stg})</td>
<td>(-65\text{~}+150)</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

| MN74HC541 | \(P_D\) | 400 | mW |
| MN74HC541S | \(P_D\) | 275 | mW |

#### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}(V))</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>(V_{CC})</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>(V_i, V_o)</td>
<td>0~(V_{CC})</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>(T_A)</td>
<td>(-40\text{~}+85)</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>(t_r, t_f)</td>
<td>(V_{CC}=2.0V)</td>
<td>0~1000 ns</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CC}=4.5V)</td>
<td>0~500  ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CC}=6.0V)</td>
<td>0~400  ns</td>
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</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}(V))</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(V_i)</td>
<td>(I_o)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{IH})</td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td>Input HIGH voltage</td>
<td>(V_{IH})</td>
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<td>1.5</td>
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<td>6.0</td>
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<tr>
<td>Input LOW voltage</td>
<td>(V_{IL})</td>
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<td>Output HIGH voltage</td>
<td>(V_{OH})</td>
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<td>(-20.0)</td>
<td>(\mu A)</td>
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<td>4.5</td>
<td>(-20.0)</td>
<td>(\mu A)</td>
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<td>6.0</td>
<td>(-20.0)</td>
<td>(\mu A)</td>
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<td></td>
<td>4.5</td>
<td>(V_{IL})</td>
<td>\pm6.0</td>
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<td>6.0</td>
<td>(-7.8)</td>
<td>(mA)</td>
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<tr>
<td>Output LOW voltage</td>
<td>(V_{OL})</td>
<td>2.0</td>
<td>(20.0)</td>
<td>(\mu A)</td>
</tr>
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<td>4.5</td>
<td>(20.0)</td>
<td>(\mu A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>(20.0)</td>
<td>(\mu A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>(V_{IL})</td>
<td>(6.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>(7.8)</td>
<td>(mA)</td>
</tr>
<tr>
<td>Input current</td>
<td>(I_i)</td>
<td>6.0</td>
<td>(V_i=V_{CC}) or GND</td>
<td>(\pm0.1)</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>(I_{OZ})</td>
<td>0.6</td>
<td>(V_{IH}=V_{IL}) or (V_{IL}=V_{CC}) or GND</td>
<td>(\pm0.5)</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>(I_{CC})</td>
<td>6.0</td>
<td>(V_i=V_{CC}) or GND, (I_o=0)</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics

(GND=0V, Input transition time $\leq 6$ns, $C_L=50$pf)

| Parameter                        | Symbol | $V_{CC}$ (V) | Test Conditions | Temperature | | | |
|----------------------------------|--------|--------------|----------------|-------------|-------------|-------------|
| | | | | Ta=25°C | Ta=-40°C to +85°C | | |
| | | | min. | typ. | max. | min. | max. | Unit |
| Output rise time | $t_{THL}$ | 2.0 | | 27 | 12 | 10 | 7 | 19 | 16 | ns |
| | | 4.5 | | 75 | 15 | 13 | 13 | 19 | 16 | ns |
| | | 6.0 | | 26 | 10 | 7 | 13 | 16 | ns |
| Output fall time | $t_{THL}$ | 2.0 | | 26 | 10 | 7 | 13 | 16 | ns |
| | | 4.5 | | 75 | 10 | 7 | 13 | 16 | ns |
| | | 6.0 | | 26 | 7 | 13 | 16 | ns |
| Propagation time (L→H) | $t_{PLH}$ | 2.0 | | 33 | 13 | 11 | 15 | 23 | 20 | ns |
| | | 4.5 | | 90 | 18 | 15 | 15 | 23 | 20 | ns |
| | | 6.0 | | 33 | 13 | 11 | 15 | 23 | 20 | ns |
| Propagation time (H→L) | $t_{PHL}$ | 2.0 | | 36 | 13 | 10 | 15 | 23 | 20 | ns |
| | | 4.5 | | 90 | 18 | 15 | 15 | 23 | 20 | ns |
| | | 6.0 | | 36 | 13 | 10 | 15 | 23 | 20 | ns |
| 3-stage output off leakage current (H→Z) | $t_{PHZ}$ | 2.0 | $R_L=1k\Omega$ | 42 | 23 | 20 | 24 | 28 | 35 | 30 |
| | | 4.5 | | 140 | 28 | 24 | 30 | 35 | 30 | ns |
| | | 6.0 | | 42 | 23 | 20 | 24 | 28 | 35 | 30 | ns |
| 3-stage output off leakage current (L→Z) | $t_{PLZ}$ | 2.0 | $R_L=1k\Omega$ | 40 | 16 | 13 | 24 | 28 | 35 | 30 |
| | | 4.5 | | 140 | 28 | 24 | 30 | 35 | 30 | ns |
| | | 6.0 | | 40 | 16 | 13 | 24 | 28 | 35 | 30 | ns |
| 3-stage output off leakage current (Z→H) | $t_{PZH}$ | 2.0 | $R_L=1k\Omega$ | 59 | 21 | 17 | 24 | 28 | 35 | 30 |
| | | 4.5 | | 140 | 28 | 24 | 30 | 35 | 30 | ns |
| | | 6.0 | | 59 | 21 | 17 | 24 | 28 | 35 | 30 | ns |
| 3-stage output off leakage current (Z→L) | $t_{PZL}$ | 2.0 | $R_L=1k\Omega$ | 63 | 22 | 17 | 24 | 28 | 35 | 30 |
| | | 4.5 | | 140 | 28 | 24 | 30 | 35 | 30 | ns |
| | | 6.0 | | 63 | 22 | 17 | 24 | 28 | 35 | 30 | ns |
High-Speed CMOS Logic MN74HC Series

Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

(1) \( t_{TLH}, t_{THL}, t_{PLH}, t_{PHL} \)

(2) \( t_{PHZ}, t_{PZH} \)

(3) \( t_{PLZ}, t_{PZL} \)

2. Waveforms

- \( V_{CC} \)
- \( GND \)
- \( \leq 6\text{ ns} \)
- \( 10\% \)
- \( 90\% \)
- \( 10\% \)
- \( 50\% \)
- \( 10\% \)
- \( 90\% \)
- \( 10\% \)

Panasonic
**MN74HC563/MN74HC563S**

Octal TRI-STATE D-Type Latches with Inverting Outputs

**Description**

MN74HC563/MN74HC563S contain eight high-speed D-type latches with inverting tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system.

When output disable input is LOW and latch enable input is HIGH, the output outputs the inverting data input state.

When latch enable is LOW, the data input is held in the output until when latch enable input becomes HIGH.

When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>D</td>
<td>Q</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>×</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
3. Q0: Q level prior to determination of input condition shown in table

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$ V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} + 0.5$ V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$ mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 35$ mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 70$ mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$ °C</td>
<td></td>
</tr>
</tbody>
</table>

#### Power dissipation

- **MN74HC536**
  - $Ta = -40 \sim +60$ °C: $P_D = 400$ mW
  - $Ta = +60 \sim +85$ °C: Decrease to 200mW at the rate of 8mW/°C
- **MN74HC536S**
  - $Ta = -40 \sim +60$ °C: $P_D = 275$ mW
  - $Ta = +60 \sim +85$ °C: Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$ V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$0 \sim V_{CC}$ V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$ °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Input rise and fall time

- $t_{r, t_f}$: 2.0 ns, 0~1000 ns, 4.5 ns, 0~500 ns, 6.0 ns, 0~400 ns

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0, 4.5, 6.0</td>
<td>$V_I$, $I_O$</td>
<td>$Ta=+25$ °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0, 4.5, 6.0</td>
<td>$V_I=V_{IH}$ or $V_{IL}$</td>
<td>20.0, 3.15 μA</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0, 4.5, 6.0</td>
<td>$V_{IH}$ or $V_{IL}$</td>
<td>$V_{IH}$ or $V_{IL}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$-20.0$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0, 4.5, 6.0</td>
<td>$V_{IH}$ or $V_{IL}$</td>
<td>20.0, 3.86 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$-7.8$</td>
<td>$-7.8$</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$V_I=V_{IH}$ or $V_{IL}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$V_I$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>6.0</td>
<td>$V_I=V_{IH}$ or $V_{IL}$</td>
<td>$V_I=V_{CC}$ or GND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I=V_{IH}$ or $V_{IL}$</td>
<td>20.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Panasonic
## AC Characteristics (GND=0V, Input transition time \( \leq 6\text{ns} \), \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>( T_a=25^\circ\text{C} )</th>
<th>( T_a=-40^-+85^\circ\text{C} )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>( D \rightarrow \overline{Q} \ (L \rightarrow H) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>( D \rightarrow \overline{Q} \ (H \rightarrow L) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Enable ( G \rightarrow \overline{Q} (L \rightarrow H) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>E Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>Enable ( G \rightarrow \overline{Q} (H \rightarrow L) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PHZ} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>( (H \rightarrow Z) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PLZ} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>( (L \rightarrow Z) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PZH} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>( (Z \rightarrow H) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>( t_{PZL} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>( (Z \rightarrow L) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{su} )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_h )</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

2. Waveforms

3. $t_{PHZ}, t_{PZH}$

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

4. $t_{PLZ}, t_{PZL}$

1. Measuring Circuit ($t_{PLH}, t_{PHL}$)

High-Speed CMOS Logic MN74HC Series

MN74HC564/MN74HC564S
Octal TRI-STATE D-Type Flip-Flops with Inverting Outputs

Description
MN74HC564/MN74HC564S contain eight high-speed D-type latches with inverting tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system. D input data satisfying set-up time is inverted and transferred to the output on the positive going edge of clock input.
When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.
Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard S4LS/74LS logic family.

Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Control CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>Q₀</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. / /: Data input is transferred to output on the positive-going edge from LOW to HIGH of the clock.
2. ×: Either HIGH or LOW; it doesn’t matter.
3. Q₀: Q level prior to determination of input condition shown in table.

Logic Diagram
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PH}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OH}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{OHD}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC564</td>
<td>$P_D$</td>
<td>400 mW</td>
</tr>
<tr>
<td></td>
<td>MN74HC564S</td>
<td>$P_D$</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td>MN74HC564S</td>
<td>$P_D$</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0 ns</td>
<td>0--1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td>0--500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td>0--400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$T_a=25^\circ$</td>
<td>$T_a=-40 \sim +85^\circ$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>3.15</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>4.4</td>
<td>4.5</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-6.0</td>
<td>3.86</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-7.8</td>
<td>3.86</td>
<td>5.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-7.8</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>0.0</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C\textsubscript{L}=50pF)

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<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<td>125</td>
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<td>4.5</td>
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**Unit**: ns, MHz
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms

3. t_{PLZ}, t_{PZL}

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Waveforms

MN74HC573/MN74HC573S

Octal TRI-STATE D-Type Latches

**Description**

MN74HC573/MN74HC573S contain eight high-speed D-type latches with tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system.

When output disable input is LOW and latch enable input is HIGH, the output outputs the data input state.

When latch enable is LOW, the data input data is held in the output until when latch enable input becomes HIGH.

When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in V_{CC} and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>Output Control</td>
<td>G</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
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<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
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</table>

Note:
1. X: Either HIGH or LOW; it doesn't matter
2. Hi-Z: High impedance
3. Qo: Q level prior to determination of input condition shown in table

**Logic Diagram**

![Logic Diagram](image)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Supply voltage VCC</td>
<td>VCC</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
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<td>VIL, VO</td>
<td>−0.5~VCC+0.5</td>
<td>V</td>
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<tr>
<td>Input protection diode current IiK</td>
<td>IiK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current IOK</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current IO</td>
<td>IO</td>
<td>±35</td>
<td>mA</td>
</tr>
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<td>Supply current ICC, IGBK</td>
<td>ICC, IGBK</td>
<td>±70</td>
<td>mA</td>
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<tr>
<td>Input/output voltage VIL, VO</td>
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<td>0~VCC</td>
<td>V</td>
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<tr>
<td>Operating temperature range TA</td>
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## Operating Conditions

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<tr>
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<td>0~VCC</td>
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### DC Characteristics (GND=0V)

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<td>min. max.</td>
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<td>Test Conditions</td>
<td>Temperature</td>
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<td>(H→Z)</td>
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<td>6.0</td>
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<tr>
<td>3-state propagation time</td>
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<tr>
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<td>tPZH</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt;=1 kΩ</td>
<td>9</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>tPZL</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt;=1 kΩ</td>
<td>11</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>tsu</td>
<td>2.0</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>th</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit \( t_{PLH}, t_{PHL} \)

\[(1) \quad t_{TLH}, t_{THL}, t_{PLH}, t_{PHL} \quad (D \rightarrow Q), \quad t_{su}, t_{th} \]

2. Waveforms

\[V_{cc} \]

\[GND\]

3. Waveforms

\[\text{See above [3] 2. for waveforms.}\]
High-Speed CMOS Logic MN74HC Series

MN74HC574/MN74HC574S

Octal TRI-STATE D-Type Flip-Flops

**Description**

MN74HC574/MN74HC574S contain eight high-speed D-type flip-flops with tri-state outputs. High output driving capability and tri-state outputs are suitable for the use of a common bus line in a bus utilized system.

D input data satisfying set-up time is inverted and transferred to the output on the rising edge of clock input.

When output disable input is HIGH, all outputs become high impedance state regardless of the state of other inputs and data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly drive. Resistors and diodes are provided in $V_{cc}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Control</th>
<th>CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>$\not{D}$</td>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>$\not{D}$</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>$\not{D}$</td>
<td>L</td>
<td>$\not{D}$</td>
<td>Qo</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>$\not{D}$</td>
<td>$\not{D}$</td>
<td>$\not{D}$</td>
<td>Hi-Z</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. $\not{D}$: Data input is transferred to output on the negative-going edge from LOW to HIGH of the clock
2. $\times$: Either HIGH or LOW; it doesn’t matter
3. Qo: Q level prior to determination of input condition shown in table
4. Hi-Z: High impedance

**Logic Diagram**

- Diagram showing the connections and logic flow of the flip-flops.

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5~V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{STG}</td>
<td>-65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>MN74HC574</th>
<th>MN74HC574S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=−40~+60°C</td>
<td>P_{D}</td>
<td>400 mW</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td>P_{D}</td>
<td>275 mW</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>−40~+85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>2.0 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V_{I}</td>
<td>I_{O}</td>
<td>T_{A}=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
<td>1.5</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>4.2</td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td>−20.0</td>
<td>μA</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>μA</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>−20.0</td>
<td>μA</td>
<td>5.9</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>2.0</td>
<td>−20.0</td>
<td>μA</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>μA</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>−7.8</td>
<td>mA</td>
<td>5.36</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>μA</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6.0</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>μA</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7.8</td>
<td>mA</td>
<td>0.32</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>I_{OZ}</td>
<td>6.0</td>
<td>V_{I}=V_{IH} or V_{IL}</td>
<td>±0.5</td>
<td>±5.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>

Panasonic
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>2.0</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>2.0</td>
<td></td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q (L→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td></td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PHZ}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>(H→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PLZ}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZL}</td>
<td>2.0</td>
<td>R_L=1 kΩ</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t_{su}</td>
<td>2.0</td>
<td></td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{h}</td>
<td>2.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>2.0</td>
<td></td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (tPLH, tPHL)

2. Waveforms

3. tPLZ, tPZL

1. Measuring Circuit (tPLH, tPHL)

2. Waveforms

MN74HC640/MN74HC640S

Inverting Octal TRI-STATE Transceivers

**Description**

MN74HC640/MN74HC640S are high-speed, inverting bidirectional buffers composed of eight 3-state outputs. Input is transferred bidirectionally, asynchronously through the data bus line. Large current output makes possible high-speed operation for driving a large capacity bus line. It has input G where output becomes enabled at LOW and directional control input DIR.

