

TOSHIBA AMERICA, INC.

**STANDARD
LOGIC
SERIES**

TC4000
4500
5000
FAMILY

TOSHIBA STANDARD LOGIC SERIES

TC4000, 4500, 5000 FAMILY

C²MOS
STANDARD SERIES

July 1988

FOREWORD

Toshiba C²MOS IC Family

The Toshiba C²MOS family is a group of all-purpose CMOS digital ICs which are composed of materials having various logic functions. They not only can be used for industrial electronics equipment and home electronics equipment but also have applications in a variety of fields.

CMOS devices have such features as low power consumption, a single power supply, a wide operating voltage range and a high noise margin. In addition, they have epoch-making characteristics which conventional ICs do not have. They have recently established a firm position as all-purpose logic elements in conjunction with TTL and LSTTL.

Since the introduction of the C²MOS IC in 1972, Toshiba has made every effort to develop products which are more reliable and less expensive.

Meanwhile, with respect to product standardization, Toshiba marketed B series products (conform to EIA/JEDEC international standards) domestically for the first time in April 1978. Then in January 1982, Toshiba became the first in Japan to develop and mass produce a compact, thin type, mini flat C²MOS and has continued to be a world leader in the field of CMOS IC development.

Currently, in the Toshiba C²MOS family, in addition to 149 types of standard dual inline devices, 58 types of mini flat devices are available.

In addition to this publication, there is a separate edition available which contains High Speed C²MOS data book. Please use it along with this publication.

IMPORTANT NOTICES

The circuit examples illustrated herein are presented only as a guide for the performances or the applications of our products.

Keep in mind that no responsibility is assumed by TOSHIBA for its use, nor for any infringements of patents or other rights of the third parties which may result from its use, and that no license is granted by implication or otherwise under any patent or patent rights of TOSHIBA.

Toshiba reserves the right to make changes to any product for improving reliability, function or other characteristics.

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NUMERICAL INDEX



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PRODUCT NAME	FUNCTION	PAGE
TC4000BP	DUAL 3 INPUT NOR GATE PLUS INVERTER	75
TC4001BP/BF	QUAD 2 INPUT NOR GATE	80
TC4001UBP	QUAD 2 INPUT NOR GATE	83
TC4002BP/BF	DUAL 4 INPUT NOR GATE	80
TC4006BP	18-STAGE STATIC SHIFT REGISTER	86
TC4007UBP/UBF	DUAL COMPLEMENTARY PAIR+INVERTER	90
TC4008BP	4-BIT FULL ADDER	94
TC4009UBP	HEX BUFFER/CONVERTER (Inverting Type)	97
TC4010BP	HEX BUFFER/CONVERTER (Non-Inverting Type)	97
TC4011BP/BF	QUAD 2 INPUT NAND GATE	107
TC4011UBP	QUAD 2 INPUT NAND GATE	83
TC4012BP/BF	DUAL 4 INPUT NAND GATE	107
TC4013BP/BF	DUAL D-TYPE FLIP FLOP	104
TC4014BP	8-STAGE STATIC SHIFT REGISTER	108
TC4015BP/BF	DUAL 4-STAGE SHIFT REGISTER	112
TC4016BP/BF	QUAD BILATERAL SWITCH	116
TC4017BP/BF	DECADE COUNTER/DIVIDER	121
TC4018BP	PRESETTABLE DIVIDE-BY-"N" COUNTER	126
TC4019BP/BF	QUAD AND/OR SELECT GATE	131
TC4020BP/BF	14 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS	134
TC4021BP	8-STAGE STATIC SHIFT REGISTER	138
TC4022BP	OCTAL COUNTER/DIVIDER	142
TC4023BP/BF	TRIPLE 3 INPUT NAND GATE	107
TC4024BP/BF	7 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS	147
TC4025BP/BF	TRIPLE 3 INPUT NOR GATE	80
TC4027BP/BF	DUAL J-K MASTER-SLAVE FLIP-FLOP	151
TC4028BP/BF	BCD-TO-DECIMAL DECODER	155
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TC4036BP	4 WORD × 8 BIT STATIC RAM	182
TC4038BP	TRIPLE SERIAL ADDER (Negative Adder)	167
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TC4043BP	QUAD 3-STAGE NOR R/S LATCH	196
TC4044BP/BF	QUAD 3-STATE NAND R/S LATCH	200
TC4047BP	LOW-POWER MONOSTABLE/ASTABLE MULTIVIBRATOR	204
TC4049BP/BF	HEX BUFFER/CONVERTER (Inverting Type)	211
TC4050BP/BF	HEX BUFFER/CONVERTER (Non-Inverting Type)	211
TC4051BP/BF	SINGLE 8-CHANNEL MULTIPLEXER/DEMULTIPLEXER	214
TC4052BP/BF	DIFFERENTIAL 4-CHANNEL MULTIPLEXER/DEMULTIPLEXER	214
TC4053BP/BF	TRIPLE 2- CHANNEL MULTIPLEXER/DEMULTIPLEXER	214
TC4054BP/BF	LIQUID-CRYSTAL DISPLAY DRIVER (4-Segment)	218
TC4055BP	LIQUID-CRYSTAL DISPLAY DRIVER (BCD TO 7-Segment)	222
TC4056BP/BF	LIQUID-CRYSTAL DISPLAY DRIVER (BCD TO 7-Segment)	222
TC4063BP/BF	4-BIT MAGNITUDE COMPARATOR	227
TC4066BP/BF	QUAD BILATERAL SWITCH	231
TC4068BP/BF	8 INPUT NAND/AND GATE	236
TC4069UBP/UBF	HEX INVERTER	239
TC4071BP/BF	QUAD 2 INPUT OR GATE	242
TC4072BP/BF	DUAL 4 INPUT OR GATE	242
TC4073BP/BF	TRIPLE 3 INPUT AND GATE	245
TC4075BP/BF	TRIPLE 3 INPUT OR GATE	242
TC4076BP	4-BIT D-TYPE REGISTER	248
TC4077BP/BF	QUAD EXCLUSIVE-NOR GATE	253
TC4078BP/BF	8 INPUT NOR/OR GATE	256
TC4081BP/BF	QUAD 2 INPUT AND GATE	245
TC4082BP	DUAL 4 INPUT AND GATE	245
TC4085BP	DUAL 2-WIDE 2 INPUT AND-OR-INVERT GATE	259
TC4086BP	4-WIDE 2 INPUT AND-OR-INVERT GATE	262
TC4093BP/BF	QUAD 2 INPUT NAND SCHMITT TRIGGER	266
TC4094BP/BF	8-BIT SHIFT-AND-STORE BUS REGISTER	269
TC4099BP/BF	8-BIT ADDRESSABLE LATCH	275
TC40102BP	8-STAGE PRESETTABLE DOWN COUNTER (2-Decode BCD Type)	280
TC40103BP	8-STAGE PRESETTABLE DOWN COUNTER (8-Bit Bynary Type)	280
TC40104BP	4-BIT BIDIRECTIONAL SHIFT REGISTER WITH 3-STATE OUTPUTS	289
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TC40160BP	PROGRAMMABLE DECADE COUNTER WITH ASYNCHRONOUS CLEAR	303
TC40161BP	PROGRAMMABLE BINARY COUNTER WITH ASYNCHRONOUS CLEAR	303
TC40162BP	PROGRAMMABLE DECADE COUNTER WITH SYNCHRONOUS CLEAR	303
TC40163BP	PROGRAMMABLE BINARY COUNTER WITH SYNCHRONOUS CLEAR	303
TC40174BP/BF	HEX "D"-TYPE FLIP-FLOP	311
TC40175BP/BF	QUAD "D"-TYPE FLIP-FLOP	315
TC40192BP	PRESETTABLE BCD UP/DOWN COUNTER	319
TC40193BP	PRESETTABLE BINARY UP/DOWN COUNTER	319
TC40194BP	4-BIT BIDIRECTIONAL SHIFT REGISTER WITH RESET	289