When DIR input is "H", data is transferred from input A to output B. When DIR input is "L", data is transferred from input B to output A. The transferred data is inverted.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard 45LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable G</th>
<th>Direction Control DIR</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>B data to A bus</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>A data to B bus</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance

**Logic Diagram**
# Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input/output voltage</td>
<td>V_{CC}</td>
<td>-0.5~+7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5~V_{CC}+0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±35 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±70 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65~+150 °C</td>
<td></td>
</tr>
</tbody>
</table>

### Power dissipation

<table>
<thead>
<tr>
<th></th>
<th>MN74HC640</th>
<th>MN74HC640S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta=-40~+60°C</td>
<td>P_{D} 400</td>
<td>P_{D} 275</td>
</tr>
<tr>
<td>Ta=+60~+85°C</td>
<td></td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC}(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4~6.0 V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>-40~+85 °C</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0 ns</td>
<td>4.5 ns</td>
<td>6.0 ns</td>
</tr>
</tbody>
</table>

# DC Characteristics (GND=OV)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
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<tr>
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<td>0.3</td>
<td>V</td>
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<td>20.0 μA</td>
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<td>I_{I}</td>
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<td>V_{I}=V_{CC} or GND</td>
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<td>±1.0</td>
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<td>3-state output off state current</td>
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<td>V_{I}=V_{IH} or V_{IL}</td>
<td>±0.5</td>
<td>±5.0</td>
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<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
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<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<td>Ta=25°C</td>
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<td>typ.</td>
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<td>Output fall time</td>
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<td>Propagation time (L→H)</td>
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<td>Propagation time (H→L)</td>
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<td>3-state propagation time (H→Z)</td>
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<td>R_i=1kΩ</td>
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<td>25</td>
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<td>3-state propagation time (L→Z)</td>
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<tr>
<td>3-state propagation time (Z→H)</td>
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<td>R_i=1kΩ</td>
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<td>25</td>
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<td>6.0</td>
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</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_PZH</td>
<td>2.0</td>
<td>R_i=1kΩ</td>
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<td>25</td>
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<td>4.5</td>
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<td>6.0</td>
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</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_PHL, t_PHL)

2. Waveforms
[2] \( t_{PHZ}, t_{PZH} \)

1. Measuring Circuit \( (t_{PLH}, t_{PHL}) \)

2. Waveforms


[3] \( t_{PLZ}, t_{PZL} \)

1. Measuring Circuit

2. Waveforms
**MN74HC643/MN74HC643S**

True-Inverting Octal TRI-STATE Transceiver

**Description**

MN74HC643/MN74HC643S are high-speed, true-inverting bidirectional buffers composed of eight 3-state outputs. Input is transferred bidirectionally, asynchronously through the data bus line. Large current output makes possible high-speed operation for driving a large capacity bus line. It has input G where output becomes enabled at "LOW" and directional control input DIR. When DIR input is "H", data is inverted and transferred from input A to output B. When DIR input is "L", data is transferred from input B to output A.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable G</th>
<th>Direction Control DIR</th>
<th>Operation</th>
</tr>
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<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>B data to A bus</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>A data to B bus</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn't matter
2. Hi-Z: High impedance

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{PK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{Stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

| MN74HC643 | $P_D$ | $400$ | Decrease to 200mW at the rate of 8mW/°C |
| MN74HC643S| $P_D$ | $275$ | Decrease to 200mW at the rate of 3.8mW/°C |

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$V_{CC}$ (V)</th>
<th>$V_{CC}$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$1.4 \sim 6.0$</td>
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<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
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</tr>
<tr>
<td>Input rise and fall time</td>
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<td>$0 \sim 1000$</td>
<td>ns</td>
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<tr>
<td></td>
<td>$4.5$</td>
<td>$0 \sim 500$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$6.0$</td>
<td>$0 \sim 400$</td>
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</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_o$</th>
<th>$V_{OH}$</th>
<th>$V_{OL}$</th>
<th>$I_I$</th>
<th>$I_{OZ}$</th>
<th>$I_{CC}$</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>$T_A=25^\circ C$</td>
<td>$T_A=-40 \sim +85^\circ C$</td>
<td>Unit</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>typ.</td>
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<tr>
<td>Input HIGH voltage</td>
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<td></td>
<td>$V_{IH}$</td>
<td>$-20.0$</td>
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<td>$1.9$</td>
<td>$2.0$</td>
<td>$1.9$</td>
<td>$0.3$</td>
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<tr>
<td></td>
<td></td>
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<td>$V_{IL}$</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
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<td>$4.5$</td>
<td>$4.4$</td>
<td>$1.2$</td>
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<tr>
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<td>$-7.8$</td>
<td>$\mu A$</td>
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<td>$6.0$</td>
<td>$5.9$</td>
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<tr>
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<td>$-6.0$</td>
<td>$m A$</td>
<td>$3.86$</td>
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<td>$0.1$</td>
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<td>$V_{IL}$</td>
<td>$20.0$</td>
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<td>$0.1$</td>
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<td>$7.8$</td>
<td>$m A$</td>
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<td>$0.37$</td>
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<td>$6.0$</td>
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<td>$7.8$</td>
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<td>$m A$</td>
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<td>$I_i$</td>
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<td>$V_i=V_{CC}$ or GND</td>
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<td>$\pm 1.0$</td>
<td>$\mu A$</td>
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<td>Input current</td>
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<td>$V_i=V_{IH}$ or $V_{II}$, $V_o=V_{CC}$ or GND</td>
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<td>$\pm 5.0$</td>
<td>$\mu A$</td>
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<td>Quiescent supply current</td>
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<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
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<td>$80.0$</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>Ta=25°C</td>
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<td>min. typ. max.</td>
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<td>4.5</td>
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<td>6</td>
<td>13</td>
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<td>Output fall time</td>
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<td></td>
<td>6</td>
<td>15</td>
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<td>4.5</td>
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<td>6</td>
<td>13</td>
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<tr>
<td>Propagation time (L→H)</td>
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<td>8</td>
<td>15</td>
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<td>4.5</td>
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<td>8</td>
<td>13</td>
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<td>Propagation time (H→L)</td>
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<td>8</td>
<td>13</td>
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<td>3-state propagation time</td>
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<td>R&lt;sub&gt;L&lt;/sub&gt;=1 kΩ</td>
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<td>25</td>
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<td>(H→Z)</td>
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<td>21</td>
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<td></td>
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<td>6.0</td>
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<td>13</td>
<td>21</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PZH&lt;/sub&gt;</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt;=1 kΩ</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PZH&lt;/sub&gt;</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt;=1 kΩ</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>10</td>
<td>17</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
### High-Speed CMOS Logic MN74HC Series

**[2] tPHZ, tPZH**

1. Measuring Circuit

![Measuring Circuit Diagram](image)

**[3] tPLZ, tPZL**

1. Measuring Circuit

![Measuring Circuit Diagram](image)

2. Waveforms

![Waveforms Diagram](image)

MN74HC688/MN74HC688S

8-Bit Magnitude Comparator (Equality Detector)

**Description**
MN74HC688/MH74HC688S are high speed magnitude comparator which compare two eight-bit words and indicate equality, when \( P = Q \) output is “L”, it indicates equality. A single input enabling output at Low level compares words greater than 8 bits, and can be used for easy dependent connection of multiple stages. This circuit can be used for decoding of memory blocks enable signal generated by computer address data.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{cc} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Data</th>
<th>Enable ( G )</th>
<th>( P = Q )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P = Q )</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>( P &gt; Q )</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>( P &lt; Q )</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>( \times )</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

**Logic Diagram**

![MN74HC688 Logic Diagram](image)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>$-0.5 \sim V_{CC} +0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IX}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OX}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>$\pm 25$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GD}$</td>
<td>$\pm 50$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation | MN74HC688 | $T_a=-40\sim +60°C$ | $P_D$ | 400 | mW |
|                  | MN74HC688S | $T_a=-40\sim +60°C$ | $P_D$ | 275 | mW |

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 \sim 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_I, V_O$</td>
<td>0 \sim $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r, t_f$</td>
<td>2.0</td>
<td>0 \sim 1000</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 \sim 500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0 \sim 400</td>
<td>ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-20.0$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_I$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>
# AC Characteristics (GND=0V, Input transition time ≤6ns, \(C_L=50\text{pF}\))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>(t_{TLH})</td>
<td>2.0</td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>(t_{THL})</td>
<td>2.0</td>
<td>6</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PLH})</td>
<td>2.0</td>
<td>17</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>P, Q→P→Q (L→H)</td>
<td></td>
<td>4.5</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PHL})</td>
<td>2.0</td>
<td>14</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>P, Q→P→Q (H→L)</td>
<td></td>
<td>4.5</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PLH})</td>
<td>2.0</td>
<td>11</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>G→P→Q (L→H)</td>
<td></td>
<td>4.5</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>(t_{PHL})</td>
<td>2.0</td>
<td>9</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>G→P→Q (H→L)</td>
<td></td>
<td>4.5</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
High-Speed CMOS Logic MN74HC Series

**MN74HC4002/MN74HC4002S**

Dual 4-Input NOR Gates

**Description**

MN74HC4002/MN74HC4002S contain two 4-input positive isolation NOR gate circuits. Adoption of a silicon gate CMOS process has made possible a low power dissipation, a high noise margin equivalent to a standard CMOS and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as standard CMOS logic 4000 family.

**Logic Diagram**

![Logic Diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5 to +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL,VIH</td>
<td>−0.5 to +5.0</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIL</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IO</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICM,IGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power</th>
<th>MN74HC4002</th>
<th>MN74HC4002S</th>
</tr>
</thead>
<tbody>
<tr>
<td>dissipation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>Ta=−40 to +60°C</td>
<td>PDS</td>
</tr>
<tr>
<td>PD</td>
<td>Ta=+60 to +85°C</td>
<td>PDS</td>
</tr>
</tbody>
</table>

Decrease to 200mW at the rate of 8mW/°C

Decrease to 200mW at the rate of 3.8mW/°C
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 – 6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{I, V_{O}} )</td>
<td>0 – ( V_{CC} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>(-40 \text{ to } +85) °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r, t_{f}} )</td>
<td>2.0 ns – 1000 ns</td>
<td>4.5 ns – 500 ns</td>
<td>6.0 ns – 400 ns</td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_{I} )</th>
<th>( I_{O} )</th>
<th>( V_{I} = V_{CC} ), or GND</th>
<th>( V_{I} = 0 )</th>
<th>( V_{CC} ), or GND</th>
<th>( I_{O} = 0 )</th>
<th>( I_{I} = 0 )</th>
<th>( I_{CC} ) (V)</th>
<th>( I_{CC} ) = ( V_{CC} ) or GND, ( I_{O} = 0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>4.2</td>
<td>3.15</td>
<td>1.9</td>
<td>2.0</td>
<td>1.5</td>
<td>0.3</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>–20.0μA</td>
<td>–4.0μA</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>( V_{IH} )</td>
<td>20.0μA</td>
<td>( V_{IL} )</td>
<td>–4.0μA</td>
<td>( V_{OH} )</td>
<td>20.0μA</td>
<td>1.9</td>
<td>6.0</td>
<td>5.9</td>
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<td></td>
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<td>4.5</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>( V_{IH} )</td>
<td>20.0μA</td>
<td>( V_{IL} )</td>
<td>5.2μA</td>
<td>( V_{OH} )</td>
<td>4.0mA</td>
<td>1.9</td>
<td>6.0</td>
<td>5.36</td>
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<td></td>
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<td>4.5</td>
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<td></td>
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<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>( I_{I} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} )</td>
<td>–20.0μA</td>
<td>( V_{I} = V_{CC} ), or GND</td>
<td>±0.1</td>
<td>±0.1</td>
<td>±1.0</td>
<td>µA</td>
<td>µA</td>
<td>µA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} )</td>
<td>–20.0μA</td>
<td>( V_{CC} ), or GND</td>
<td>2.0</td>
<td>20.0</td>
<td>µA</td>
<td>µA</td>
<td>µA</td>
<td>µA</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_{L} = 50\)pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>( V_{I} )</th>
<th>( I_{O} )</th>
<th>( V_{I} = V_{CC} ), or GND</th>
<th>( V_{I} = 0 )</th>
<th>( V_{CC} ), or GND</th>
<th>( I_{O} = 0 )</th>
<th>( I_{I} = 0 )</th>
<th>( I_{CC} ) (V)</th>
<th>( I_{CC} ) = ( V_{CC} ) or GND, ( I_{O} = 0 )</th>
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<td>( t_{TLH} )</td>
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<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
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<td></td>
</tr>
<tr>
<td>Propagation time ((L \rightarrow H))</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
<td>95</td>
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<td>13</td>
<td>16</td>
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<td></td>
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</tr>
<tr>
<td>Propagation time ((H \rightarrow L))</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>25</td>
<td>75</td>
<td>95</td>
<td>8</td>
<td>15</td>
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<td>16</td>
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**MN74HC4015/MN74HC4015S**

Dual 4-Stage Shift Registers with Serial-Input/Parallel-Output

- **Description**

MN74HC4015/MH74HC4015S contain dual four-stage static shift registers in one chip. Flip-flop at each stage has common clear input, enabling asynchronous clearing with an external input at any time. Flip-flop at each stage is triggered by the rise of the clock pulse.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard CMOS logic 4000 family.

- **Truth Table**

<table>
<thead>
<tr>
<th>n</th>
<th>CLK</th>
<th>D</th>
<th>CLR</th>
<th> Q0  </th>
<th> Q1  </th>
<th> Q2  </th>
<th> Q3  </th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>—</td>
<td>D1</td>
<td>L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>D2</td>
<td>L</td>
<td>D2</td>
<td>D1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>D3</td>
<td>L</td>
<td>D3</td>
<td>D2</td>
<td>D1</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>—</td>
<td>D4</td>
<td>L</td>
<td>D4</td>
<td>D3</td>
<td>D2</td>
<td>D1</td>
</tr>
<tr>
<td>—</td>
<td>×</td>
<td>X</td>
<td>L</td>
<td>no change</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. ×: Either HIGH or LOW; it doesn't matter
2. D: “H” or “L”
3. n: Number of clock pulse
4. —: The rise of clock from “L” to “H”
5. —: The fall of clock from “H” to “L”

- **Logic Diagram**

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input/output voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 ) V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{IL}, V_{OH} )</td>
<td>(-0.5 \sim V_{CC}+0.5 ) V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{PK} )</td>
<td>( \pm 20 ) mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 ) mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>( \pm 25 ) mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{GND} )</td>
<td>( \pm 50 ) mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150 ) °C</td>
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</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC4015</th>
<th>( P_{D} )</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC4015S</td>
<td>( P_{D} )</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 \sim 6.0. V</td>
<td>( V_{IL}, V_{OH} )</td>
<td>( 0 \sim V_{CC} ) V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>(-40 \sim +85 ) °C</td>
<td>( T_{R}, T_{F} )</td>
<td>( 0 \sim 1000 ) ns</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( T_{R}, T_{F} )</td>
<td>2.0 \sim 4.5 ns</td>
<td>( T_{R}, T_{F} )</td>
<td>( 0 \sim 400 ) ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>( V_{I} )</th>
<th>( I_{O} )</th>
<th>( T_{A}=25 ) °C</th>
<th>( T_{A}=-40 \sim +85 ) °C</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
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<tr>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
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<tr>
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<td>6.0</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
<td>0.3</td>
<td>0.9</td>
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<td></td>
<td>4.5</td>
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<td>6.0</td>
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</tr>
<tr>
<td></td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>(-20.0 )</td>
<td>( \mu A )</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>(-20.0 )</td>
<td>( \mu A )</td>
<td>4.4</td>
<td>4.5</td>
<td>4.4</td>
<td>V</td>
</tr>
<tr>
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<td>(-20.0 )</td>
<td>( \mu A )</td>
<td>5.9</td>
<td>6.0</td>
<td>5.9</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>(-4.0 )</td>
<td>( mA )</td>
<td>3.86</td>
<td>5.36</td>
<td>3.76</td>
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<td>4.5</td>
<td>(-5.2 )</td>
<td>( mA )</td>
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<td>5.36</td>
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</tr>
<tr>
<td></td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>20.0</td>
<td>( \mu A )</td>
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<td>20.0</td>
<td>( \mu A )</td>
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<td>0.1</td>
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<td>( \mu A )</td>
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<td>0.1</td>
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<tr>
<td></td>
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<td>( mA )</td>
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<td>0.32</td>
<td>0.37</td>
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<tr>
<td></td>
<td>5.2</td>
<td>( mA )</td>
<td>0.32</td>
<td>0.32</td>
<td>0.32</td>
<td>0.37</td>
<td>V</td>
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<tr>
<td>Input current</td>
<td>( I_{I} )</td>
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<td>( V_{IL}=V_{CC} ) or GND</td>
<td>( \pm 0.1 )</td>
<td>( \pm 1.0 )</td>
<td>( \mu A )</td>
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</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
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<td>( V_{I}=V_{CC} ) or GND, ( I_{O}=0 )</td>
<td>8.0</td>
<td>80.0</td>
<td>( \mu A )</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

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<th>Parameter</th>
<th>Symbol</th>
<th>V_CC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tr>
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<td>Ta=25°C</td>
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<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<td>t_{TLH}</td>
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<td>4.5</td>
<td>13</td>
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<td></td>
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<td>6.0</td>
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<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
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<td>6.0</td>
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<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
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<td>20</td>
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</tr>
<tr>
<td>CLK→Qn (L→H)</td>
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<td>4.5</td>
<td></td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td></td>
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<td>6.0</td>
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<td>30</td>
<td>37</td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
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<td></td>
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</tr>
<tr>
<td>CLK→Qn (H→L)</td>
<td></td>
<td>4.5</td>
<td>19</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>2.0</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLR→Qn (H→L)</td>
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<td>35</td>
<td>44</td>
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<td></td>
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<td>6.0</td>
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<td>30</td>
<td>37</td>
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<td>Minimum Set-up time</td>
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<td></td>
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<td>4.5</td>
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<td>6.0</td>
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<td>Minimum Hold time</td>
<td>t_{h}</td>
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<td>Minimum recovery time</td>
<td>t_{rem}</td>
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<td>Maximum clock frequency</td>
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<td>6.0</td>
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</tbody>
</table>

Panasonic
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
MN74HC4020/MN74HC4020S

14-Stage Binary Counter

- **Description**
  MN74HC4020/4020S high-speed 14-Stage binary counter. This counter provides increments on the falling edge of clock input. The clear input operates in the counter, and all outputs (Q1~Q14) become “L” regardless of the clock input, when the clear input is “H”.
  Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard CMOS logic 4000 family.