TC4500 Series

PRODUCT NAME	FUNCTION	PAGE
TC4501BP	TRIPLE GATE (Dual 4 Input NAND+2 Input NOR/OR)	326
TC4502BP	STROBED HEX INVERTER/BUFFER	330
TC4503BP/BF	HEX NON-INVERTING 3-STATE BUFFER	334
TC4508BP	DUAL 4-BIT LATCH	337
TC4510BP/BF	PRESETTABLE BCD UP/DOWN COUNTER	342
TC4511BP/BF	BCD TO 7-SEGMENT LATCH/DECODER/DRIVER	348
TC4512BP/BF	8-CHANNEL DATA SELECTOR	353
TC4514BP	4-BIT LATCH/4-TO-16 LINE DECODER (High)	356
TC4515BP	4-BIT LATCH/4-TO-16 LINE DECODER (Low)	356
TC4516BP/BF	PRESETTABLE BINARY UP/DOWN COUNTER	361
TC4518BP/BF	DUAL BCD UP COUNTER	367
TC4519BP	4-BIT AND/OR SELECTOR	373
TC4520BP/BF	DUAL BINARY UP COUNTER	367
TC4521BP	24-STAGE FREQUENCY DIVIDER	376
TC4522BP	PROGRAMMABLE DIVIDE-BY-N 4-BIT COUNTER (BCD)	381
TC4526BP/BF	PROGRAMMABLE DIVIDE-BY-N 4-BIT COUNTER (Binary)	381
TC4527BP	BCD RATE MULTIPLIER	389
TC4528BP/BF	DUAL MONOSTABLE MULTIVIBRATOR	395
TC4530BP	DUAL 5 - INPUT MAJORITY LOGIC GATE	399
TC4531BP	12-BIT PARITY TREE	402
TC4532BP	8-BIT PRIORITY ENCODER	405
TC4538BP/BF	DUAL PRECISION MONOSTABLE MULTIVIBRATOR	409
TC4539BP/BF	DUAL 4-CHANNEL DATA SELECTOR/MULTIPLEXER	414

TC4500 Series (Continued)

PRODUCT NAME	FUNCTION	PAGE
TC4543BP/BF	BCD TO 7-SEGMENT LATCH/DECODER/DRIVER	4 1 7
TC4555BP	DUAL BINARY TO 1-OF-4 DECODER/DEMULTIPLEXER (Hihg)	4 2 2
TC4556BP/BF	DUAL BINARY TO 1-OF-4 DECODER/DEMULTIPLEXER (Low)	4 2 2
TC4560BP	NBCD ADDER	4 2 6
TC4561BP	9's COMPLEMENTER	4 3 1
TC4572BP/BF	HEX GATE (4 INVERTER+2 Input NOR+2 Input NAND)	4 3 5
TC4583BP	DUAL SCHMITT TRIGGER.	4 3 8
TC4584BP/BF	HEX SCHMITT TRIGGER	4 4 2
TC4585BP	4-BIT MAGNITUDE COMPARATOR	4 4 5

TC5000 Series

PRODUCT NAME	FUNCTION	PAGE
TC5001P	4-DIGIT DECADE COUNTER	4 4 9
TC5002BP	BCD TO 7-SEGMENT DECODER/LED DRIVER	4 5 9
TC5012BP/BF	HEX NON-INVERTING 3-STATE BUFFER	4 6 4
TC5018P	4-BIT BINARY COUNTER/CLOCK GENERATOR	4 6 7
TC5020BP	HEX LOW-TO-HIGH VOLTAGE TRANSLATOR	4 7 1
TC5022BP	BCD TO 7-SEGMENT DECODER/LED DRIVER	4 5 9
TC5023BP	16-CHANNEL MULTIPLEXER	4 7 4
TC5024BP	QUAD 3-STATE NON-INVERTING BUFFER	4 7 7
TC5025BP	QUAD 3-STATE NON-INVERTING BUFFER	4 7 7
TC5026BP	DECADE COUNTER	4 8 1
TC5027BP	BINARY COUNTER	4 8 5
TC5029BP	QUAD 2-INPUT NAND OPEN DRAIN GATE (N-CHANNEL)	4 8 9
TC5032P	6-DIGIT DECADE COUNTER	4 9 2
TC5036P	17-STAGE HIGH SPEED FREQUENCY DIVIDER (DYNAMIC)	5 0 1
TC5036AP	17-STAGE HIGH SPEED FREQUENCY DIVIDER	5 0 5
TC5037P	4-DIGIT DECADE COUNTER	5 1 0
TC5043P	CR TIMER	5 1 7
TC5048P	17-STAGE HIGH SPEED FREQUENCY DIVIDER (DYNAMIC)	5 0 1
TC5048AP	17-STAGE HIGH SPEED FREQUENCY DIVIDER	5 0 5
TC5050P	DUAL 50/64-STAGE STATIC SHIFT REGISTER	5 2 4
TC5051P	4-DIGIT DECADE COUNTER	5 2 6
TC5052P	4-DIGIT DECADE COUNTER	5 2 6
TC5053P	4-DIGIT UP/DOWN DECADE COUNTER	5 3 3
TC5054P	4-DIGIT UP/DOWN DECADE COUNTER	5 3 3
TC5064BP	HEX HIGH VOLTAGE BUFFER WITH INHIBIT	5 4 0

TC5000 Series (Continued)

PRODUCT NAME	FUNCTION	PAGE
TC5065BP	HEX HIGH VOLTAGE BUFFER WITH INHIBIT	5 4 0
TC5066BP	7-LINE HIGH VOLTAGE BUFFER	5 4 4
TC5067BP	7-LINE HIGH VOLTAGE BUFFER	5 4 4
TC5068BP	BCD-TO-7 SEGMENT LATCH/DECODER/DRIVER	5 4 8
TC5069BP	BCD-TO-7 SEGMENT LATCH/DECODER/DRIVER	5 4 8
TC5070P	6 DIGIT UNIVERSAL COUNTER "999999"	5 5 4
TC5071P	6 DIGIT UNIVERSAL TIMER "995959"	5 5 4
TC5072P	6 DIGIT UNIVERSAL TIMER "595999"	5 5 4

TC7400 Series

PRODUCT NAME	FUNCTION	PAGE
TC7400BP	QUAD 2-INPUT POSITIVE NAND GATE	5 6 8
TC7404UBP	HEX INVERTING BUFFER	5 7 1
TC7476BP	DUAL J-K MASTER SLAVE FLIP FLOP	5 7 4

TC5000 Series/TC35000 Series (A/D CONVERTER Series)

PRODUCT NAME	FUNCTION	PAGE
TC5090AP	8 BIT A/D CONVERTER	5 7 7
TC5091AP	8 BIT A/D CONVERTER (WITH 6ch ANALOG MPX.)	5 9 0
TC5092AP	13 BIT A/D CONVERTER (WITH 8ch ANALOG MPX.)	6 0 3
TC5093AP	8 BIT A/D CONVERTER (WITH 8ch ANALOG MPX.)	6 1 4
TC35094P	8 BIT A/D CONVERTER	6 2 0
TC35095P	8 BIT 8ch SERIAL I/O A/D CONVERTER	6 2 5
TC35096P	8 BIT 4ch SERIAL I/O A/D CONVERTER	6 3 1
TC35097P	8 BIT 2ch SERIAL I/O A/D CONVERTER	6 3 7
TC35098P	8 BIT SERIAL I/O A/D CONVERTER	6 4 2

FUNCTION SELECTION TABLE

FUNCTION		DEVICES	
GATES BUFFERS	NAND	TC4011BP/BF, TC4011UBP, TC4012BP/BF, TC4023BP/BF, TC4068BP/BF TC7400BP	
	NOR	TC4000BP, TC4001BP/BF, TC4001UBP, TC4002BP/BF, TC4025BP/BF TC4078BP/BF	
	AND	TC4068BP/BF, TC4073BP/BF, TC4081BP/BF, TC4082BP	
	OR	TC4071BP/BF, TC4072BP/BF, TC4075BP/BF, TC4078BP/BF	
	INVERTER	TC4007UBP/UBF, TC4009UBP, TC4049BP/BF, TC4069UBP/UBF, TC7404UBP	
	BUFFERS		TC4009UBP, TC4010BP, TC4049BP/BF, TC4050BP/BF
		3-STATE	TC4502BP, TC5012BP/BF, TC5024BP, TC5025BP, TC4503BP
		OPEN DRAIN	TC40107BP, TC5029BP, TC5064BP, TC5065BP, TC5066BP, TC5067BP
	MULTIFUNCTION	TC4019BP/BF, TC4030BP/BF, TC4077BP/BF, TC4085BP, TC4086BP, TC4501BP TC4519BP, TC4530BP, TC4572BP/BF	
	SCHMITT TRIGGER	TC4093BP/BF, TC4583BP, TC4584BP/BF	
LEVEL SHIFTER	TC4009UBP, TC4010BP, TC4049BP/BF, TC4050BP/BF, TC5020BP		
FLIP-FLOP	TC4013BP/BF, TC4027BP/BF, TC40174BP/BF, TC40175BP/BF, TC7476BP		
LATCHES	TC4042BP/BF, TC4043BP, TC4044BP/BF, TC4099BP/BF, TC4508BP		
MULTIVIBRATORS	TC4047BP, TC4528BP/BF, TC4538BP/BF		
DECODERS	TC4028BP/BF, TC4514BP, TC4515BP, TC4555BP, TC4556BP/BF		
DISPLAY DRIVER	LED	TC4511BP/BF, TC5002BP, TC5022BP	
	LCD	TC4054BP/BF, TC4055BP, TC4056BP/BF, TC4543BP/BF	
	DIGITRON	TC5068BP, TC5069BP	
ENCODER	TC4532BP		
REGISTERS	SHIFT	TC4006BP, TC4014BP, TC4015BP/BF, TC4021BP, TC4034BP, TC4035BP TC4094BP/BF, TC40104BP, TC40194BP, TC5050P	
	STORAGE	TC4076BP	
COUNTERS	BINARY	TC4029BP/BF, TC40161BP, TC40163BP, TC40193BP, TC4516BP/BF TC4520BP/BF, TC5018BP, TC5027BP	
	DECADE	TC4029BP/BF, TC40160BP, TC40162BP, TC40192BP, TC4510BP/BF TC4518BP/BF, TC5026BP	
	DIVIDER	TC4020BP/BF, TC4024BP/BF, TC4040BP/BF, TC4521BP, TC5036P, TC5036AP, TC5048P, TC5048AP	
	DIVIDE-BY-"N"	TC4018BP, TC40102BP, TC40103BP, TC4522BP, TC4526BP/BF	
	N-DIGIT DECADE	TC5001P, TC5032P, TC5037P, TC5051P, TC5052P, TC5053P, TC5054P, TC5070P	
OTHER	TC4017BP/BF, TC4022BP		
TIMERS	TC5043P, TC5071P, TC5072P		
MULTI- PLEXERS	ANALOG	TC4051BP/BF, TC4052BP/BF, TC4053BP/BF	
	DIGITAL	TC4512BP/BF, TC4539BP/BF, TC5023BP	
ARITHMETIC CIRCUITS	ADDER	TC4008BP, TC4032BP, TC4038BP, TC4560BP	
	COMPARATOR	TC4063BP/BF, TC4585BP	
	PARITY TREE	TC4531BP	
	RATE MULTIPLIER	TC4527BP	
	9's COMPLEMENTER	TC4561BP	
MEMORIES (RAM)	TC4036BP, TC4039BP		
ANALOG SWITCH	TC4016BP/BF, TC4066BP/BF		
OTHER	TC40117BP		
A/D CONVERTERS	TC5090AP, TC5091AP, TC5092AP, TC5093AP, TC35094P, TC35095P, TC35096P, TC35097P, TC35098P		

EXPLANATION



OUTLINE

1. C²MOS IC Family

1.1 CMOS and C²MOS

"CMOS" is an abbreviation of "Complementary Metal Oxide Semiconductor", and "Complementary" means to combine P-channel type MOS FET and N-channel type MOS FET complementarily. The CMOS circuit configuration, since its announcement at ISSCC in 1963, attracted a large expectation for its performance with super-low power consumption and operation at low voltage, and after such process as settlement of production problems through the ion implantation process, reduction in pattern size through circuit research, etc., has now been established as one field of integrated circuits.

At present, use of CMOS LSI in electronic calculators, clocks, etc. is remarkable. In addition to these LSI, the features of CMOS are also very attractive in the field of so-called industrial electronic equipment including measuring and control equipment, business machines, etc., and it may be said to be a matter of course that CMOS logic family is demanded.

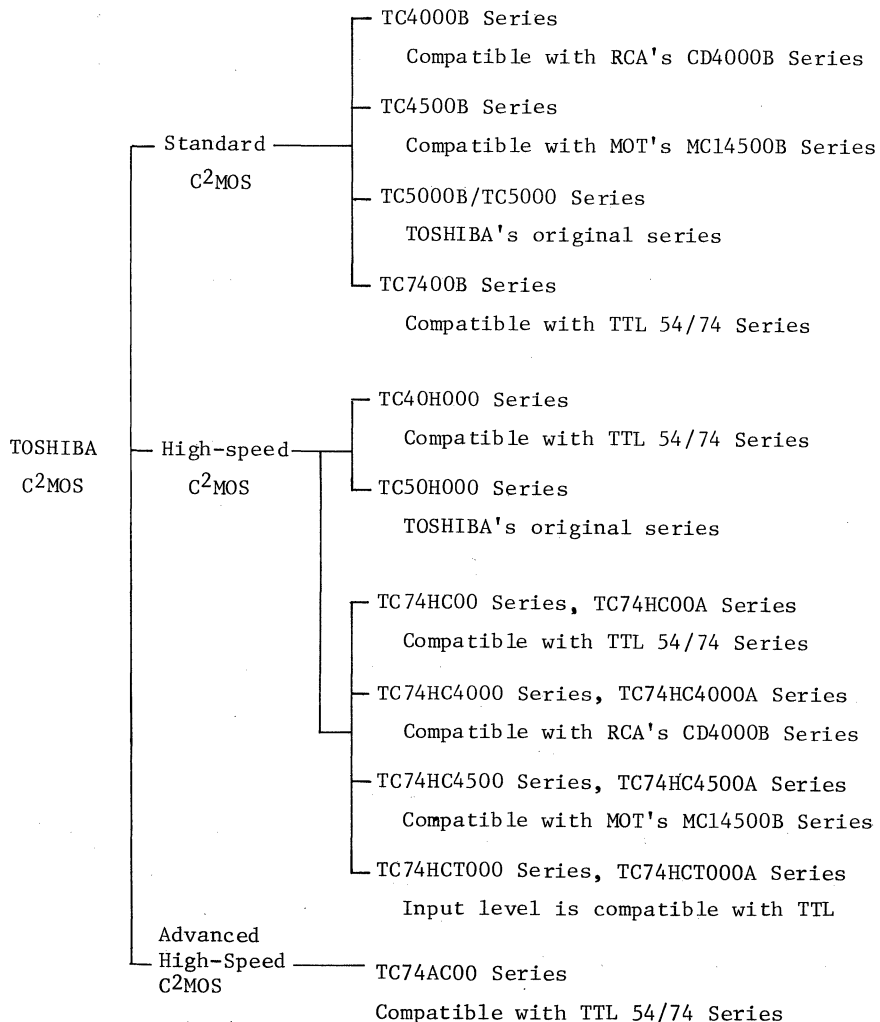
To respond these need promptly, TOSHIBA has put CMOS logic element on sale as C²MOS IC Family.