- **Truth Table**
<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>H</td>
<td>All Outputs are low</td>
</tr>
<tr>
<td>¬</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>¬</td>
<td>L</td>
<td>Counter Advances</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. ¬: The fall of clock from “H” to “L”
3. ¬: The rise of clock from “L” to “H”

- **Logic Diagram**

![MN74HC4020/MN74HC4020S Logic Diagram](image)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>-0.5~+7.0 V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;, V&lt;sub&gt;o&lt;/sub&gt;</td>
<td>-0.5~V&lt;sub&gt;CC&lt;/sub&gt;+0.5 V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I&lt;sub&gt;PK&lt;/sub&gt;</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I&lt;sub&gt;OK&lt;/sub&gt;</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt;</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;, I&lt;sub&gt;GND&lt;/sub&gt;</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>-65~+150 °C</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation                              | MN74HC4020 | Ta=−40~+60 °C   | PD     | 400 mW          |
|                                                | MN74HC4020S | Ta=+60~+85 °C   | PD     | Decrease to 200mW at the rate of 8mW/°C |

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>1.4~6.0 V</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;, V&lt;sub&gt;o&lt;/sub&gt;</td>
<td>0~V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T&lt;sub&gt;a&lt;/sub&gt;</td>
<td>-40~+85 °C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t&lt;sub&gt;r&lt;/sub&gt;, t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>2.0 ns</td>
<td>0~1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td>0~500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td>0~400 ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V&lt;sub&gt;H&lt;/sub&gt;</td>
<td>2.0 V</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 V</td>
<td>3.15</td>
<td>3.15</td>
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<tr>
<td></td>
<td></td>
<td>6.0 V</td>
<td>4.2</td>
<td>4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>V&lt;sub&gt;L&lt;/sub&gt;</td>
<td>2.0 V</td>
<td>0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 V</td>
<td>0.9</td>
<td>0.9</td>
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<tr>
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<td>6.0 V</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Output HIGH voltage</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>2.0 V</td>
<td>-20.0</td>
<td>μA</td>
<td>1.9</td>
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<tr>
<td></td>
<td></td>
<td>4.5 V</td>
<td>-20.0</td>
<td>or</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 V</td>
<td>-20.0</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>2.0 V</td>
<td>-4.0</td>
<td>mA</td>
<td>3.86</td>
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<td>4.5 V</td>
<td>-5.2</td>
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<td>6.0 V</td>
<td>20.0</td>
<td>mA</td>
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<td></td>
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<td>6.0 V</td>
<td>20.0</td>
<td>or</td>
<td>μA</td>
</tr>
<tr>
<td></td>
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<td>4.5 V</td>
<td>20.0</td>
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<td>μA</td>
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<td></td>
<td>6.0 V</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
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<tr>
<td>Input current</td>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>6.0 V</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>6.0 V</td>
<td>V&lt;sub&gt;i&lt;/sub&gt;=V&lt;sub&gt;CC&lt;/sub&gt; or GND, I&lt;sub&gt;O&lt;/sub&gt;=0</td>
<td>8.0</td>
<td>80.0</td>
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</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C min.</td>
<td>Ta=-40~+85°C min.</td>
<td>typ.</td>
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<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;TLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>8</td>
<td>75</td>
<td>95</td>
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<td></td>
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<td>4.5</td>
<td>15</td>
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<td>6.0</td>
<td>13</td>
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<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
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<td></td>
<td>4.5</td>
<td>15</td>
<td></td>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
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</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>16</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>CLK→Q&lt;sub&gt;1&lt;/sub&gt; (L→H)</td>
<td></td>
<td></td>
<td>30</td>
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<td>4.5</td>
<td>26</td>
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<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>16</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>CLK→Q&lt;sub&gt;1&lt;/sub&gt; (H→L)</td>
<td></td>
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<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>5</td>
<td>75</td>
<td>95</td>
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<tr>
<td>Qn→Q&lt;sub&gt;n+1&lt;/sub&gt; (L→H)</td>
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<td>15</td>
<td></td>
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<td></td>
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<td>4.5</td>
<td>13</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>5</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>Qn→Q&lt;sub&gt;n+1&lt;/sub&gt; (H→L)</td>
<td></td>
<td></td>
<td>15</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>16</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>CLR→Q&lt;sub&gt;n&lt;/sub&gt; (H→L)</td>
<td></td>
<td></td>
<td>30</td>
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<td></td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
<td>26</td>
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<tr>
<td>Minimum pulse width</td>
<td>tw</td>
<td>2.0</td>
<td>12</td>
<td>125</td>
<td>155</td>
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<tr>
<td>CLR</td>
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<td>4.5</td>
<td>25</td>
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<td>21</td>
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<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
<td>2.0</td>
<td>2</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td></td>
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</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td>4</td>
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<td></td>
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<td>4.5</td>
<td>30</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>35</td>
<td></td>
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</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Typical Operating Conditions
High-Speed CMOS Logic MN74HC Series

MN74HC4024/MN74HC4024S

7-Stage Binary Counter

- **Description**
  MN74HC4024/4024S high speed 7-stage ripple-carry counter. This counter provides increments on the falling edge of clock input. The clear input operates in the counter, and all outputs (Q1~Q7) become “L” regardless of the clock, when the clear input is “H”.
  Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{cc} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard CMOS logic 4000 family.

- **Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>H</td>
<td>All Outputs are low</td>
</tr>
<tr>
<td>L</td>
<td>X</td>
<td>No Change</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>Counter Advances</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. L: The fall of clock from “H” to “L”
3. F: The rise of clock from “L” to “H”

- **Logic Diagram**

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>±25 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>±50 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

<table>
<thead>
<tr>
<th>Power dissipation</th>
<th>MN74HC4024</th>
<th>MN74HC4024S</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_a=-40 \sim +60$</td>
<td>$P_D$ 400 mW</td>
<td>$P_D$ 275 mW</td>
</tr>
<tr>
<td>$T_a=+60 \sim +85$</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i, V_o$</td>
<td>0 ~ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>2.0 0 ~ 1000 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 0 ~ 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 0 ~ 400 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$V_i, V_o$</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>1.5</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
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<td>4.5</td>
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<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td>$-20.0$</td>
<td>1.9</td>
<td>2.0</td>
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<td>4.5</td>
<td>$-20.0$</td>
<td>4.4</td>
<td>4.5</td>
</tr>
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<td>6.0</td>
<td>$-20.0$</td>
<td>5.9</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$-4.0$</td>
<td>3.86</td>
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<td></td>
<td>6.0</td>
<td>$-5.2$</td>
<td>5.36</td>
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</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td>20.0</td>
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<td>0.1</td>
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<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
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<td>20.0</td>
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<td>4.0</td>
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<td>6.0</td>
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<td>0.32</td>
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<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Ta=25°C</th>
<th>T_a = -40~+85°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
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<td>8</td>
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<td>CLK→Q1 (L→H)</td>
<td></td>
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<td>190</td>
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<tr>
<td>CLK→Q1 (H→L)</td>
<td></td>
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<td>30</td>
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</tr>
<tr>
<td>Qn→Q_n+1 (L→H)</td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
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<td>6.0</td>
<td>13</td>
<td>16</td>
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</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
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<td>7</td>
<td>75</td>
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</tr>
<tr>
<td>Qn→Q_n+1 (H→L)</td>
<td></td>
<td>4.5</td>
<td>15</td>
<td>19</td>
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<td></td>
<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
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<td>17</td>
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<td>CLR→Q_n (H→L)</td>
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<td>19</td>
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<td></td>
<td>6.0</td>
<td>13</td>
<td>16</td>
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</table>

Panasonic
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Typical Operating Conditions

CLK | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128
CLR |   |   |   |   |   |   |   |   
Q1  |   |   |   |   |   |   |   |   
Q2  |   |   |   |   |   |   |   |   
Q3  |   |   |   |   |   |   |   |   
Q4  |   |   |   |   |   |   |   |   
Q5  |   |   |   |   |   |   |   |   
Q6  |   |   |   |   |   |   |   |   
Q7  |   |   |   |   |   |   |   |   

P.G.  
-------
CLK  
CLR  
Qn  
Output  

Vcc  
CLR  
CLK  
Qn

CLC

Vcc
CLR
CLK
Qn

Typical Operating Conditions

CLK  
CLR  
Q1  
Q2  
Q3  
Q4  
Q5  
Q6  
Q7

P.G.  
-------
CLK  
CLR  
Qn  
Output

Vcc  
CLR  
CLK  
Qn

Typical Operating Conditions

CLK  
CLR  
Q1  
Q2  
Q3  
Q4  
Q5  
Q6  
Q7

P.G.  
-------
CLK  
CLR  
Qn  
Output

Vcc  
CLR  
CLK  
Qn
High-Speed CMOS Logic MN74HC Series

**MN74HC4040/MN74HC4040S**

14-Stage Binary Counter

**Description**
MN74HC4040/4040S high speed 12-stage ripple-carry counter. This counter provides increments on the falling edge of clock input. The clear input operates in the counter, and all outputs (Q1~Q12) become “L” regardless of the clock, when the clear input is “H”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>CLR</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>H</td>
<td>All Outputs are low</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>Counter Advances</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. L: The fall of clock from “H” to “L”
3. L: The rise of clock from “L” to “H”

**Logic Diagram**

---

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>-0.5 to +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>-0.5 to VCC+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIL</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOL</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65 to +150</td>
<td>°C</td>
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#### Power Dissipation

<table>
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<tr>
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<th>MN74HC4040</th>
<th>MN74HC4040S</th>
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</thead>
<tbody>
<tr>
<td>Ta=-40 to +60°C</td>
<td>PD=400</td>
<td>PD=275</td>
</tr>
<tr>
<td>Ta=+60 to +85°C</td>
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<tr>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
<td></td>
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<tr>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4 to 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VIO</td>
<td>0 to VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40 to +85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0 to 0-1000</td>
<td>ns</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4.5 to 0-500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 to 0-400</td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VIL, IO</td>
<td>Ta=25°C</td>
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<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td>min. max.</td>
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<td>1.5</td>
<td>3.15</td>
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<td></td>
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<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
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<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
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<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
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<td>-20.0</td>
<td>0.3</td>
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<td></td>
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<td>-4.0</td>
<td>0.9</td>
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<td>-5.2</td>
<td>1.2</td>
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<td>-20.0</td>
<td>1.9</td>
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<td>-20.0</td>
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<td>6.0</td>
<td>VIL=VCC or GND</td>
<td>±0.1</td>
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<td>Quiescent supply current</td>
<td>ICC</td>
<td>6.0</td>
<td>VIL=VCC or GND, IO=0</td>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<td>typ.</td>
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<td>Output rise time</td>
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<td>10</td>
<td>13</td>
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<td>Output fall time</td>
<td>t&lt;sub&gt;TH.L&lt;/sub&gt;</td>
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<td>4.5</td>
<td>6.0</td>
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<td>13</td>
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<td>Propagation time</td>
<td>t&lt;sub&gt;PL.H&lt;/sub&gt;</td>
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<td>34</td>
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<tr>
<td>Propagation time</td>
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<td>30</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PL.H&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>18</td>
</tr>
<tr>
<td>Qn→Qn+1 (L→H)</td>
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<td>13</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PH.L&lt;/sub&gt;</td>
<td>2.0</td>
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<td>6.0</td>
<td>17</td>
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<td>Qn→Qn+1 (H→L)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PH.L&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>55</td>
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<tr>
<td>CLR→Qn (H→L)</td>
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<td>17</td>
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<td>14</td>
<td>26</td>
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<tr>
<td>Minimum CLR pulse width</td>
<td>t&lt;sub&gt;W&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>20</td>
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<td>6</td>
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<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>15</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>4.5</td>
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<td>6</td>
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</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit \( t_{PLH}, t_{PHL} \)

![Switching Time Measuring Circuit and Waveforms](image)

- Typical Operating Condition

<table>
<thead>
<tr>
<th>CLK</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>16</th>
<th>32</th>
<th>64</th>
<th>128</th>
<th>256</th>
<th>512</th>
<th>1024</th>
<th>2048</th>
<th>4096</th>
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<tbody>
<tr>
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</table>
MN74HC4049/MN74HC4049S

Hex Inverting Logic Level Down Converters

Description
MN74HC4049/MN74HC4049S are inverting logic level down converters which function to correct input protection construction. This construction is used for the logic level converter, changing HIGH to LOW logic while it is not operated by LOW logic voltage.

For example, 0-15V CMOS logic can be converted to 0-5V logic when a 5V power supply voltage is used.

As for corrected input protection, input voltage can exceed the power supply voltage because the diode is not connected to Vcc. The zener diode connected to GND protects the input against plus-minus quiescent voltage, and can be used as an inverter without level conversion.

Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Same pin configuration and function as the standard CMOS logic 4000 family.

Schematic Diagram

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>Vo</td>
<td>−0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>Vi</td>
<td>−0.5~16</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Ik</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>Io</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Ignd</td>
<td>±70</td>
<td>mA</td>
</tr>
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<td>Storage temperature range</td>
<td>Tstg</td>
<td>−65~+150</td>
<td>°C</td>
</tr>
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<td>Power dissipation</td>
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<td>Ta=−40~+60°C</td>
<td>PD</td>
</tr>
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<td>Ta=+60~+85°C</td>
<td>400</td>
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<td></td>
<td>MN74HC4049S</td>
<td>Ta=−40~+60°C</td>
<td>PD</td>
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<tr>
<td></td>
<td></td>
<td>Ta=+60~+85°C</td>
<td>275</td>
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</table>

Panasonic
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
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<td>1.4~6.0</td>
<td></td>
<td>V</td>
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<tr>
<td>Output voltage</td>
<td>( V_O )</td>
<td>0~( V_{CC} )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>( V_I )</td>
<td>0~15</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>-40~+85( ^\circ )C</td>
<td>2.0</td>
<td>0~1000 ns</td>
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<tr>
<td>Input rise and fall time</td>
<td>( t_r ), ( t_f )</td>
<td>4.5</td>
<td>0~500 ns</td>
<td>ns</td>
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<tr>
<td></td>
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<td>6.0</td>
<td>0~400 ns</td>
<td>ns</td>
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### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>( V_I )</td>
<td>1.5</td>
<td>( V_{CC} )</td>
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<tr>
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<td>4.5</td>
<td>3.15</td>
<td>4.2</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>2.0</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>5.9</td>
</tr>
<tr>
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<td></td>
<td>4.5</td>
<td>( -4.0 )</td>
<td>mA</td>
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<td>( -5.2 )</td>
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<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>( V_{IL} )</td>
<td>20.0</td>
<td>( \mu A )</td>
</tr>
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<td></td>
<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
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<td>6.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
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<td>4.5</td>
<td>4.0</td>
<td>mA</td>
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<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
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<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>( V_{IH} )</td>
<td>20.0</td>
<td>( \mu A )</td>
</tr>
<tr>
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<td>4.5</td>
<td>20.0</td>
<td>( \mu A )</td>
<td>0.0</td>
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<td></td>
<td>6.0</td>
<td>( -20.0 )</td>
<td>( \mu A )</td>
<td>0.0</td>
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<td>4.5</td>
<td>4.0</td>
<td>mA</td>
<td>0.32</td>
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<td>6.0</td>
<td>5.2</td>
<td>mA</td>
<td>0.32</td>
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<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND</td>
<td>±0.1</td>
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<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND,( I_O=0 )</td>
<td>4.0</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50pF \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output rise time</td>
<td>( t_{TL,H} )</td>
<td>2.0</td>
<td>( V_I )</td>
<td>19</td>
<td>75</td>
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<td></td>
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<td>4.5</td>
<td>75</td>
<td>10</td>
<td>15</td>
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<td>6.0</td>
<td>19</td>
<td>9</td>
<td>13</td>
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<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>( V_I )</td>
<td>18</td>
<td>75</td>
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<td>4.5</td>
<td>75</td>
<td>10</td>
<td>15</td>
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<td></td>
<td>6.0</td>
<td>18</td>
<td>8</td>
<td>13</td>
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<tr>
<td>Propagation time (( L\rightarrow H ))</td>
<td>( t_{PL,H} )</td>
<td>2.0</td>
<td>( V_I )</td>
<td>15</td>
<td>100</td>
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<td>4.5</td>
<td>100</td>
<td>11</td>
<td>20</td>
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<td>6.0</td>
<td>15</td>
<td>10</td>
<td>17</td>
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<tr>
<td>Propagation time (( H\rightarrow L ))</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>( V_I )</td>
<td>18</td>
<td>100</td>
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<td></td>
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<td>4.5</td>
<td>100</td>
<td>11</td>
<td>20</td>
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<td>6.0</td>
<td>18</td>
<td>9</td>
<td>17</td>
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</table>
MN74HC4050/MN74HC4050S

Hex Logic Level Down Converter

Description

MN74HC4050/MN74HC4050S are non-inverted logic level down converters which function to correct input protection construction. This construction is used for the logic level converter, changing HIGH to LOW logic while it is not operated by LOW logic voltage.