C²MOS is an abbreviation of "Clocked CMOS", which is one of the CMOS circuit configurations. This type of circuit was made public by Toshiba at ISSCC in 1973 and since then, it has been applied to mainly sequential circuits of TOSHIBA's MSI and LSI as it becomes an extremely powerful circuit means.

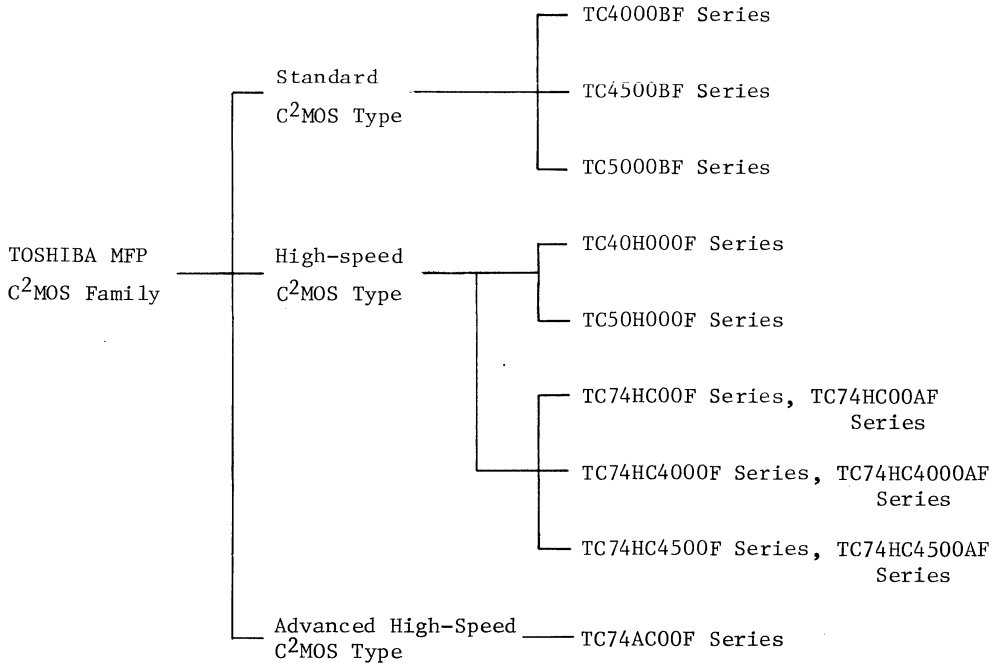
Therefore, C²MOS is used as the general name of TOSHIBA CMOS ICs including combined circuits without clocked gate used.

1.2 TOSHIBA C²MOS Family

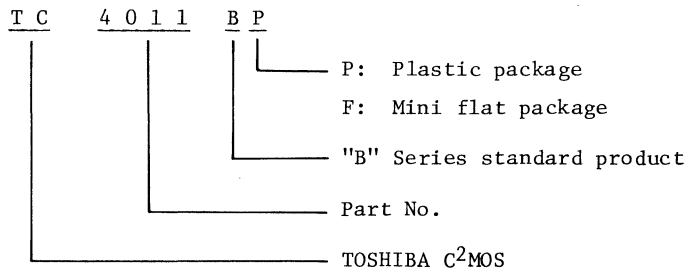
C²MOS Family products shown below are made available from TOSHIBA for use in all sorts of equipment.



Further, the Mini-Flat Package (MFP) C²MOS Family products are also available from TOSHIBA to satisfy demands of equipment for compact size and light weight.



1.3 Standard Construction of Model No. of C²MOS Family Products



1.4 TOSHIBA B Series C²MOS

TOSHIBA B Series C²MOS have ratings and characteristics satisfying EIA/JEDEC standards; definitely speaking, they have basic characteristics shown below:

- o A wider operating supply voltage range of 3 ~ 18V.
- o Guaranteed electrical characteristics under 3 supply voltage conditions of 5V, 10V and 15V.
- o Buffer structure adopted for all outputs
- o 2 inputs of LTTL (Low Power TTL) and 1 input of LSTTL (Low Power Shottkey TTL) can be directly driven.

Noise Immunity: $\left. \begin{array}{l} 1\text{V (Min)} \quad @ V_{DD} = 5\text{V} \\ 2\text{V (Min)} \quad @ V_{DD} = 10\text{V} \\ 2.5\text{V (Min)} @ V_{DD} = 15\text{V} \end{array} \right\} *1$

*1 "UB" Series products and some products including analog switch, level shifter, etc. have different noise margins.

2. Operational Principle and Features of CMOS

2.1 Basic circuit and structure of CMOS

Inverter circuit is taken as an example of CMOS basic circuit. CMOS inverter, as shown in Fig. 2-1, consists of the common input terminal shared by P-channel enhancement (normally off) type MOS FET and N-channel enhancement type MOS FET and the common output terminal shared by each drain.

As shown in the same figure, CMOS inverter uses P-channel and N-channel MOS FETs complementarily.

Usually, the source of P-channel MOS FET is connected to V_{DD} (+supply) and the source of N-channel MOS FET is connected to V_{SS} (usually GND).

Fig. 2-2 illustrates the cross section using the basic process. N-type silicon is used as substrate for CMOS basic process.

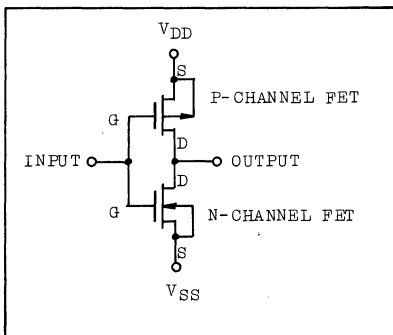


Fig. 2-1 Circuit Diagram of CMOS Inverter

For normal P-channel MOS FETs, P-type impure material is selectively diffused in the domain of N-type substrate to form the source and the drain. For CMOS, however, since N-channel MOS FET is also required to be formed in same substrate, after forming P-type island domain (P-well) in N-type substrate by means of ion implantation, N-channel MOS FET is formed in this P-well. And P-channel MOS FET is formed in the substrate outside of this island domain.