For example, 0–15V CMOS logic can be converted to 0–5V logic when a 5V power supply voltage is used.

As for corrected input protection, input voltage can exceed the power supply voltage because the diode is not connected to V_{CC}.

The zener diode connected to GND protects the input against plus-minus quiescent voltage, and can be used as a buffer without level conversion.

Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Same pin configuration and function as the standard CMOS logic 4000 family.

Schematic Diagram

![Schematic Diagram](image)

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>−0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>V_{O}</td>
<td>−0.5~V_{CC}+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>V_{I}</td>
<td>−0.5~16</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20</td>
<td>mA</td>
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<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±35</td>
<td>mA</td>
</tr>
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<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>−65~+150</td>
<td>°C</td>
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<tr>
<td>Power dissipation</td>
<td>PD</td>
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<tr>
<td>MN74HC4050</td>
<td>Ta=−40~+60°C</td>
<td>400</td>
<td>mW</td>
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<td></td>
<td>Ta=+60~+85°C</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
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<tr>
<td>MN74HC4050S</td>
<td>Ta=−40~+60°C</td>
<td>275</td>
<td>mW</td>
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<td>Ta=+60~+85°C</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
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</table>
### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>( V_C )</td>
<td>1.4–6.0</td>
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<td>V</td>
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<tr>
<td>Output voltage</td>
<td>( V_O )</td>
<td>0–( V_{CC} )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>( V_I )</td>
<td>0–15</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>-40–+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r ), ( t_f )</td>
<td>4.5–500</td>
<td></td>
<td>ns</td>
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</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
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<td>max.</td>
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<td>min.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td></td>
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<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
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<td>1.5</td>
<td>V</td>
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<td>4.5</td>
<td>3.15</td>
<td>3.15</td>
<td>V</td>
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<tr>
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<td>6.0</td>
<td>4.2</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
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<td>0.3</td>
<td>V</td>
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<td>4.5</td>
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<td>0.9</td>
<td>V</td>
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<td></td>
<td>6.0</td>
<td>1.2</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>V</td>
</tr>
<tr>
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<td>4.5</td>
<td>-20.0</td>
<td>4.4</td>
<td>V</td>
</tr>
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<td>6.0</td>
<td>-20.0</td>
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<td>V</td>
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<td>Output LOW voltage</td>
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<td>V</td>
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<td>20.0</td>
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<td>V</td>
</tr>
<tr>
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<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ), ( GND )</td>
<td>±0.1</td>
<td>±1.0</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ), ( GND,I_O=0 )</td>
<td>4.0</td>
<td>40.0</td>
</tr>
</tbody>
</table>

### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50pF \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output rise time</td>
<td>( t_{1LH} )</td>
<td>2.0</td>
<td>21</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>2.0</td>
<td>13</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>7</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>39</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>10</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>8</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>
MN74HC4051/MN74HC4051S

Single 8-Channel Multiplexer/Demultiplexer

- Description
MN74HC4051/MN74HC4051S are an analog multiplexer which controls 8-channel analog switch with three input digital signal. Since each switch ON resistance is low, this chip can be connected to low impedance circuits. Pin configuration is same as the standard CMOS logic 4000 family.

- Truth Table

<table>
<thead>
<tr>
<th>INH</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Channel ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>Y0 – Z</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>Y1 – Z</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>Y2 – Z</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>Y3 – Z</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>Y4 – Z</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Y5 – Z</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>Y6 – Z</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>Y7 – Z</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>All OFF</td>
</tr>
</tbody>
</table>

Note: X: don’t care

- Logic Diagram

Panasonic -384-
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>VCC</td>
<td>−0.5 to +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>−0.5 to VCC + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IIK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IOK</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>IO</td>
<td>±35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>ICC, IGGND</td>
<td>±70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>TSTG</td>
<td>−65 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC4051</th>
<th>Ta=−40 to +60°C</th>
<th>PD</th>
<th>400 mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC4051S</td>
<td>Ta=40 to +85°C</td>
<td>PD</td>
<td>Decrease to 200 mW at the rate of 8 mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>2.0 to 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>0 to VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>−40 to +85°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0 to 1000 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 to 500 ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 to 400 ns</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>VIH</td>
<td>2.0</td>
<td>V = VCC or GND</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>min. 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>3.15</td>
<td>max. 3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40 to +85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>VIL</td>
<td>2.0</td>
<td>V = VIL or GND</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.3</td>
<td>min. 0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.9</td>
<td>max. 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=−40 to +85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>Ii</td>
<td>6.0</td>
<td>V = VCC or GND</td>
<td>±0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>±1.0 μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>Icc</td>
<td>6.0</td>
<td>V = VCC or GND</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80.0 μA</td>
</tr>
<tr>
<td>Input/output off peak current</td>
<td>IS(off)</td>
<td>6.0</td>
<td>V = VIL or VIL</td>
<td>±0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>±1.0 μA</td>
</tr>
<tr>
<td>On resistance</td>
<td>RON</td>
<td>2.0</td>
<td>V = VCC or GND</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
<td>2000</td>
<td>3000 Ω</td>
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<td></td>
<td></td>
<td>4.5</td>
<td>400</td>
<td>600 Ω</td>
</tr>
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<td></td>
<td></td>
<td>6.0</td>
<td>80</td>
<td>240 Ω</td>
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<td>60</td>
</tr>
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<td>120</td>
</tr>
<tr>
<td>Variation of On resistance</td>
<td>ΔRON</td>
<td>2.0</td>
<td>V = VCC or GND</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
<td>25</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>10</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>Ω</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, \( C_L=50\text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>( T_a=25^\circ\text{C} )</th>
<th>( T_a=-40\text{°C}+85^\circ\text{C} )</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>50</td>
<td>65</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>Input transition time = 15ns</td>
<td>50</td>
<td>65</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PHL} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>150</td>
<td>190</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>( t_{PLH} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>30</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>Output Disable Time</td>
<td>( t_{PHZ} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>150</td>
<td>190</td>
<td>ns</td>
</tr>
<tr>
<td>Output Disable Time</td>
<td>( t_{PLZ} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>30</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>Output Enable Time</td>
<td>( t_{PZH} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>150</td>
<td>190</td>
<td>ns</td>
</tr>
<tr>
<td>Output Enable Time</td>
<td>( t_{PZL} )</td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( C_L=50\text{pF} ) INH=GND</td>
<td>30</td>
<td>38</td>
<td>ns</td>
</tr>
<tr>
<td>Sine Wave Distortion</td>
<td></td>
<td>2.0</td>
<td>( f_i=1\text{kHz} ) ( Y=\frac{1}{2}V_{CC}\text{(P-P)} )</td>
<td>0.1</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Crosstalk (2 channel)</td>
<td></td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( Y=\frac{1}{2}V_{CC}\text{(P-P)} )</td>
<td>t.b.f</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Crosstalk (Address Input→Output)</td>
<td></td>
<td>2.0</td>
<td>( R_L=10\text{k}\Omega ) ( C_L=50\text{pF} ) INH or A, B, C=( V_{CC} )</td>
<td>t.b.f</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>Feedthrough (OFF)</td>
<td></td>
<td>2.0</td>
<td>( R_L=10\text{k}\Omega ) ( Y=\frac{1}{2}V_{CC}\text{(P-P)} ) ( C_L=50\text{pF} ) INH=GND</td>
<td>t.b.f</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Frequency Response</td>
<td></td>
<td>2.0</td>
<td>( R_L=1\text{k}\Omega ) ( INH=\frac{1}{2}V_{CC}\text{(P-P)} )</td>
<td>t.b.f</td>
<td></td>
<td>MHz</td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit
(Fig. 1) Propagation Delay Time, Output Disable/Enable Time, Crosstalk Measuring Circuit

(Fig. 2) Sine Wave Distortion, Feedthrough, Frequency Response Measuring Circuit

2. Waveforms
**MN74HC4052/MN74HC4052S**

Dual 4-Channel Analog Multiplexer/Demultiplexer

- **Description**
  MN74HC4052/MN74HC4052S are dual 4-channel multiplexer/demultiplexer for analog or digital signals. The switch to each channel become ON with the control signal. Since each switch ON resistance is low, it can be connected to low impedance circuits. Pin configuration is same as standard CMOS logic 4000 family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Channel ON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>INH</td>
<td>B</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
</tbody>
</table>

Note:
1. ×: don’t care

- **Logic Diagram**

---

Panasonic -388-
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5-+7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>$-0.5-V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65-+150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Power dissipation**

- MN74HC4052: $P_D = 400$ mW  
  Decrease to 200mW at the rate of 8mW/°C
- MN74HC4052S: $P_D = 275$ mW  
  Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>2.0-6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>0-$V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_A$</td>
<td>$-40-+85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_r$, $t_f$</td>
<td>2.0-4.5</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0-1000</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5-500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0-400</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_a=25$°C</th>
<th>$T_a=-40-+85$°C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_i = V_{CC}$ or $GND$</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0-6.0</td>
<td>1.5-3.15</td>
<td>1.5-3.15</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0-6.0</td>
<td>0.3-0.9</td>
<td>0.3-0.9</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_1$</td>
<td>6.0</td>
<td>$\pm 0.1$</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>µA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_i = V_{CC}$ or $GND$</td>
<td>8.0</td>
<td>80.0</td>
<td>µA</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>$I_o = 0$</td>
<td></td>
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<td>µA</td>
</tr>
<tr>
<td>Input/output off peak current</td>
<td>$t_{THL}$</td>
<td>6.0</td>
<td>$V_i = V_{IH}$ or $V_{IL}$</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
<td>µA</td>
</tr>
<tr>
<td>On resistance</td>
<td>$R_{ON}$</td>
<td>2.0-6.0</td>
<td>$V_i = V_{CC}$ or $GND$</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
<td></td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>80</td>
<td>160</td>
<td>240</td>
</tr>
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<td></td>
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<td>6.0</td>
<td></td>
<td>60</td>
<td>120</td>
<td>180</td>
</tr>
<tr>
<td>Variation of On resistance</td>
<td>$\Delta R_{ON}$</td>
<td>2.0-6.0</td>
<td>$V_i = V_{CC}$ or $GND$</td>
<td>150</td>
<td>25</td>
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<tr>
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<td></td>
<td>3.0</td>
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<td>10</td>
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<td>4.5</td>
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<td>7</td>
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<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
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</tr>
</tbody>
</table>
## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50\,\text{pF}$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$Ta=25\degree\text{C}$</td>
<td>$Ta=-40\sim+85\degree\text{C}$</td>
</tr>
<tr>
<td>Propagation time $V_{IS} \rightarrow V_{OS}$ (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>10</td>
<td>13</td>
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<tr>
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<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Propagation time $V_{IS} \rightarrow V_{OS}$ (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Propagation time $A, B \rightarrow V_{OS}$ (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
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<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Propagation time $A, B \rightarrow V_{OS}$ (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Output Disable Time $INH \rightarrow V_{OS}$ (H)</td>
<td>$t_{PHZ}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Output Disable Time $INH \rightarrow V_{OS}$ (L)</td>
<td>$t_{PLZ}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Output Enable Time $INH \rightarrow V_{OS}$ (H)</td>
<td>$t_{PZH}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Output Enable Time $INH \rightarrow V_{OS}$ (L)</td>
<td>$t_{PZL}$</td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$V_{IH}=\text{GND}$</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Sine Wave Distortion</td>
<td></td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>$C_L=50,\text{pF}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>$f=1,\text{MHz}$, $Y=\frac{1}{2}V_{CC}(P-P)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosstalk 2 channel</td>
<td></td>
<td>2.0</td>
<td>$R_L=1,\text{k}\Omega$</td>
<td>t.b.f</td>
<td></td>
</tr>
</tbody>
</table>
|                                        |        | 4.5 | $Y=\frac{1}{2}V_{CC}(P-P)$ | | |%
| Crosstalk (Address Input→Output) | | 2.0 | $R_L=10\,\text{k}\Omega$ | t.b.f | | mV |
|                                        |        | 4.5 | $C_L=50\,\text{pF}$ | | | mV |
|                                        |        | 6.0 | $INH$ or $A, B, C=V_{CC}$ | | | mV |
| Feedthrough (OFF) | | 2.0 | $R_L=10\,\text{k}\Omega$ | t.b.f | | MH z |
|                                        |        | 4.5 | $C_L=50\,\text{pF}$ | | | MH z |
|                                        |        | 6.0 | $INH=\text{GND}, Y=\frac{1}{2}V_{CC}(P-P)$ | | | MH z |
| Frequency Response | | 2.0 | $R_L=1\,\text{k}\Omega$ | t.b.f | | MH z |
|                                        |        | 4.5 | $INH=\frac{1}{2}V_{CC}(P-P)$ | | | MH z |
|                                        |        | 6.0 | | | | |
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

(Fig. 1) Propagation Delay Time, Output Disable/Enable Time, Crosstalk Measuring Circuit

(Fig. 2) Sine Wave Distortion, Feedthrough, Frequency Response Measuring Circuit

(Fig. 3) Crosstalk Measuring Circuit

2. Waveforms
MN74HC4053/MN74HC4053S

Triple 2-Channel Analog Multiplexer/Demultiplexer

**Description**

MN74HC4053/MN74HC4053S are triple 2-channel multiplexers/demultiplexers for analog or digital signals. The switch to each channel becomes ON with the control signal. Since each switch ON resistance is low, it can be connected to low impedance circuits. Pin configuration is same as standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Channel ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>INH</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
</tr>
</tbody>
</table>