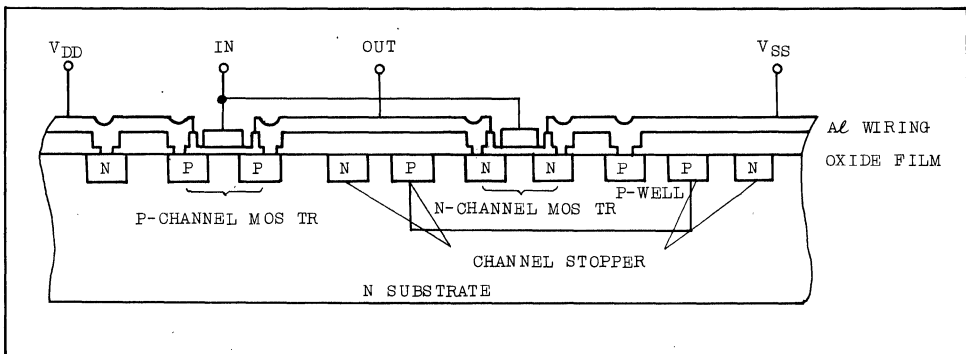


Fig. 2-2 Structural Cross Section of Al Gate CMOS

N-type substrate and P-well are separated (reverse biased) by V_{DD} and V_{SS} . Therefore, P-channel and N-channel FETs operate independently each other with no mutual interferences.

Fig. 2-2 is the basic cross section of CMOS inverter. The static protection circuit is inserted in the input gate as shown in Fig. 2-3 for the actual products.

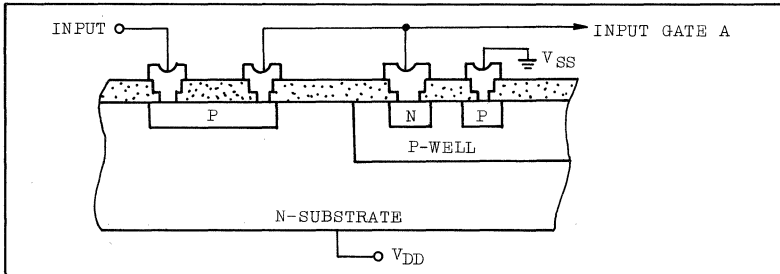


Fig. 2-3 CMOS Input Protection Circuit

Fig. 2-4 shows the equivalent circuit of CMOS inverter including the input protection circuit and the parasitic circuits. Fig. 2-4 actually represents the circuits of TC4069 UBP and TC7404 UBP.

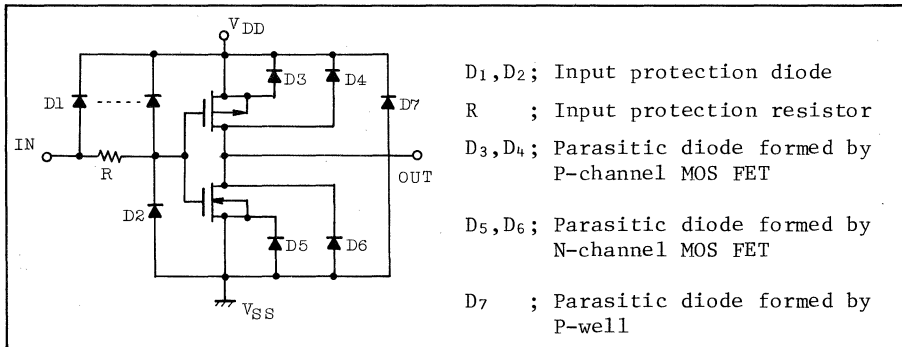


Fig. 2-4 CMOS Inverter taking Parasitic Circuits into Consideration

Although the diodes inserted in the equivalent circuit are all reverse bias during operation without causing any interferences for normal circuit operation, caution should be observed since degradation and damage of the elements may be resulted by making those diodes forward biased when the power supply is connected with reverse polarity or the interface is driven roughly.

2.2 Basic characteristics of CMOS

CMOS is a classification based on the circuit configuration and the characteristics of each MOS FET actually used are equal to common enhancement type FETs.

Therefore, in the case of CMOS also, the characteristics of P-channel and N-channel MOS FETs can be basically approximated by Shockley's equation.

$$I_{DS} = K [2V_{DS}(V_{GS} - V_T) - V_{DS}^2], \quad V_{DS} < V_{GS} - V_T \quad \dots (2.1)$$

$$I_{DS} = K (V_{GS} - V_T)^2, \quad V_{DS} \geq V_{GS} - V_T \quad \dots (2.2)$$

$$I_{DS} = 0, \quad V_{GS} \leq V_T \quad \dots (2.3)$$

Where the constant K is

$$K = \frac{W}{2L} \cdot \frac{E_{OX}}{t_{OX}} \cdot \mu$$

L	;	Channel length
W	;	Channel width
E_{OX}	;	Dielectric constant of gate oxide film
t_{OX}	;	Thickness of gate oxide film
μ	;	Mobility of electron or positive hole
V_{DS}	;	Potential difference between drain and source
V_{GS}	;	Potential difference between gate and source
V_T	;	Threshold voltage

Using the above approximation equations (2.1) ~ (2.3), the basic characteristics are explained below taking inverter as an example.

(1) Transfer characteristic of inverter

The input voltage, the output voltage and the power supply voltages are assumed to be V_{IN} , V_{OUT} and $+V_0$ volts respectively.

The threshold voltages are assumed to be V_{TP} for P-channel FET and V_{TN} for N-channel FET respectively.

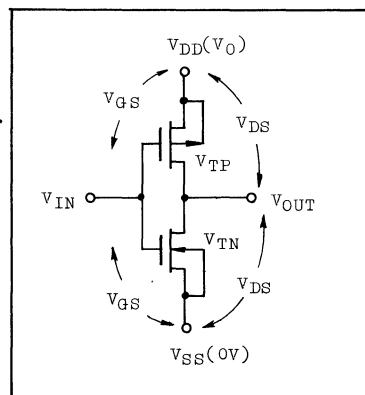


Fig. 2-5 Relationships of Various Bias

Here, V_{TP} is considered to have negative value and V_{TN} to have positive value. As it is clear from Fig. 2-5, V_{DS} and V_{GS} which appeared in equations (2.1) ~ (2.3) are

$$V_{DS} = V_{OUT} , V_{GS} = V_{IN}$$

for N-channel FET.

So, equations (2.1) ~ (2.3) can be rewritten as shown below.

$$I_{DSN} = K_N [2V_{OUT}(V_{IN}-V_{TN})-V_{OUT}^2], \quad V_{OUT} < V_{IN} - V_{TN} \dots (2.4)$$

$$I_{DSN} = K_N (V_{IN} - V_{TN})^2 \quad , \quad V_{OUT} \geq V_{IN} - V_{TN} \dots (2.5)$$

$$I_{DSN} = 0 \quad , \quad V_{IN} \leq V_{TN} \quad \dots (2.6)$$

On the other hand, since

$$V_{DS} = V_0 - V_{OUT} \quad \text{AND} \quad V_{GS} = V_0 - V_{IN}$$

for P-channel, equations (2.1) ~ (2.3) can be rewritten as follows.

$$I_{DSP} = K_P [2(V_0-V_{OUT})(V_0-V_{IN}-|V_{TP}|)-(V_0-V_{OUT})^2],$$

$$V_{OUT} > V_{IN} + |V_{TP}| \quad \dots (2.7)$$

$$I_{DSP} = K_P (V_0-V_{IN}-|V_{TP}|)^2, V_{OUT} \leq V_{IN} + |V_{TP}| \quad \dots (2.8)$$

$$I_{DSP} = 0 \quad , V_{IN} + |V_{TP}| \geq V_0 \quad \dots (2.9)$$

When the input voltage of inverter varies from 0 volts to V_0 volts, the operating range of each MOS FET can be classified into the following five regions.

- ① $0V \leq V_{IN} \leq V_{TN}$
- ② $V_{TN} < V_{IN} < V_{OUT} - |V_{TP}|$
- ③ $V_{OUT} - |V_{TP}| \leq V_{IN} \leq V_{OUT} + V_{TN}$
- ④ $V_{OUT} + V_{TN} < V_{IN} < V_0 - |V_{TP}|$
- ⑤ $V_0 - |V_{TP}| \leq V_{IN} \leq V_0$

The currents in the above five regions for each FET forming the inverter can be represented by equations (2.4) ~ (2.9) respectively.

When the input/output transfer characteristic is to be obtained, since the current carried by P-channel, I_{DSP} is equal to the current carried by N-channel, I_{DSN} , the transfer characteristic in each region is obtained by making $I_{DSN} = I_{DSP}$.

Especially, by making $I_{DSN} = I_{DSP}$ in the equations (2.5) and (2.8) of current in the region of 2, the following equation is obtained.

$$V_{IN} = \frac{V_{TN} \left(\sqrt{\frac{K_N}{K_P}} \right) + V_O - |V_{TP}|}{1 + \left(\sqrt{\frac{K_N}{K_P}} \right)}$$

Fig. 2-6 shows the comparison between the theoretical values obtained by those equations and the measuring values.

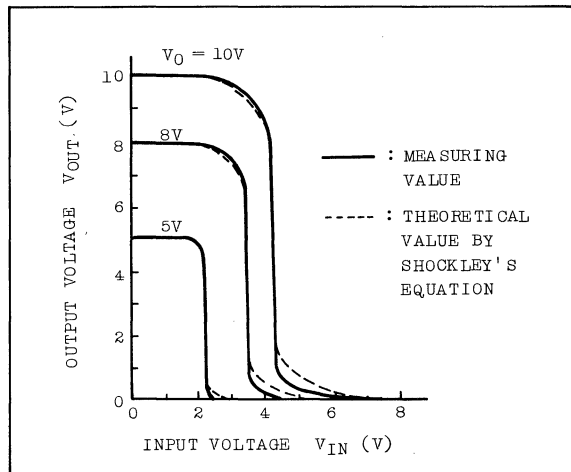


Fig. 2-6 Input/Output Transfer Characteristics

(2) Step response of inverter

When step input which varies from 0 volts to $+V_0$ volts is applied to the inverter input, P-channel FET is turned off and N-channel FET is turned on. As a result, electrical charge stored in the load capacitor C_{OUT} is discharged through N-channel FET and the output voltage V_{OUT} varies from $+V_0$ volts to 0 volts as the discharge proceeds.

a) When $V_{OUT} \geq V_0 - V_{TN}$

The equation for current is given by (2.5) and since C_{OUT} is discharged by this current,

$$-I_{DSN} = C_{OUT} \frac{dV_{OUT}}{dt}, \quad V_{OUT} = V_0 \text{ at } t = 0$$

When this is integrated,

$$\int_0^t dt = -\int_{V_0}^{V_{OUT}} \frac{C_{OUT}}{K_N(V_0 - V_{TN})^2} \cdot dV_{OUT}$$

Namely,

$$t = \frac{C_{OUT}}{K_N(V_0 - V_{TN})^2} (V_0 - V_{OUT}) \dots\dots (2.10)$$

If t_0 is defined at $V_{OUT} = V_0 - V_{TN}$,

$$t_0 = \frac{C_{OUT} \cdot V_{TN}}{K_N(V_0 - V_{TN})^2}$$

b) When $V_{OUT} \leq V_0 - V_{TN}$

If integrated similarly as a) using equation (2.4),

$$\int_0^t dt = \frac{-C_{OUT}}{2K_N(V_0 - V_{TN})} \times \int_{V_0 - V_{TN}}^{V_{OUT}} \left\{ \frac{1}{V_{OUT}} + \frac{1}{2(V_0 - V_{OUT}) - V_{OUT}} \right\} dV_{OUT}$$

Then,

$$t = \frac{C_{OUT} V_{TN}}{K_N(V_0 - V_{TN})} + \frac{C_{OUT}}{2K_N(V_0 - V_{TN})} \ln \left[\frac{2(V_0 - V_{TN}) - V_{OUT}}{V_{OUT}} \right] \dots\dots (2.11)$$

As the fall time t_f is the time required for the output voltage to vary from 90% to 10%, if t_1 is assumed to be the time for the output voltage to reach 90% of V_0 and t_2 is assumed to be the time to reach 10% of V_0 , t_1 and t_2 are given from equations (2.10) and (2.11) as follows.

$$t_1 = \frac{C_{OUT}}{K_N(V_0 - V_{TN})^2} \times 0.1V_0$$

$$t_2 = \frac{C_{OUT} V_{TN}}{K_N(V_0 - V_{TN})} + \frac{C_{OUT}}{2K_N(V_0 - V_{TN})} \ln \left[\frac{2(V_0 - V_{TN}) - 0.1V_0}{0.1V_0} \right]$$

Therefore,

$$t_f = t_2 - t_1 = \left\{ \frac{V_{TN} - 0.1V_0}{V_0 - V_{TN}} + 1/2 \ln \left[20 \left(1 - \frac{V_{TN}}{V_0} \right) - 1 \right] \right\} \times \gamma_N \dots (2.12)$$

$$\text{where } \left\{ \begin{array}{l} \tau_N = \frac{C_{OUT}}{K_N(V_0 - V_{TN})} \\ K_N = 1/2 \cdot \frac{\epsilon_{OX} \mu_N}{t_{OX}} \cdot \frac{W_N}{L_N} \end{array} \right\}$$

The rise time t_r can be obtained similarly and the result will be the same as equation (2.12) except that N is replaced by P.

2.3 Features of CMOS

Table 2-1 compares the characteristics of logic families including CMOS. From this table it is clear that although the speed is slower than others, the power dissipation in quiescent state and the noise immunity are far superior to others.

And since CMOS has wider operating supply voltage range, the supply voltage can be flexibly set according to the applications and where to be used.

Table 2-1 Comparison of Various Logic Families

Parameter (typical values)	Standard TTL	Low power TTL	Low power Schottky TTL	CMOS (5V)	CMOS (10V)
Propagation Delay Time(ns)	10	33	5 ~ 10	70	35
F/F Toggle Frequency (MHz)	35	3	40 ~ 80	3	6
Quiescent Power Dissipation (mW)	10	1	8.5	5×10^{-6}	2×10^{-5}
Noise Immunity (V)	1	1	0.8	2	4
Fanout	10	10	20	50	50

(1) Propagation delay time and F/F toggle frequency

As shown by equation (2.12) in 2.2, the propagation delay time of CMOS is proportional to C_{OUT} (load capacitance) and inversely proportional to the constant K_N which is determined by design and process.

Therefore, in order to make the propagation delay time shorter, it is necessary to make C_{OUT} smaller and W/L in design considerations. However, since the internal diffusion capacitance in CMOS is included in C_{OUT} , the internal capacitance increases proportionally to W/L and actually the propagation delay time tends to have a limitation.