Note:
1. ×: don't care

**Logic Diagram**

![Logic Diagram Image]
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V\text{CC}</td>
<td>-0.5~+7.0 V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V\text{IL}, V\text{OL}</td>
<td>-0.5~V\text{CC}+0.5 V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I\text{IK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I\text{OK}</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I\text{O}</td>
<td>±35 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>I\text{CC, I\text{GND}}</td>
<td>±70 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T\text{stg}</td>
<td>-65~+150°C</td>
<td></td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>MN74HC4053</th>
<th>Ta=−40~+60°C</th>
<th>P\text{D}</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC4053S</td>
<td>Ta=−40~+60°C</td>
<td>P\text{D}</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V\text{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V\text{CC}</td>
<td>2.0~6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V\text{IL}, V\text{OL}</td>
<td>0~V\text{CC}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T\text{A}</td>
<td>−40~+85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t\text{R}, t\text{F}</td>
<td>2.0 ns</td>
<td>0~1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td>0~500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td>0~400 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V\text{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V\text{IH}</td>
<td>2.0</td>
<td>V\text{I}=V\text{CC} or GND</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>±0.1</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>1.5</td>
<td>1000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>3.15</td>
<td>2000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>4.2</td>
<td>3000</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V\text{IL}</td>
<td>2.0</td>
<td>V\text{I}=V\text{CC} or GND</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>±0.1</td>
<td>min.</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>0.3</td>
<td>1000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.9</td>
<td>2000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2</td>
<td>3000</td>
<td>V</td>
</tr>
<tr>
<td>Input current</td>
<td>I\text{I}</td>
<td>6.0</td>
<td>±0.1</td>
<td>min.</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I\text{CC}</td>
<td>6.0</td>
<td>V\text{I}=V\text{CC} or GND</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.0</td>
<td>±0.1</td>
<td>min.</td>
</tr>
<tr>
<td>Input/output off reak current</td>
<td>I\text{s(off)}</td>
<td>6.0</td>
<td>V\text{I}=V\text{IH} or V\text{IL}</td>
<td>±0.1</td>
</tr>
<tr>
<td>On resistance</td>
<td>R\text{ON}</td>
<td>2.0</td>
<td>V\text{I}=V\text{CC}~GND</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
<td>200</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>400</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>600</td>
<td>Ω</td>
</tr>
<tr>
<td>Variation of On resistance</td>
<td>ΔR\text{ON}</td>
<td>2.0</td>
<td>V\text{I}=V\text{CC}~GND</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0</td>
<td>25</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>10</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>Ω</td>
</tr>
</tbody>
</table>
## AC Characteristics (GND=0V, Input transition time ≤6ns, C\textsubscript{L}=50pF)

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Symbol</th>
<th>V\textsubscript{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40~+85°C</td>
<td></td>
</tr>
<tr>
<td>Propagation time V\textsubscript{IL}→V\textsubscript{OS} (H→L)</td>
<td>t\textsubscript{PHL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=1kΩ</td>
</tr>
<tr>
<td>Propagation time V\textsubscript{IL}→V\textsubscript{OS} (L→H)</td>
<td>t\textsubscript{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>Input transition time=15ns</td>
</tr>
<tr>
<td>Propagation time A, B, →V\textsubscript{OS} (H→L)</td>
<td>t\textsubscript{PHL}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=1kΩ</td>
</tr>
<tr>
<td>Propagation time A, B, →V\textsubscript{OS} (L→H)</td>
<td>t\textsubscript{PLH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
</tr>
<tr>
<td>Output Disable Time INH→V\textsubscript{OS} (H)</td>
<td>t\textsubscript{PHZ}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>18</td>
</tr>
<tr>
<td>Output Enable Time INH→V\textsubscript{OS} (L)</td>
<td>t\textsubscript{PZH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=1kΩ</td>
</tr>
<tr>
<td>Output Enable Time INH→V\textsubscript{OS} (H)</td>
<td>t\textsubscript{PZH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>14</td>
</tr>
<tr>
<td>Output Disable Time INH→V\textsubscript{OS} (L)</td>
<td>t\textsubscript{PZH}</td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>15</td>
</tr>
<tr>
<td>Sine Wave Distortion</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=10kΩ</td>
</tr>
<tr>
<td>Crosstalk 2 channel</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=1kΩ</td>
</tr>
<tr>
<td>Crosstalk (Address Input→Output)</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=10kΩ</td>
</tr>
<tr>
<td>Feedthrough (OFF)</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=10kΩ</td>
</tr>
<tr>
<td>Frequency Response</td>
<td></td>
<td>2.0</td>
<td>4.5</td>
<td>6.0</td>
<td>R\textsubscript{L}=1kΩ</td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

(Fig. 1) Propagation Delay Time, Output Disadable
/Enable Time, Crosstalk Measuring Circuit

(Fig. 2) Sine Wave Distortion,
Feedthrough, Frequency Response
Measuring Circuit

\[
\begin{align*}
20 \log \frac{V_{os}}{V_{i1}} &= -50 \text{dB} \\
20 \log \frac{V_{os}}{V_{i1}} &= -3 \text{dB}
\end{align*}
\]

(Fig. 3) Crosstalk Measuring Circuit

2. Waveforms
MN74HC4060/MN74HC4060S

14-Stage Ripple-Carry Binary Counter

**Description**
MN74HC4060/4060S are high-speed 14-stage ripple-carry counter. This counter provides increments on the falling edge of clock input. The clear input operates in the counter, and all outputs become “L” regardless of the clock, when the clear input is “H”. The clock line is provided with 2-input terminal, which makes the connection with RC or crystal oscillation easy.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>Clock</th>
<th>Reset</th>
<th>Output State</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>J</td>
<td>L</td>
<td>Advance to next state</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
<td>All outputs are Low</td>
</tr>
</tbody>
</table>

Note:
1. J: The rise of clock from “L” to “H”
2. ×: The fall of clock from “H” to “L”
3. ×: Don’t care.

**Logic Diagram**

P-3

16-pin plastic DIL package

P-4

16-pin Panaflat package (SO-16D)

Pin Configuration (top view)
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 ) V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>(-0.5 \sim V_{CC} +0.5 ) V</td>
<td></td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>( \pm 20 ) mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 ) mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>( I_O )</td>
<td>( \pm 25 ) mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{GND} )</td>
<td>( \pm 50 ) mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150 ) °C</td>
<td></td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC4060</td>
<td>( P_D )</td>
<td>Decrease to 200m Watt the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td>MN74HC4060S</td>
<td>( P_D )</td>
<td>Decrease to 200m Watt the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4 \sim 6.0 V</td>
<td>( V )</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>0 \sim ( V_{CC} )</td>
<td>( V )</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>(-40 \sim +85 ) °C</td>
<td>( °C )</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r, t_f )</td>
<td>2.0 ns</td>
<td>0 \sim 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>0 \sim 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>0 \sim 400 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>( V_I )</th>
<th>( I_O )</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( V_T )</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>0.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>( V_{OH} )</td>
<td>2.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-20.0</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>5.9</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>5.9</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-5.2</td>
<td>5.36</td>
<td>5.26</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>( V_{OL} )</td>
<td>2.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>4.0</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>Input current</td>
<td>( I_I )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND</td>
<td>( \pm 0.1 )</td>
<td>( \pm 1.0 )</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_I=V_{CC} ) or GND, ( I_O=0 )</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C min.</td>
<td>Ta=−40~+85°C min.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;TLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>8</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>330</td>
<td>415</td>
<td>56</td>
</tr>
<tr>
<td>CLK→Q4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(L→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>330</td>
<td>415</td>
<td>56</td>
</tr>
<tr>
<td>CLK→Q4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
<td>20</td>
</tr>
<tr>
<td>Q&lt;sub&gt;n&lt;/sub&gt;→Q&lt;sub&gt;n+1&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(L→H)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
<td>20</td>
</tr>
<tr>
<td>Q&lt;sub&gt;n&lt;/sub&gt;→Q&lt;sub&gt;n+1&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>2.0</td>
<td>150</td>
<td>190</td>
<td>30</td>
</tr>
<tr>
<td>RESET→Q&lt;sub&gt;n&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H→L)</td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t&lt;sub&gt;W&lt;/sub&gt;</td>
<td>2.0</td>
<td>100</td>
<td>125</td>
<td>20</td>
</tr>
<tr>
<td>CLK, RESET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>t&lt;sub&gt;rem&lt;/sub&gt;</td>
<td>2.0</td>
<td>75</td>
<td>95</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.0</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>30</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>35</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit \((t_{PHL}, t_{PLH})\)

2. Switching Waveforms

\[
\begin{align*}
&\text{CLK} \\
&\text{Qn} \\
&\text{Output}
\end{align*}
\]
MN74HCT4060/MN74HCT4060S

14-Stage Ripple-Carry Binary Counter (TTL Input)

**Description**
MN74HCT4060/MN74HCT4060S are high-speed 14-stage ripple-carry counter. This counter provides increments on the negative going edge of clock input. The clear input operates in the counter, and all outputs become “L” regardless of the clock, when the clear input is “H”.

The clock line is provided with 2-input terminal, which makes the connection with RC or crystal oscillation easy.

All inputs are compatible with TTL logic level: 0.8V or less is logic “0” input and 2.0V or more is logic “1”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>Clock</th>
<th>Reset</th>
<th>Output State</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>✓</td>
<td>L</td>
<td>Advance to next state</td>
</tr>
<tr>
<td>×</td>
<td>H</td>
<td>All outputs are Low</td>
</tr>
</tbody>
</table>

Note:
1. ✓ : The rise of clock from “L” to “H”
2. ✓ : The fall of clock from “H” to “L”
3. × : Don’t care.

**Logic Diagram**

```
CLK2
CLK1
CLK

Q12 Q13 Q14 Q10 Q9 Q8 Q7 Q6 Q5 Q4
Q12 Q13 Q14 Q10 Q9 Q8 Q7 Q6 Q5 Q4
```

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>(-0.5\text{~}+7.0)</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>(-0.5\text{~}V_{CC}\text{+}0.5)</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{PI}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{PO}</td>
<td>±20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{Stg}</td>
<td>(-65\text{~}+150)</td>
<td>°C</td>
</tr>
</tbody>
</table>

| Power dissipation               | MN74HCT4060 | Ta=\(-40\text{~}+60°C\) | P_{D} | 400 | Decrease to 200m Watt the rate of 8mW/°C |
|                                | MN74HCT4060S | Ta=\(+00\text{~}+85°C\) | P_{D} | 275 | Decrease to 200m Watt the rate of 3.8mW/°C |

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC}(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation supply voltage</td>
<td>V_{CC}</td>
<td>4.5~5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0~V_{CC}</td>
<td>V</td>
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<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>(-40\text{~}+85)</td>
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<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>4.5</td>
<td>0~500</td>
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### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC}(V)</th>
<th>Test Conditions</th>
<th>Temperature-Ta=25°C</th>
<th>Temperature-Ta=(-40\text{~}+85°C)</th>
<th>Unit</th>
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<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>4.5</td>
<td>V_{I}</td>
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<td>2.0</td>
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<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>4.5</td>
<td>I_{O}</td>
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<td>0.8</td>
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<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>4.5</td>
<td>V_{IH}</td>
<td>4.4</td>
<td>4.5</td>
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<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
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<td>V_{IL}</td>
<td>3.86</td>
<td>3.76</td>
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<td>Input current</td>
<td>I_{I}</td>
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<td>V_{I}=V_{CC} or GND</td>
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<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
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<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
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<td>80.0</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tr>
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<td>4.5</td>
<td>8 15 19</td>
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<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>4.5</td>
<td>6 15 19</td>
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<tr>
<td>Propagation time CLK→Q4</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td>66 83</td>
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<tr>
<td>(L→H)</td>
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<tr>
<td>Propagation time CLK→Q4</td>
<td>t_{PLH}</td>
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<td>66 83</td>
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<tr>
<td>(H→L)</td>
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<tr>
<td>Propagation time Qn→Qn+1</td>
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<td>4.5</td>
<td>20 25</td>
<td>ns</td>
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<tr>
<td>(L→H)</td>
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<tr>
<td>Propagation time Qn→Qn+1</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td>20 25</td>
<td>ns</td>
</tr>
<tr>
<td>(H→L)</td>
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<tr>
<td>Propagation time Qn→Qn+1</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td>30 38</td>
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<tr>
<td>RESET→Qn</td>
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<td>Minimum pulse width</td>
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<td>20 25</td>
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<tr>
<td>Minimum recovery time</td>
<td>t_{rem}</td>
<td>4.5</td>
<td>15 19</td>
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<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
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<td>30 24</td>
<td>MHz</td>
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</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit (t_{PLH}, t_{PHL})

2. Switching Waveforms
MN74HC4066/MN74HC4066S
Quad Analog Switch

- Description
MN74HC4066/MN74HC4066S are quad independent bidirectional analog switch. When inhibit input (INH) is “H”, the state between switch input and output becomes LOW impedance (ON). When inhibit input is “L”, it becomes HIGH impedance (OFF). Pin configuration is same as standard CMOS logic 4000 family.

- Schematic Diagram

- Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>-0.5 to +7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>-0.5 to Vcc+0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>IiK</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>IoK</td>
<td>±20 mA</td>
<td>mA</td>
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<tr>
<td>Output current</td>
<td>Io</td>
<td>±35 mA</td>
<td>mA</td>
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<tr>
<td>Supply current</td>
<td>ICC, IGD</td>
<td>±70 mA</td>
<td>mA</td>
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<tr>
<td>Storage temperature range</td>
<td>Tsstg</td>
<td>-65 to +150 °C</td>
<td>°C</td>
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<td>Power dissipation</td>
<td>MN74HC4066</td>
<td>P0 = 400 mW</td>
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<td></td>
<td>MN74HC4066S</td>
<td>P0 = 275 mW</td>
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Panasonic
## Operating Conditions

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<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Rating ( V_{CC} )</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>( V_{CC} )</td>
<td>2.0 - 6.0</td>
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<td>V</td>
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<tr>
<td>Input/output voltage</td>
<td>( V_{I}, V_{O} )</td>
<td>0 - ( V_{CC} )</td>
<td></td>
<td>V</td>
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<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>-40 ~ +85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0</td>
<td>0 ~ 1000</td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0 ~ 500</td>
<td>ns</td>
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<td></td>
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<td>6.0</td>
<td>0 ~ 400</td>
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## DC Characteristics (GND=0V)

<table>
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<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>( V_{IH} )</td>
<td>2.0</td>
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<td>( T_{A} = 25°C )</td>
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<td>Input LOW voltage</td>
<td>( V_{IL} )</td>
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<td>( T_{A} = -40 ~ +85°C )</td>
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<tr>
<td>Input current</td>
<td>( I_{i} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or ( GND )</td>
<td>±0.1</td>
<td>( T_{A} = 25°C )</td>
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<tr>
<td>Quiescent supply current</td>
<td>( I_{CC} )</td>
<td>6.0</td>
<td>( V_{I} = V_{CC} ) or ( GND )</td>
<td>1.0</td>
<td>( I_{CC} = 0 )</td>
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<tr>
<td>Input/output off-peak current</td>
<td>( I_{off} )</td>
<td>6.0</td>
<td>( V_{I} = V_{IH} ) or ( V_{IL} )</td>
<td>±1.0</td>
<td>( I_{off} = 0 )</td>
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<td>µA</td>
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<td>On resistance</td>
<td>( R_{ON} )</td>
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<td>( V_{I} = V_{CC} ) or ( GND )</td>
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<td>Variation of On resistance</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propagation time (H → L)</td>
<td>tPHL</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 1kΩ, CL=50pF</td>
<td>Ta=25°C</td>
<td>min. typ. max. min. max.</td>
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<td></td>
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<td>4.5</td>
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<td>Ta=−40~+85°C</td>
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<td>min. typ. max.</td>
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<td>Propagation time (L → H)</td>
<td>tPLH</td>
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<td>INH = V&lt;sub&gt;CC&lt;/sub&gt;</td>
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<td>4.5</td>
<td>Input transition time=15ns</td>
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<tr>
<td>3-state propagation time (H → Z)</td>
<td>tPHZ</td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 1kΩ, CL=50pF</td>
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<td>min. typ. max.</td>
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<td>150</td>
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<td>3-state propagation time (Z → H)</td>
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<td>INH = V&lt;sub&gt;CC&lt;/sub&gt;</td>
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<td>min. typ. max.</td>
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<td>4.5</td>
<td>Input transition time=15ns</td>
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<td>3-state propagation time (L → Z)</td>
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<td>R&lt;sub&gt;L&lt;/sub&gt; = 10kΩ, CL=50pF</td>
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<td>3-state propagation time (Z → L)</td>
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<td>Input transition time=15ns</td>
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<td>26</td>
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<tr>
<td>Sine Wave Distortion</td>
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<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 10kΩ, CL=50pF, f&lt;sub&gt;i&lt;/sub&gt;=1kHz, Y=(\frac{1}{2}V_{CC}(P-P))</td>
<td>Ta=25°C</td>
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<tr>
<td>Crosstalk (2 channel)</td>
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<td>P&lt;sub&gt;L&lt;/sub&gt; = 1kΩ, Y=(\frac{1}{2}V_{CC}(P-P))</td>
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<td>t.b.f</td>
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<td>Crosstalk (INH→V&lt;sub&gt;SS&lt;/sub&gt;)</td>
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<td>R&lt;sub&gt;L&lt;/sub&gt; = 10kΩ, CL=50pF, INH = V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
<td>t.b.f</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedthrough</td>
<td></td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 1kΩ, CL=50pF, INH = GND, Y=(\frac{1}{2}V_{CC}(P-P))</td>
<td></td>
<td>t.b.f</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>6.0</td>
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</tr>
<tr>
<td>Frequency Response</td>
<td></td>
<td>2.0</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 1kΩ, INH = V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
<td>t.b.f</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms
  1. Measuring Circuit (t_{PLH}, t_{PHL})

  (Fig. 1) Propagation Delay Time, Crosstalk Measuring circuit

  (Fig. 2) Sine Wave Distortion, Feedthrough Measuring Circuit

  2. Switching Time Waveforms

  (V_{1s} \rightarrow V_{os})
High-Speed CMOS Logic MN74HC Series

**MN74HC4075/MN74HC4075S**

Triple 3-Input OR Gates

**Description**

MN74HC4075/MN74HC4075S contain three 3-input positive isolation OR gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in V_{CC} and GND for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard CMOS 4000 logic family.