In the standard C^2MOS ICs the propagation delay time is determined by balancing other electrical parameters since there are other limitations such as the output current and the breakdown voltage causing to have larger value than other logic elements as shown in Table 2-1.

However, the products for specific applications and CMOS ICs having the capabilities of high speed operations for the high speed frequency divider are currently being developed, and the speed of around 10ns delay per internal stage of CMOS at 5 volts has been obtained providing the expectation that the product range of such CMOS will be expanded for the systems requiring the high frequency operations in the future.

(2) Quiescent (Static) power dissipation and operating power dissipation

In the standard CMOS, when the input holds "L" (V_{SS}) level or "H" (V_{DD}) level, N-channel FET or P-channel FET is kept turned off. So, the current from V_{DD} to V_{SS} is limited to the reverse direction saturation current of PN junction and the surface leakage current caused mainly by contamination on the chip surface; consequently, the value is only $\ln A \sim 2nA$ at the normal temperature for gate ICs.

In the case of other logic circuits except CMOS, when the output driving transistor is turned on, direct current flows down from V_{CC} to GND through the load causing the power dissipation in the quiescent state to be approximately equal to the operating power dissipation.

The operating power dissipation of CMOS can be considered to be only the switching power loss which is generated to charge/discharge the load capacitance while inverting the logical levels, so that the operating power dissipation is proportional to the switching frequency.

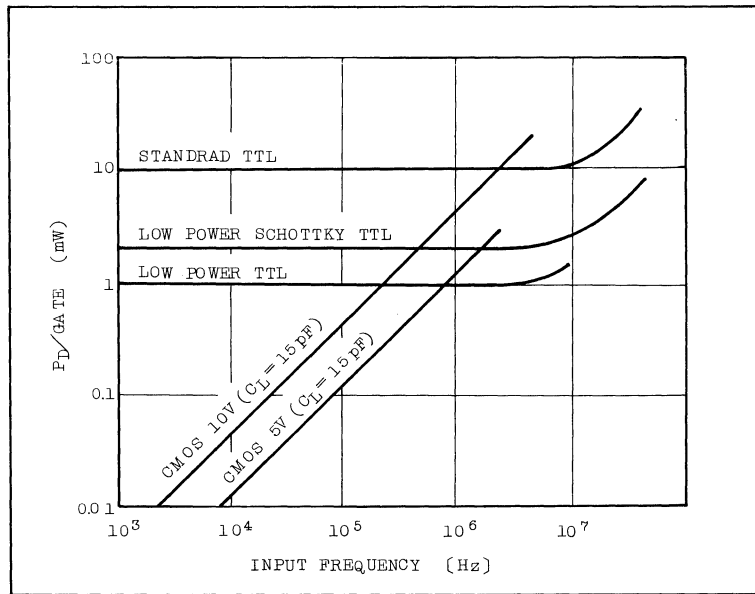


Fig. 2-7 Operating frequency VS Power Dissipation of CMOS/TTL

Fig. 2-7 shows the relationship between the operating frequency and the power dissipation of TTL and CMOS, As shown in the figure, the advantages of CMOS will be fully utilized at the operating frequency lower than 10^6 Hz.

(3) Noise immunity

For CMOS circuits as shown in Fig.2-6, since the device threshold voltage is ideally set to the mid-point of supply voltage, the maximum noise immunity can be obtained among the various logic devices. It can be seen from the same figure that the standard value of noise immunity for CMOS is 2 volts (at $V_{DD} = 5V$) or 4 volts (at $V_{DD} = 10V$), which are considerably larger than the value of 1 volt for TTL.

The device threshold voltage of CMOS, however, is determined by On-resistance ratio of P-channel and N-channel MOS FETs and directly affected by the variations of those values. Therefore, the noise immunity guaranteed in the catalog of "B Series" products is 1 volt (at $V_{DD} = 5V$) or 2 volts (at $V_{DD} = 10V$), and attention should be paid to this point.

(4) Fanout

Since the protection diodes are reversely biased as long as rating voltages ($V_{SS} \sim V_{DD}$) are applied, CMOS input has extremely high DC impedance ($R_{IN} \doteq 10^{11}\Omega$).

Furthermore, since the gate of MOS FET equivalently functions as one of electrodes of parallel plate capacitor, AC characteristic indicates the capacitive value of approximately 5pF.

This situation can be illustrated as shown in Fig. 2-8. These resistive component and capacitive component are insertes in parallel to V_{DD} side and V_{SS} side.

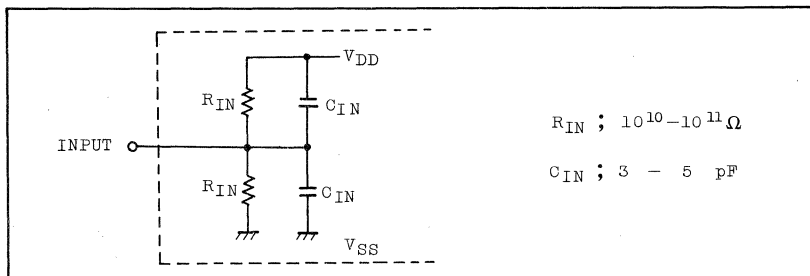


Fig. 2-8 Equivalent Circuit of CMOS Input

Therefore, in order to drive CMOS input, only very little current is required electrically to supply or to drain. This fact means that the output impedance of normal CMOS is around 200 - 1K Ω which makes it possible to drive the almost unlimited number of CMOS in DC operation.

However, as the number of fanout increases (n, for example), all of input capacitance C_{IN} are connected in parallel, increasing the load capacitance of output. So, the load capacitance viewed from the driving side is,

$$C_L = n \cdot C_{IN} + C_S \dots\dots\dots (2.13)$$

C_S : Stray capacitance generated by wiring, etc.

and this C_L causes the propagation delay time to increase.

Considering these situations, the practical number of fanout for C^2MOS has been determined to be 50. The fact that 50 fanouts can be actually provided eliminates almost all restrictions in the wiring arrangements of wired logic circuits.

3. Basic Circuit of CMOS

3.1 Positive logic and negative logic

The difference between positive logic and negative logic is only conceptual difference and it can not be said that the positive logic should be sued for CMOS.

The netative logic is easier to consider about P-channel MOS device due to the fact that negative supply voltages are used and that FET is turned on when negative potential is applied. However in CMOS both P channel and N-channel are the driving MOS and also the load MOS, so the conditions are same for the positive logic and the negative logic.

It has been decided that C^2MOS family is described in the positive logic in the catalog because of the facts that the positive logic is easier to handle for the design engineers who are familiar with the design works of wired logic circuits especially with TTL and that recently N-channel LSI become more and more popular and the positive logic is more convenient for the interfaces.

In order to avoid any confusion on the positive logic and the negative logic of the truth table, the potentially high logic level is described to be "H" level and the low logic level to be "L" level. Therefore, "H" in the truth table corresponds to "1" of the positive logic and "L" corresponds to "0" of the same posotive logic.