**Logic Diagram (1 gate)**

[Diagram]

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>−0.5~+7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>−0.5~V_{CC}+0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±25 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±50 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>−65~+150 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC4075</td>
<td>P_{D} 400 mW</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>MN74HC4075S</td>
<td>P_{D} 275 mW</td>
<td>mW</td>
</tr>
</tbody>
</table>

MN74HC4075: Ta=−40~+60°C

MN74HC4075S: Ta=−40~+60°C

Decrease to 200mW at the rate of 8mW/°C

Decrease to 200mW at the rate of 3.8mW/°C
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>1.4~6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I, V_{O}}$</td>
<td>0~$V_{CC}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>-40~+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r, t_{f}}$</td>
<td>2.0~1000</td>
<td>4.5~500</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>0~400</td>
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## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>$V_{OH}$</th>
<th>$V_{OL}$</th>
<th>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</th>
<th>$I_{CC}$</th>
<th>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</th>
<th>$I_{CC}$</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
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<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
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<td>1.5</td>
<td>3.15</td>
<td>4.2</td>
<td>0.3</td>
<td>1.2</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
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<td>4.5</td>
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<td></td>
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<tr>
<td>Output LOW voltage</td>
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</tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>±0.1</td>
<td>±1.0</td>
<td>±0.1</td>
<td>±1.0</td>
<td>±0.1</td>
<td>±1.0</td>
<td>±0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>6.0</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
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<td>20.0</td>
<td>2.0</td>
<td>20.0</td>
<td>2.0</td>
<td>20.0</td>
<td>2.0</td>
</tr>
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</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, $C_{L}=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$T_{A}=25^\circ C$</th>
<th>$T_{A}=-40~+85^\circ C$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<tr>
<td>Output rise time</td>
<td>$t_{TLH}$</td>
<td>2.0</td>
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<td>25</td>
<td>75</td>
<td>95</td>
</tr>
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<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>2.0</td>
<td></td>
<td>20</td>
<td>75</td>
<td>95</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>$t_{PLH}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>$t_{PHL}$</td>
<td>2.0</td>
<td></td>
<td>25</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>
MN74HC4078/MN74HC4078S

8-Input NOR Gate

**Description**
MN74HC4078/MN74HC4078S contain 8-input positive isolation NOR gate circuits. Adoption of a silicon gate CMOS process has resulted in low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. Input/output transfer characteristics have been improved by applying a buffer to the gate output, and fluctuation of transfer time due to increased load capacitance is limited to the minimum. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in \( V_{DD} \) and \( V_{SS} \) for protection of the input/output against damage by static electricity. Same pin configuration and function as the standard CMOS 4000 logic family.

**Logic Diagram**

![Logic Diagram](image)

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5 \sim +7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{IL, VO} )</td>
<td>(-0.5 \sim V_{CC} +0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>( \pm 25 )</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC, IGN} )</td>
<td>( \pm 50 )</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65 \sim +150 )</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC4078</td>
<td>( P_{D} )</td>
<td>( 400 )</td>
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<tr>
<td></td>
<td>MN74HC4078S</td>
<td>( P_{D} )</td>
<td>( 275 )</td>
</tr>
<tr>
<td></td>
<td>MN74HC4078S</td>
<td>( P_{D} )</td>
<td>Decrease to 200mW at the rate of 8mW/°C</td>
</tr>
<tr>
<td></td>
<td>MN74HC4078S</td>
<td>( P_{D} )</td>
<td>Decrease to 200mW at the rate of 3.8mW/°C</td>
</tr>
</tbody>
</table>
## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>VCC</td>
<td>1.4 - 6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>VIL, VOL</td>
<td>0 - VCC</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>TA</td>
<td>-40 - +85 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>2.0 ns</td>
<td>0 - 1000 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ns</td>
<td>0 - 500 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ns</td>
<td>0 - 400 ns</td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vi</td>
<td>Io</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>Vih</td>
<td>2.0</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>Input LOW voltage</td>
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<td>2.0</td>
<td></td>
<td>0.3</td>
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<tr>
<td></td>
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<td>4.5</td>
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<td>0.9</td>
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<td>Output HIGH voltage</td>
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<td>2.0</td>
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<td>1.9</td>
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<td>6.0</td>
<td></td>
<td>5.9</td>
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<tr>
<td>Output LOW voltage</td>
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<td>0.32</td>
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<td>Vih</td>
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</tr>
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<td>or</td>
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</tr>
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<td></td>
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<td>0.36</td>
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<td>Quiescent supply current</td>
<td>Icc</td>
<td>6.0</td>
<td>Vih</td>
<td>20.0</td>
</tr>
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<td></td>
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<td></td>
<td>or</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>0.36</td>
</tr>
</tbody>
</table>

## AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>Output rise time</td>
<td>tTlh</td>
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<td>75</td>
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<td></td>
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<td>4.5</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Output fall time</td>
<td>tTlh</td>
<td>2.0</td>
<td>20</td>
<td>75</td>
</tr>
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<td></td>
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<td>4.5</td>
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<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
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<td>25</td>
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<td>15</td>
<td>155</td>
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<td>26</td>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>21</td>
<td>26</td>
</tr>
</tbody>
</table>

Panasonic
MN74HC4301/MN74HC4301S
TTL Input Octal TRI-STATE Latch with Inverting Outputs

**Description**

MN74HC4301/MN74HC4301S contain TTL input octal tri-state latches with inverting outputs. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more logic “1”. High output driving capacity and tri-state output driving capacity and tri-state output are suited for the use of common bus line in the bus utilized system. When output disable input is “L”, and latch enable input is “H”, data input is inverted and transferred to output. When latch enable is “L”, data input is maintained as is until when latch enable input becomes “H” again. When output disable input is “H”, all outputs become high impedance state regardless of other inputs or data hold circuits. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Output Control</th>
<th>Enable</th>
<th>D</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
<td>Q0</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
<td>X</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. X: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
3. Q0: Q level prior to determination of input condition shown in table

**Logic Diagram**

![Logic Diagram](image-url)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{cc}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{i}, V_{o}$</td>
<td>$-0.5 \sim V_{cc} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{ik}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{ok}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{o}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{cc}, I_{gnd}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power dissipation

<table>
<thead>
<tr>
<th>Model</th>
<th>$T_a= -40 \sim + 60°C$</th>
<th>$P_d$</th>
<th>$400$</th>
<th>mW</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74 HC4301</td>
<td>$T_a= +60 \sim +85°C$</td>
<td>$P_d$</td>
<td>Decrease to 200mW at the rate of 8mW°C</td>
<td></td>
</tr>
<tr>
<td>MN74 HC4301S</td>
<td>$T_a= -40 \sim + 60°C$</td>
<td>$P_d$</td>
<td>$275$</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>$T_a= +60 \sim +85°C$</td>
<td>$P_d$</td>
<td>Decrease to 200mW at the rate of 3.8mW°C</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{cc}$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{ee}$</td>
<td>$4.5 \sim 5.5$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{i}, V_{o}$</td>
<td>$0 \sim V_{cc}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{a}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$tr, tf$</td>
<td>$4.5$</td>
<td>$0 \sim 500$</td>
<td>ns</td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{cc}$</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td>$V_{i}$</td>
<td>$I_{o}$</td>
<td>$T_{a}=25°C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{ih}$</td>
<td>4.5</td>
<td>$-20$</td>
<td>$0.4$</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>$V_{ih}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td>3.86</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{il}$</td>
<td>4.5</td>
<td></td>
<td>$-6.0$</td>
<td>$-20$</td>
</tr>
<tr>
<td></td>
<td>$V_{il}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{oh}$</td>
<td>4.5</td>
<td>$20$</td>
<td>$0.1$</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>$V_{oh}$</td>
<td>4.5</td>
<td></td>
<td>$-20$</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td>$V_{oh}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{oh}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{ol}$</td>
<td>4.5</td>
<td>$20$</td>
<td>$0.1$</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>$V_{ol}$</td>
<td>4.5</td>
<td></td>
<td>$-20$</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td>$V_{ol}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{ol}$</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{i}$</td>
<td>5.5</td>
<td>$I_{i}=V_{cc}$</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
</tr>
<tr>
<td></td>
<td>$I_{i}$</td>
<td>5.5</td>
<td>$I_{i}=GND$</td>
<td>$\pm 0.1$</td>
<td>$\pm 1.0$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{oz}$</td>
<td>5.5</td>
<td>$V_{i}=V_{ih}$ or $V_{il}$</td>
<td>$\pm 0.5$</td>
<td>$\pm 5.0$</td>
</tr>
<tr>
<td></td>
<td>$I_{oz}$</td>
<td>5.5</td>
<td>$V_{o}=V_{cc}$ or $GND$</td>
<td>$\pm 0.5$</td>
<td>$\pm 5.0$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{cc}$</td>
<td>5.5</td>
<td>$I_{i}=V_{cc}$ or $G_{cc}, I_{o}=0$</td>
<td>8.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C<sub>L</sub>=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V&lt;sub&gt;CC&lt;/sub&gt; (V)</th>
<th>Test Conditions</th>
<th>Temperature Condition</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t&lt;sub&gt;TLH&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t&lt;sub&gt;THL&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time D→Q (L→H)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Propagation time D→Q (H→L)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time enable G→Q(L→H)</td>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Propagation time enable G→Q(H→L)</td>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>4.5</td>
<td></td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PHZ&lt;/sub&gt;,</td>
<td>4.5</td>
<td>R&lt;sub&gt;i&lt;/sub&gt; = 1kΩ</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>(H→Z)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PLZ&lt;/sub&gt;</td>
<td>4.5</td>
<td>R&lt;sub&gt;i&lt;/sub&gt; = 1kΩ</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PZH&lt;/sub&gt;</td>
<td>4.5</td>
<td>R&lt;sub&gt;i&lt;/sub&gt; = 1kΩ</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t&lt;sub&gt;PZL&lt;/sub&gt;</td>
<td>4.5</td>
<td>R&lt;sub&gt;i&lt;/sub&gt; = 1kΩ</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

\[ t_{\text{PLH}}/t_{\text{PHL}} \ (\text{EG} \rightarrow \overline{Q}) \]

2. Waveforms

\[ t_{\text{PLH}}/t_{\text{PHL}} \ (\text{D} \rightarrow \overline{Q}) \]

3. Waveforms

\[ t_{\text{PHZ}}, t_{\text{PZH}} \]

4. Waveforms

\[ t_{\text{PLZ}}, t_{\text{PZL}} \]

**MN74HC4302/MN74HC4302S**

**TTL Input Octal TRI-STATE Latches**

**Description**

MN74HC4302/MN74HC4302S contain TTL input octal tri-state latches with outputs. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more logic “1”. High output driving capacity and tri-state output driving capacity and tri-state output are suited for the use of common bus line in the bus utilized system. When output disable input is “L”, and latch enable input is “H”, data input is inverted and transferred to output. When latch enable is “L”, data input is maintained as is until when latch enable input becomes “H” again. When output disable input is “H”, all outputs become high impedance state regardless of other inputs or data hold circuits. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in \( V_{CC} \) and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Output Control</th>
<th>Enable G</th>
<th>D</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>×</td>
<td>Qo</td>
</tr>
<tr>
<td>H</td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ×: Either HIGH or LOW; it doesn’t matter
2. Hi-Z: High impedance
3. Qo: Q level prior to determination of input condition shown in table

**Logic Diagram**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Vcc</td>
<td>-0.5~+7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>-0.5~Vcc+0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>Ipk</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>Iok</td>
<td>±20 mA</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I0</td>
<td>±35 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>Icc, Icgb</td>
<td>±70 mA</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>Tstg</td>
<td>-65~+150 °C</td>
<td></td>
</tr>
<tr>
<td>MN74HC4302 Power dissipation</td>
<td>Pd</td>
<td>400 mW</td>
<td></td>
</tr>
<tr>
<td>MN74HC4302S Power dissipation</td>
<td>Pd</td>
<td>275 mW</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>Vcc</td>
<td>4.5~5.5 V</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V1, V0</td>
<td>0~Vcc</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>Ta</td>
<td>-40~+85 °C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>tr, tf</td>
<td>4.5V</td>
<td>0~500 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>Vih</td>
<td>4.5</td>
<td>20.0 mA</td>
<td>Ta=25°C</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>-20.0 μA</td>
<td>Ta=-40~+85 °C</td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>Vil</td>
<td>4.5</td>
<td>0.8 V</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>0.8 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>Voh</td>
<td>4.5</td>
<td>4.4 mA</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>3.86 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>Vol</td>
<td>4.5</td>
<td>0.0 mA</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>0.32 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>l1</td>
<td>5.5</td>
<td>±0.1 μA</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>Ioz</td>
<td>5.5</td>
<td>±0.5 μA</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>lcc</td>
<td>5.5</td>
<td>8.0 μA</td>
<td></td>
<td>μA</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>Ta=−40~+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>4.5</td>
<td></td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>4.5</td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>D→Q (L→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>D→Q (H→L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>enable G→Q(L→H)</td>
<td></td>
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<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>15</td>
<td>25</td>
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<td>enable G→Q(H→L)</td>
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<td></td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PHZ}</td>
<td>4.5</td>
<td>R_L=1kΩ</td>
<td>10</td>
<td>25</td>
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<td>(H→Z)</td>
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<td>3-state propagation time</td>
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<td>4.5</td>
<td>R_L=1kΩ</td>
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<td>(L→Z)</td>
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<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>4.5</td>
<td>R_L=1kΩ</td>
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<td>20</td>
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<td>(Z→H)</td>
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<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>4.5</td>
<td>R_L=1kΩ</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
• Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

**MN74HC4303/MN74HC4303S**

**TTL Input Octal TRI-STATE D-Type Flip-Flops with Inverting Outputs**

**Description**
MN74HC4303/MN74HC4303S are TTL input octal tri-state D-type flip-flop with inverting outputs. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more logic “1”. High output driving capacity and tri-state output are suited for the use of common bus line in the bus utilized system D input data satisfying set-up time is inverted by the rising edge of clock input and transferred to output. When output disable input is “H”, all outputs become high impedance regardless of other inputs or data hold circuits.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output Control</th>
<th>CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>L</td>
<td>×</td>
<td>Qo</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td>×</td>
<td>×</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

**Logic Diagram**

- **Pin Configuration (top view)**
- **20-pin plastic DIL package**
- **20-pin Panafloat package (ISO-20D)**
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,I,O}$</td>
<td>$-0.5 \sim V_{CC} + 0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC,I,GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>MN74HC4303</td>
<td>$P_{D}$</td>
<td>400 mW</td>
</tr>
<tr>
<td></td>
<td>MN74HC4303S</td>
<td>$P_{D}$</td>
<td>275 mW</td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>4.5 $\sim$ 5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I,I,O}$</td>
<td>0 $\sim$ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_{A}$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r,t_{f}}$</td>
<td>4.5 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{I,I,O}$</td>
<td>$T_{A}=25^\circ C$</td>
<td>$T_{A}= -40 \sim +85^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{1,I,O}$</td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>$4.5 \sim 5.5$</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>$4.5 \sim 5.5$</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>$V_{IH}$</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or $V_{IL}$</td>
<td>3.86</td>
<td>3.76</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>$V_{IH}$</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or $V_{IL}$</td>
<td>0.32</td>
<td>0.37</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_{I}$</td>
<td>$5.5$</td>
<td>$V_{I}=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{0Z}$</td>
<td>$5.5$</td>
<td>$V_{I}=V_{IH}$ or $V_{IL}$</td>
<td>$\pm 0.5$</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{CC}$</td>
<td>$5.5$</td>
<td>$V_{I}=V_{CC}$ or GND, $I_{O}=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
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<td>typ.</td>
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<td></td>
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<td></td>
<td>max.</td>
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<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>4.5</td>
<td></td>
<td>min.</td>
<td>6</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>typ.</td>
<td>15</td>
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<td>max.</td>
<td>19</td>
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<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>4.5</td>
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<td>Ta=-40~85°C</td>
<td></td>
</tr>
<tr>
<td>CLK→Q (L→H)</td>
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<td>min.</td>
<td>13</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>38</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>Ta=-40~85°C</td>
<td></td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
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<td></td>
<td>min.</td>
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<tr>
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<td>max.</td>
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<tr>
<td>3-state propagation time</td>
<td>t_{PHZ}</td>
<td>4.5</td>
<td>RL=1 kΩ</td>
<td>Ta=25°C</td>
<td>18</td>
</tr>
<tr>
<td>(H→Z)</td>
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<td></td>
<td></td>
<td>typ.</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>38</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZL}</td>
<td>4.5</td>
<td>RL=1 kΩ</td>
<td>Ta=-40~85°C</td>
<td>15</td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>31</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZH}</td>
<td>4.5</td>
<td>RL=1 kΩ</td>
<td>Ta=25°C</td>
<td>14</td>
</tr>
<tr>
<td>(Z→H)</td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>31</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>t_{PZI}</td>
<td>4.5</td>
<td>RL=1 kΩ</td>
<td>Ta=-40~85°C</td>
<td>14</td>
</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Minimum Set-up time</td>
<td>t_{su}</td>
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<td>min.</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>max.</td>
<td>25</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{hb}</td>
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<td></td>
<td>min.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>typ.</td>
<td>0</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>4.5</td>
<td></td>
<td>Min.</td>
<td>30</td>
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<td>typ.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>24</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

[1] \( t_{\text{THL}}, t_{\text{THL}}, f_{\text{max}}, t_{\text{PLH}} / t_{\text{PHL}} \) (CLK→Q)

1. Measuring Circuit

![Measuring Circuit Diagram](image)

2. Waveforms

![Waveforms Diagram](image)

[2] \( t_{\text{PHL}}, t_{\text{PZH}} \)

1. Measuring Circuit

![Measuring Circuit Diagram](image)

2. Waveforms

![Waveforms Diagram](image)

[3] \( t_{\text{PLZ}}, t_{\text{PZL}} \)

1. Measuring Circuit

![Measuring Circuit Diagram](image)

2. Waveforms

MN74HC4304/MN74HC4304S
TTL Input Octal TRI-STATE Flip-Flops

- Description
MN74HC4304/MN74HC4304S are TTL input octal tri-state D type flip-flop. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more logic “1”. High output driving capacity and tri-state output are suited for the use of common bus line in the bus utilized system. D input data satisfying set-up time is transferred to output by the rising edge of clock input. When output disable input is “H”, all outputs become high impedance regardless of other inputs or data hold circuits. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard 54LS/74LS logic family.

- Truth Table

<table>
<thead>
<tr>
<th>Input</th>
<th>Output Control</th>
<th>CLK</th>
<th>D</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>Qo</td>
<td>Hi-Z</td>
</tr>
</tbody>
</table>

Note:
1. ⊕: Data input is transferred to output on the positive-going edge from LOW to HIGH of the clock
2. x: Either HIGH or LOW; it doesn’t matter
3. Qo: Q level prior to determination of input condition shown in table
4. Hi-Z: High impedance

- Logic Diagram

Panasonic
# Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_{O}$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}, I_{GND}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{STG}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

- Power dissipation
  - MN74HN4304 with $T_a = -40 \sim +60^\circ C$
  - $P_D = 400$ mW
  - Decrease to 200 mW at the rate of 8 mW/°C
  - MN74HC4304S with $T_a = -40 \sim +65^\circ C$
  - $P_D = 275$ mW
  - Decrease to 200 mW at the rate of 3.8 mW/°C

# Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>$4.5 \sim 5.5$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_{I}, V_{O}$</td>
<td>$0 \sim V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{r}, t_{f}$</td>
<td>$4.5$ V</td>
<td>$0 \sim 500$</td>
<td>ns</td>
</tr>
</tbody>
</table>

# DC Characteristics (GND = 0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_a=25^\circ C$</td>
<td>$T_a=40 \sim +85^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unit</td>
<td>min.</td>
</tr>
</tbody>
</table>

- Input HIGH voltage
  - $V_{IH}$ with $V_{II} \leq 0$
  - $4.5$ V
  - $2.0$ mV
  - $2.0$ mV

- Input LOW voltage
  - $V_{IL}$ with $V_{II} \geq 0$
  - $4.5$ V
  - $0.8$ mV

- Output HIGH voltage
  - $V_{OH}$ with $V_{II} \geq 0$ or $V_{II} \leq 0$
  - $4.5$ V
  - $V_{OH}$ with $V_{II} = 20.0$ or $V_{II} = 6.0$
  - $0.4$ mA

- Output LOW voltage
  - $V_{OL}$ with $V_{II} \leq 0$ or $V_{II} \geq 0$
  - $4.5$ V
  - $V_{OL}$ with $V_{II} = 20.0$ or $V_{II} = 6.0$

- Input current $I_{I}$
  - $5.5$ V

- 3-state output off state current $I_{OZ}$
  - $5.5$ V

- Quiescent supply current $I_{CC}$
  - $5.5$ V

Panasonic
## AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>VCC (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40~+85°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min. max.</td>
<td></td>
</tr>
<tr>
<td>Output rise time</td>
<td>t_{TLH}</td>
<td>4.5</td>
<td></td>
<td>8 15 19</td>
<td>ns</td>
</tr>
<tr>
<td>Output fall time</td>
<td>t_{THL}</td>
<td>4.5</td>
<td></td>
<td>6 15 19</td>
<td>ns</td>
</tr>
<tr>
<td>Propagation time</td>
<td>t_{PLH}</td>
<td>4.5</td>
<td></td>
<td>15 30 38</td>
<td>ns</td>
</tr>
<tr>
<td>CLK→Q (L→H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLK→Q (H→L)</td>
<td>t_{PHL}</td>
<td>4.5</td>
<td></td>
<td>16 30 38</td>
<td>ns</td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>t_{PHZ}</td>
<td>4.5</td>
<td>R_L=1 k Ω</td>
<td>16 20 25</td>
<td>ns</td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>t_{PLZ}</td>
<td>4.5</td>
<td>R_L=1 k Ω</td>
<td>15 20 25</td>
<td>ns</td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>t_{PZH}</td>
<td>4.5</td>
<td>R_L=1 k Ω</td>
<td>14 20 25</td>
<td>ns</td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>t_{PZL}</td>
<td>4.5</td>
<td>R_L=1 k Ω</td>
<td>14 20 25</td>
<td>ns</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>t_{ss}</td>
<td>4.5</td>
<td></td>
<td>2 20 25</td>
<td>ns</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>t_{sh}</td>
<td>4.5</td>
<td></td>
<td>- 0</td>
<td>ns</td>
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<tr>
<td>Maximum clock frequency</td>
<td>f_{max}</td>
<td>4.5</td>
<td></td>
<td>30 87 24</td>
<td>MHz</td>
</tr>
</tbody>
</table>
High-Speed CMOS Logic MN74HC Series

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

3. Measuring Circuit

2. Waveforms

**MN74HC4305/MN74HC4305S**

TTL Input Octal TRI-STATE Inverting Buffers

- **Description**

MN74HC4305/MN74HC4305S are TTL input octal tri-state inverting buffer.

All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more is logic “1”. Large current output makes possible high-speed operation for driving a large capacity busline. It has input 1G and 2G where output becomes enabled at LOW, and each can control 4 buffers.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity.

- **Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>1A</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note:
Hi-Z: High impedance

- **Logic Diagram**

[Logic Diagram Image]

Panasonic
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{CC}$</td>
<td>$-0.5 \sim +7.0$</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>$-0.5 \sim V_{CC}+0.5$</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>$I_{IK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>$I_{OK}$</td>
<td>$\pm 20$</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>$\pm 35$</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>$I_{CC}$, $I_{OLD}$</td>
<td>$\pm 70$</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td>$-65 \sim +150$</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

| MN74HC4305 | $T_a=+40 \sim +60^\circ C$ | $P_D$ | 400 mW |
| MN74HC4305 S | $T_a=+60 \sim +85^\circ C$ | $P_D$ | 275 mW |

Decrease to 200mW at the rate of 8mW/°C

Decrease to 200mW at the rate of 3.8mW/°C

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}(V)$</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>$V_{CC}$</td>
<td>4.5 ~ 5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>$V_i$, $V_o$</td>
<td>0 ~ $V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>$T_a$</td>
<td>$-40 \sim +85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>$t_{ri}$</td>
<td>4.5</td>
<td>0 ~ 500 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_i$, $I_o$</td>
<td>$T_a=25^\circ C$</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>4.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>4.5</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>4.5</td>
<td>$V_{IH}$ or $V_{IL}$</td>
<td>$-20.0$</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>4.5</td>
<td>$V_{IH}$ or $V_{IL}$</td>
<td>$20.0$</td>
</tr>
<tr>
<td>Input current</td>
<td>$I_i$</td>
<td>5.5</td>
<td>$V_i=V_{CC}$ or GND</td>
<td>$\pm 0.1$</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>$I_{OZ}$</td>
<td>5.5</td>
<td>$V_i=V_{IH}$ or $V_{II}$</td>
<td>$V_{OL}=V_{CC}$ or GND</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>$I_{QC}$</td>
<td>5.5</td>
<td>$V_i=V_{CC}$ or GND, $I_o=0$</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{cc} ) (V)</th>
<th>Vee Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
<td>min.</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{TLH} )</td>
<td>4.5</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Output fall time</td>
<td>( t_{THL} )</td>
<td>4.5</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>( t_{PLH} )</td>
<td>4.5</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Propagation time (H→L)</td>
<td>( t_{PHL} )</td>
<td>4.5</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>3-state propagation time (H→Z)</td>
<td>( t_{PHZ} )</td>
<td>4.5</td>
<td>( R_L = 1 , k\Omega )</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>3-state propagation time (L→Z)</td>
<td>( t_{PLZ} )</td>
<td>4.5</td>
<td>( R_L = 1 , k\Omega )</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>3-state propagation time (Z→H)</td>
<td>( t_{PZH} )</td>
<td>4.5</td>
<td>( R_L = 1 , k\Omega )</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>3-state propagation time (Z→L)</td>
<td>( t_{PZL} )</td>
<td>4.5</td>
<td>( R_L = 1 , k\Omega )</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

[1] \( t_{TLH}, t_{THL}, t_{PLH}, t_{PHL} \)

---

Panasonic
[2] t_{PHZ}, t_{PZH}
1. Measuring Circuit

[3] t_{PLZ}, t_{PZL}
1. Measuring Circuit

MN74HC4306/MN74HC4306S
TTL Input Octal TRI-STATE Buffer

**Description**

MN74HC4305/MN74HC4305S are TTL input octal tri-state buffers. All inputs are compatible with TTL logic level: 0.8V or less is logic “0” and 2.0V or more is logic “1”. Large current output makes possible high-speed operation for driving a large capacity busline. It has input $1\bar{G}$ and $2\bar{G}$ where output becomes enabled at LOW, and each can control 4 buffers. Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in $V_{cc}$ and GND to protect the input/output from damage by static electricity.

**Truth Table**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1\bar{G}$</td>
<td>1A</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Y</td>
<td>2Y</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G</td>
<td>2A</td>
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<tr>
<td>L</td>
<td>L</td>
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<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

**Logic Diagram**

![Logic Diagram](image)

**Pin Configuration (top view)**

![Pin Configuration](image)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>−0.5 ~ +7.0 V</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>−0.5 ~ V_{CC} + 0.5 V</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IK}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>±20 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>±35 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>±70 mA</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>−65 ~ +150 °C</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Power Dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Ta=−40 ~ +60°C</th>
<th>Ta=+60 ~ +85°C</th>
<th>P_{D}</th>
<th>Decrease to 200mW at the rate of 8mW/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74 HC4306</td>
<td>P_{D}</td>
<td>400 mW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MN74 HC4306S</td>
<td>P_{D}</td>
<td>275 mW</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC}(V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>4.5 ~ 5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0 ~ V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>−40 ~ +85 °C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>4.5 ns</td>
<td>0 ~ 500 ns</td>
<td></td>
</tr>
</tbody>
</table>

### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>4.5</td>
<td>2.0</td>
<td>Ta=25°C</td>
<td>V</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>4.5</td>
<td>0.8</td>
<td>Ta=25°C</td>
<td>V</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>V_{IH} or V_{IL}</td>
<td>−20.0</td>
<td>Ta=25°C</td>
<td>μA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>V_{IH} or V_{IL}</td>
<td>20.0</td>
<td>Ta=25°C</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>5.5</td>
<td>V_{I}=V_{CC} or GND</td>
<td>±0.1</td>
<td>μA</td>
</tr>
<tr>
<td>3-state output off state current</td>
<td>I_{OZ}</td>
<td>5.5</td>
<td>V_{I}=V_{IH} or V_{IL}, V_{O}=V_{CC} or GND</td>
<td>±0.5</td>
<td>μA</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>5.5</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
<td>μA</td>
</tr>
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</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Vcc (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40°+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min. typ. max.</td>
</tr>
<tr>
<td>Output rise time</td>
<td>tTLH</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 15 19</td>
</tr>
<tr>
<td>Output fall time</td>
<td>tTHL</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
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<td></td>
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<td></td>
<td>6 15 19</td>
</tr>
<tr>
<td>Propagation time (L→H)</td>
<td>tPLH</td>
<td>4.5</td>
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<td></td>
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<td>8 20 25</td>
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<tr>
<td>Propagation time (H→L)</td>
<td>tPHL</td>
<td>4.5</td>
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<td>12 20 25</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>tPHZ</td>
<td>4.5</td>
<td>R_L = 1 kΩ</td>
<td></td>
</tr>
<tr>
<td>(H→Z)</td>
<td></td>
<td></td>
<td></td>
<td>14 25 31</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>tPLZ</td>
<td>4.5</td>
<td>R_L = 1 kΩ</td>
<td></td>
</tr>
<tr>
<td>(L→Z)</td>
<td></td>
<td></td>
<td></td>
<td>14 25 31</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>tPZH</td>
<td>4.5</td>
<td>R_L = 1 kΩ</td>
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</tr>
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<td>(Z→H)</td>
<td></td>
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<td>10 20 25</td>
</tr>
<tr>
<td>3-state propagation time</td>
<td>tPZL</td>
<td>4.5</td>
<td>R_L = 1 kΩ</td>
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</tr>
<tr>
<td>(Z→L)</td>
<td></td>
<td></td>
<td></td>
<td>14 25 31</td>
</tr>
</tbody>
</table>

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

![Switching Time Measuring Circuit diagram](image)

![Waveforms diagram](image)
[2] $t_{PHZ}, t_{PZH}$
1. Measuring Circuit

2. Waveforms

[3] $t_{PLZ}, t_{PZL}$
1. Measuring Circuit

2. Waveforms

**MN74HC4520/MN74HC4520S**

Dual Binary Up Counter

**Description**
MN74HC4520/MN74HC4520S contain independent dual 4-bit binary up counters.

It is counted by the rise of CLK, when $\overline{CLK}$ is “H” and counted by the fall of CLK, when $\overline{CLK}$ is “L”. When clear input is “H”, it clears the counter regardless of clock and all outputs (Q0~Q3) is “L”.

Adoption of a silicon gate CMOS process has made possible low power dissipation, a high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 10-inputs can be directly driven. Resistors and diodes are provided in $V_{CC}$ and GND to protect the input/output from damage by static electricity. Same pin configuration and function as the standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>CLK</th>
<th>$\overline{CLK}$</th>
<th>CLR</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>H</td>
<td>All outputs are low</td>
</tr>
<tr>
<td>$\overline{J}$</td>
<td>H</td>
<td>L</td>
<td>Counter Advances</td>
</tr>
<tr>
<td>L</td>
<td>$\overline{J}$</td>
<td>L</td>
<td>Counter Advances</td>
</tr>
<tr>
<td>$\overline{J}$</td>
<td>X</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>X</td>
<td>$\overline{J}$</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>$\overline{J}$</td>
<td>L</td>
<td>L</td>
<td>No Change</td>
</tr>
<tr>
<td>H</td>
<td>$\overline{J}$</td>
<td>L</td>
<td>No Change</td>
</tr>
</tbody>
</table>

Note:
1. $\times$: Either HIGH or LOW; it doesn’t matter
2. $\overline{\times}$: The fall of clock from "H" to "L"
3. $\overline{\times}$: The rise of clock from "L" to "H"

**Logic Diagram**
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_{CC}</td>
<td>-0.5 ~ +7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>-0.5 ~ V_{CC} + 0.5</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>I_{IR}</td>
<td>± 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>I_{OK}</td>
<td>± 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>± 25</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_{CC}, I_{GND}</td>
<td>± 50</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>T_{stg}</td>
<td>-65 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Power dissipation:
- **MN74HC4520**
  - **TA=−40 ~ +60°C**: P_{D} = 400 mW
  - **TA=+60 ~ +85°C**: Decrease to 200 mW at the rate of 8 mW/°C
- **MN74HC4520S**
  - **TA=−40 ~ +60°C**: P_{D} = 275 mW
  - **TA=+60 ~ +85°C**: Decrease to 200 mW at the rate of 3.8 mW/°C

## Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating supply voltage</td>
<td>V_{CC}</td>
<td>1.4 ~ 6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>V_{I}, V_{O}</td>
<td>0 ~ V_{CC}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>T_{A}</td>
<td>-40 ~ +85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>t_{r}, t_{f}</td>
<td>2.0 ~ 1000 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 ~ 500 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 ~ 400 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_{CC} (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>V_{I}</td>
<td>I_{O}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>V_{IH}</td>
<td>2.0</td>
<td>1.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>V_{IL}</td>
<td>2.0</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>V_{OH}</td>
<td>2.0</td>
<td>-20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>V_{IH}</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>or</td>
<td>-20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>V_{IH}</td>
<td>-4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>-5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>V_{OL}</td>
<td>2.0</td>
<td>20.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>V_{IH}</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>or</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>V_{IL}</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>5.2</td>
<td>mA</td>
</tr>
<tr>
<td>Input current</td>
<td>I_{I}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND</td>
<td>± 0.1</td>
</tr>
<tr>
<td>Quiescent supply current</td>
<td>I_{CC}</td>
<td>6.0</td>
<td>V_{I}=V_{CC} or GND, I_{O}=0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### AC Characteristics (GND=0V, Input transition time ≤6ns, CL=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>(V_{CC}) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Ta=25^\circ\C)</td>
<td>(Ta=-40^\circ\C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td>typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Output rise time</td>
<td>(\tau_{TLH})</td>
<td></td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Output fall time</td>
<td>(\tau_{THL})</td>
<td></td>
<td></td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Propagation time</td>
<td>(\tau_{PLH})</td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>CLK, CLK(\rightarrow)Q(_3) (L(\rightarrow)H)</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>Propagation time</td>
<td>(\tau_{PHL})</td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>CLK(\rightarrow)CLK(\rightarrow)Q(_3) (H(\rightarrow)L)</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>Propagation time</td>
<td>(\tau_{PLH})</td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>CLK, CLK(\rightarrow)Q(_3) (L(\rightarrow)H)</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>Propagation time</td>
<td>(\tau_{PLH})</td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>CLK, CLK(\rightarrow)Q(_3) (H(\rightarrow)L)</td>
<td></td>
<td></td>
<td></td>
<td>175</td>
<td>35</td>
</tr>
<tr>
<td>Low level Minimum pulse width t(_{WL})</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>High level Minimum pulse width t(_{WH})</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Minimum pulse width t(_{WCD})</td>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>Minimum Set-up time t(_{SU})</td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>Minimum Set-up time t(_{SU})</td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>Minimum recovery time t(_{REM})</td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>Maximum clock frequency f(_{MAX})</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>30</td>
</tr>
</tbody>
</table>
- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
MN74HC40104/MN74HC40104S

4-Bit TRI-STATE Bidirectional Universal Shift Register

- **Description**

MN74HC40104/MN74HC40104S are 4-bit 3-state bidirectional shift registers with parallel inputs, parallel outputs, right-shift and left-shift serial inputs, and operational mode control inputs. Large current output makes possible high-speed operation for driving a large capacity busline.

For synchronized-parallel loads, 4-bit data are added to the parallel input, when both mode control inputs (S0 and S1) are HIGH.

Data are loaded to the respective flip-flops, and are transferred to the output on the positive going edge of the clock pulse.

The serial-shift function can be stopped between parallel loads. The right shift functions (when mode-control input S0 is HIGH and S1 is LOW) when there is synchronization to the rise of the clock pulse.

When S0 is LOW and S1 is HIGH, the left shift functions as a result of insertion of new data to the left-shift serial input.

When S0 is LOW and S1 is LOW, all outputs become LOW regardless of the clock pulse.

When enable input is LOW, all outputs become high impedance.

Adoption of a silicon gate CMOS process has made possible low power dissipation, high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in VCC and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard CMOS logic 4000 family.

- **Truth Table**

<table>
<thead>
<tr>
<th>Enable E</th>
<th>Mode</th>
<th>Clock</th>
<th>Serial DSR DSR</th>
<th>Parallel A B C D</th>
<th>Output QA QB QC QD</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>Hi-Z</td>
</tr>
<tr>
<td>H</td>
<td>x</td>
<td>x</td>
<td>L</td>
<td>x</td>
<td>QA QBo QC QDo</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
<td>x</td>
<td>x x x x x x</td>
<td>a b c d</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>x</td>
<td>H</td>
<td>H QAn QBe QCn</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>x</td>
<td>L</td>
<td>L QAn QBe QCn</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>x</td>
<td>x x x x x x</td>
<td>QBo QCn QDo H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>x</td>
<td>x x x x x x</td>
<td>QBo QCn QDo L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>x x x x x x x x</td>
<td></td>
<td>L L L L</td>
</tr>
</tbody>
</table>

Note:
1. $\sim$: Data input is transferred to output on the positive-going edge from LOW to HIGH of the clock
2. X: Either HIGH or LOW; it doesn’t matter
3. Hi-Z: High impedance

Panasonic
High-Speed CMOS Logic MN74HC Series

■ Logic Diagram

---

■ Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>-0.5~+7.0</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{IL}, V_{OL} )</td>
<td>-0.5~( V_{CC}+0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{IK} )</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{OK} )</td>
<td>\pm 20</td>
<td>mA</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>\pm 35</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{GND} )</td>
<td>\pm 70</td>
<td>mA</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>-65~+150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Power dissipation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN74HC40104 Ta=(-40\sim+60)°C</td>
<td>( P_{D} )</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>MN74HC40104S Ta=(+60\sim+85)°C</td>
<td>( P_{D} )</td>
<td>275</td>
<td>mW</td>
</tr>
</tbody>
</table>

Decrease to 200m Watt the rate of 8mW/°C
Decrease to 200m Watt the rate of 3.8mW/°C

■ Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation supply voltage</td>
<td>( V_{CC} )</td>
<td>1.4~6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_{IL}, V_{OL} )</td>
<td>0~( V_{CC} )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_{A} )</td>
<td>-40~+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_{r}, t_{f} )</td>
<td>2.0, 4.5, 6.0</td>
<td>0<del>1000, 0</del>500, 0~400</td>
<td>ns</td>
</tr>
</tbody>
</table>
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>$V_{EE}$ (Ta=25°C)</th>
<th>$V_{EE}$ (Ta=-40~+85°C)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>max.</td>
<td>min.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>Input HIGH voltage</td>
<td>$V_{IH}$</td>
<td>2.0</td>
<td></td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>3.15</td>
<td>3.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>4.2</td>
<td>4.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input LOW voltage</td>
<td>$V_{IL}$</td>
<td>2.0</td>
<td></td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>0.9</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>1.2</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output HIGH voltage</td>
<td>$V_{OH}$</td>
<td>2.0</td>
<td></td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td>4.4</td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td>6.0</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output LOW voltage</td>
<td>$V_{OL}$</td>
<td>2.0</td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>4.5</td>
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<td>0.1</td>
<td>0.1</td>
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<tr>
<td></td>
<td></td>
<td>6.0</td>
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<td>0.1</td>
<td>0.1</td>
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<td>Quiescent supply current</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_{L}=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>$V_{I}$</th>
<th>$I_{O}$</th>
<th>$V_{EE}$ (Ta=25°C)</th>
<th>$V_{EE}$ (Ta=-40~+85°C)</th>
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<td>Output fall time</td>
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<td>Propagation time</td>
<td>$t_{PHL}$</td>
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<td>150</td>
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<tr>
<td>CLK→Q4 (H→L)</td>
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<td></td>
<td>26</td>
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<tr>
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<td>(Z→H)</td>
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### AC Characteristics (GND=0V, Input transistion time ≥6ns, C_L=50pF)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>V_Cc (V)</th>
<th>Test Conditions</th>
<th>( T_a=25^\circ C )</th>
<th>( T_a=-40\sim+85^\circ C )</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>min.</td>
<td>typ.</td>
<td>max.</td>
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<td>190</td>
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<td>Minimum Set-up time</td>
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<td>Minimum recovery time</td>
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<td>Maximum clock frequency</td>
<td>( f_{\text{max}} )</td>
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<td>30</td>
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<td>4.5</td>
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<td>6.0</td>
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</tbody>
</table>

1. Measuring Circuit \( (I_{\text{PLH}}-I_{\text{PHL}}) \)

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Panasonic
2. Waveforms

- Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms
**MN74HCT40104/MN74HCT40104S**

4-Bit TRI-STATE Bidirectional Universal Shift Register (TTL Input)

**Description**

MN74HCT40104/MN74HCT40104S are TTL input level 4-bit 3-state bidirectional shift registers with parallel inputs, parallel outputs, right-shift and left-shift serial inputs, and operational mode-control inputs.

Large current output makes possible for driving a large capacity bus line.

For synchronized-parallel loads, 4-bit data are added to the parallel input, when both mode control inputs (S0 and S1) are HIGH.

Data are loaded to the respective flip-flops, and are transferred to the output at the positive going edge of the clock pulse.

The serial-shift function can be stopped between parallel loads. The right shift functions (when mode-control input S0 is HIGH and S1 is LOW) when there is synchronization to the rise of the clock pulse.

When S0 is LOW and S1 is HIGH, the left shift functions as result of insertion of new data to the left-shift serial input.

When S0 is LOW and S1 is LOW, all outputs become LOW regardless of the clock pulse.

When the enable input is LOW, all outputs become high impedance.

Adoption of a silicon gate CMOS process has made possible low power dissipation, high noise margin equivalent to a standard CMOS, and an operation speed of LS TTL. LS TTL 15-inputs can be directly driven. Resistors and diodes are provided in Vcc and GND to protect the input/output from damage by static electricity.

Same pin configuration and function as the standard CMOS logic 4000 family.

**Truth Table**

<table>
<thead>
<tr>
<th>Enable</th>
<th>Mode</th>
<th>Clock</th>
<th>Input</th>
<th>Output</th>
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<tbody>
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<td>S1</td>
<td>S0</td>
<td>Serial</td>
<td>Parallel</td>
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<td></td>
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<td>Dst</td>
<td>Dsr</td>
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<tr>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td>L</td>
<td>x</td>
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<tr>
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<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Note:
1. $\checkmark$: Data input is transferred to output on the positive-going edge from LOW to HIGH of the clock
2. X: Either HIGH or LOW; it doesn't matter.
3. Hi-Z: High impedance
- Logic Diagram

- Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>( V_{CC} )</td>
<td>(-0.5〜+7.0 )</td>
<td>V</td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>(-0.5〜V_{CC}+0.5 )</td>
<td>V</td>
</tr>
<tr>
<td>Input protection diode current</td>
<td>( I_{PK} )</td>
<td>±20 mA</td>
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</tr>
<tr>
<td>Output parasitic diode current</td>
<td>( I_{PK} )</td>
<td>±20 mA</td>
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</tr>
<tr>
<td>Output current</td>
<td>( I_O )</td>
<td>±35 mA</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>( I_{CC}, I_{GND} )</td>
<td>±70 mA</td>
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</tr>
<tr>
<td>Storage temperature range</td>
<td>( T_{stg} )</td>
<td>(-65〜+150 )</td>
<td>°C</td>
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</tbody>
</table>

Power dissipation

- MN74HCT40104
  - \( T_A = -40〜+60°C \)
  - \( P_D = 400 \) mW
  - Decrease to 200m Watt the rate of 8mW/°C

- MN74HCT40104S
  - \( T_A = -40〜+60°C \)
  - \( T_A = +60〜+85°C \)
  - \( P_D = 275 \) mW
  - Decrease to 200m Watt the rate of 3.8mW/°C

- Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC}(V) )</th>
<th>Rating</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Operation supply voltage</td>
<td>( V_{CC} )</td>
<td>4.5〜5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input/output voltage</td>
<td>( V_I, V_O )</td>
<td>0〜( V_{CC} )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>( T_A )</td>
<td>(-40〜+85 ) °C</td>
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<td></td>
</tr>
<tr>
<td>Input rise and fall time</td>
<td>( t_r, t_f )</td>
<td>4.5 ns</td>
<td>0〜500 ns</td>
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</table>
### DC Characteristics (GND=0V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_I$</td>
<td>$I_O$</td>
<td>$V_{IH}$ or $V_{IL}$</td>
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<td></td>
<td></td>
<td>Unit</td>
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<td>typ.</td>
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<td>Input HIGH voltage</td>
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<td>Output HIGH voltage</td>
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<td>−4.0</td>
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<td>Output HIGH voltage</td>
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<td>Input current</td>
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<td>$V_I=V_{CC}$ or GND</td>
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<td>$V_{I}=V_{IH}$ or $V_{IL}$</td>
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<td>Quiescent supply current</td>
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<td>$V_I=V_{CC}$ or GND, $I_O=0$</td>
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### AC Characteristics (GND=0V, Input transition time ≤6ns, $C_L=50pF$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>$V_{CC}$ (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
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<tbody>
<tr>
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<td>$V_I=V_{CC}$ or GND</td>
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<td>$RL=1K\Omega$</td>
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<td>$t_{TLH}$</td>
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<tr>
<td>Output fall time</td>
<td>$t_{THL}$</td>
<td>4.5</td>
<td>6</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PLH}$</td>
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<td>30</td>
<td>38</td>
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<td>(CLK→Q) (L→H)</td>
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<tr>
<td>Propagation time</td>
<td>$t_{PHL}$</td>
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<td>(Z→L)</td>
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</table>
AC Characteristics (GND = 0V, Input transition time ≤ 6ns, \( C_L = 50\, \text{pF} \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>( V_{CC} ) (V)</th>
<th>Test Conditions</th>
<th>Temperature</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum pulse width CLK</td>
<td>( t_w )</td>
<td>4.5</td>
<td></td>
<td>Ta=25°C</td>
<td>min. typ. max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ta=-40~+85°C</td>
<td>min. max.</td>
</tr>
<tr>
<td>Minimum Set-up time</td>
<td>( t_{su} )</td>
<td>4.5</td>
<td></td>
<td>20</td>
<td>25 ns</td>
</tr>
<tr>
<td>Minimum Hold time</td>
<td>( t_h )</td>
<td>4.5</td>
<td></td>
<td>0</td>
<td>0 ns</td>
</tr>
<tr>
<td>Minimum recovery time</td>
<td>( t_{rem} )</td>
<td>4.5</td>
<td></td>
<td>25</td>
<td>31 ns</td>
</tr>
<tr>
<td>Maximum clock frequency</td>
<td>( f_{max} )</td>
<td>4.5</td>
<td></td>
<td>30</td>
<td>24 MHz</td>
</tr>
</tbody>
</table>

Switching Time Measuring Circuit and Waveforms

1. Measuring Circuit

2. Waveforms

Panasonic
1. Measuring Circuit (t_{PLH}, t_{PHL})

Refer to truth table

2. Waveforms

SO SI

CLR

CLK

Data Input (A, B, C, D)

Output Q

\( t_{pu} \)

\( t_{pw} \)

\( t_{su} \)

\( t_{th} \)

\( t_{ts} \)

\( t_{tr} \)

\( t_{tsu} \)

\( t_{tsh} \)

\( t_{phl} \)

\( t_{plh} \)

\( V_{EE} \)

\( V_{CC} \)

\( 0.3V \)

\( 1.3V \)

\( 2.7V \)

\( 1.3V \)

\( 0.3V \)

\( 90\% \)

\( \leq 6ns \)

\( \leq 6ns \)

\( \leq 6ns \)

\( \leq 6ns \)

\( \leq 6ns \)
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