Table 3-1 Basic Logical Circuits

Circuit Function	Logical Symbol	Logical Equation or Truth Table																																																
Inverter		$X = \bar{A}$																																																
NAND Gate		$X = \overline{A \cdot B} = \bar{A} + \bar{B}$																																																
NOR Gate		$X = \overline{A + B} = \bar{A} \cdot \bar{B}$																																																
AND Gate		$X = A \cdot B = \overline{\bar{A} + \bar{B}}$																																																
OR Gate		$X = A + B = \overline{\bar{A} \cdot \bar{B}}$																																																
Clocked Inverter		<table border="1"> <thead> <tr> <th>ϕ</th> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>H</td> <td>L</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> </tr> <tr> <td>L</td> <td>*</td> <td>HZ</td> </tr> </tbody> </table> <p>* ; DON'T CARE HZ; HIGH IMPEDANCE</p>	ϕ	A	X	H	H	L	H	L	H	L	*	HZ																																				
ϕ	A	X																																																
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Transmission Gate		<table border="1"> <thead> <tr> <th>ϕ</th> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>H</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> </tr> <tr> <td>L</td> <td>*</td> <td>HZ</td> </tr> </tbody> </table> <p>* ; DON'T CARE HZ; HIGH IMPEDANCE</p>	ϕ	A	X	H	H	H	H	L	L	L	*	HZ																																				
ϕ	A	X																																																
H	H	H																																																
H	L	L																																																
L	*	HZ																																																
EXCLUSIVE-OR Gate		$X = (A + B) \cdot (\bar{A} + \bar{B})$																																																
EXCLUSIVE-NOR Gate		$X = (A \cdot B) + (\bar{A} \cdot \bar{B})$																																																
D - Type Flip - Flop		<table border="1"> <thead> <tr> <th>S</th> <th>R</th> <th>D</th> <th>CL</th> <th>Q</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>L</td> <td>*</td> <td>*</td> <td>H</td> </tr> <tr> <td>L</td> <td>H</td> <td>*</td> <td>*</td> <td>L</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>*</td> <td>H</td> </tr> <tr> <td>L</td> <td>L</td> <td>L</td> <td></td> <td>L</td> </tr> <tr> <td>L</td> <td>L</td> <td>*</td> <td></td> <td>$Q_n \triangle$</td> </tr> </tbody> </table> <p>* ; DON'T CARE \triangle ; NO CHANGE</p>	S	R	D	CL	Q	H	L	*	*	H	L	H	*	*	L	L	L	H	*	H	L	L	L		L	L	L	*		$Q_n \triangle$																		
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J/K Type Flip - Flop		<table border="1"> <thead> <tr> <th>S</th> <th>R</th> <th>J</th> <th>K</th> <th>CL</th> <th>Q</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>L</td> <td>*</td> <td>*</td> <td>*</td> <td>H</td> </tr> <tr> <td>L</td> <td>H</td> <td>*</td> <td>*</td> <td>*</td> <td>L</td> </tr> <tr> <td>L</td> <td>L</td> <td>L</td> <td>L</td> <td></td> <td>Q_n</td> </tr> <tr> <td>L</td> <td>L</td> <td>L</td> <td>H</td> <td></td> <td>L</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>L</td> <td></td> <td>H</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>H</td> <td></td> <td>$Q_{n+1} \nabla$</td> </tr> <tr> <td>L</td> <td>L</td> <td>*</td> <td>*</td> <td></td> <td>$Q_n \triangle$</td> </tr> </tbody> </table> <p>* ; DON'T CARE \triangle ; NO CHANGE ∇ ; TOGGLE</p>	S	R	J	K	CL	Q	H	L	*	*	*	H	L	H	*	*	*	L	L	L	L	L		Q_n	L	L	L	H		L	L	L	H	L		H	L	L	H	H		$Q_{n+1} \nabla$	L	L	*	*		$Q_n \triangle$
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L	L	H	H		$Q_{n+1} \nabla$																																													
L	L	*	*		$Q_n \triangle$																																													

3.2 Basic logic circuits

The basic logic blocks used in C²MOS are shown in Table 3-1. The logic diagrams illustrated in the technical bulletin of each product and the logic diagrams in this manual are configured by the basic blocks shown in Table 3-1. With partial exceptions, these logic diagrams are based on MIL-STD806(C). (Special symbols are used for the clocked inverter, the transmission gate, etc.)

3.3 Configuration of basic circuit

(1) NAND/NOR

CMOS NAND gate, as illustrated in Fig. 3-1 i), is formed by connecting P-channel FETs in parallel between V_{DD} and the output and by connecting N-channel FETs in series between V_{SS} and the output.

When both inputs A and B are "H", both of N-channel FETs in series are turned on, causing the impedance between X and V_{SS} to be low. At this time, both of P-channel FETs are turned off cutting off X from V_{DD} .

Therefore, the output becomes nearly equal to V_{SS} generating "L" level.

In the case of other input modes, at least one of P-channel FETs is turned on and one N-channel FETs are turned off causing the output to be "H" level.

NOR gate of ii) in Fig. 3-1 is fabricated in the reversed way of NAND gate i) to generate "H" output only when both of inputs A and B are "L".

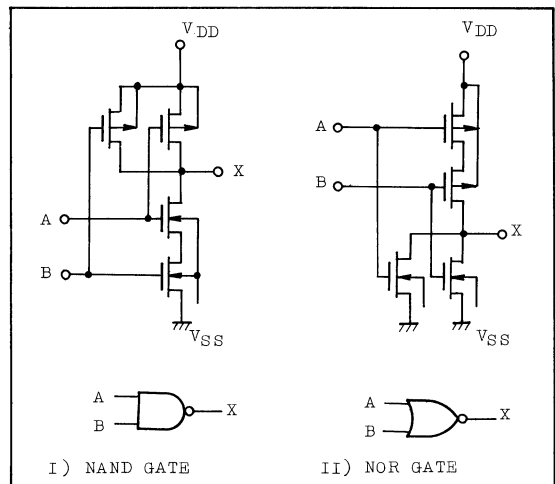


Fig. 3-1 NAND/NOR Gate

The gates with 3 inputs or more can be realized with the same configuration simply by increasing the number of stages of P-channel or N-channel FETs in series or in parallel. In the case of C²MOS up to around four inputs the device can be configured with one stage, but the gates with more inputs are realized by combining the basic circuits.

(2) AND/OR

Since the output is always inverted by one stage of CMOS gate, AND gate and OR gate are realized by adding an inverter to the output of NAND/OR of (1).

Therefore, it is important for CMOS MSI/LSI to effectively combine NAND/NOR rather than to fabricate the gates with AND/OR, in order to reduce the number of elements.

(3) Transmission gate

Fig. 3-2 illustrates the basic circuit of transmission gate. This circuit provides the function of reed switch which transmits the data when both of P-channel and N-channel are "ON" (C="H") and separates the output from the input when those are "OFF" (C="L").

Since both of P-channel and N-channel are used, the capability of cancelling the back gate bias effect is one of advantages and the capability of keeping the low impedance over the wide signal range of $V_{SS} \sim V_{DD}$ is another advantage.

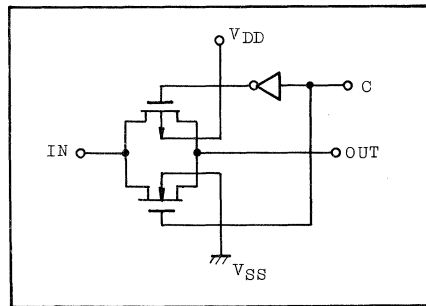


Fig. 3-2 Transmission Gate

The applications would be as follows.

- i) Switching functions of sequential circuits, such as shift registers, counters, etc.
- ii) Analog switches
- iii) 3-stage gates*

*3-state gates: 3-state is named for the capability of providing three states of output which are normal "H", normal "L" and high impedance condition not being connected to V_{DD} or V_{SS} , namely not "H" nor "L". This characteristic can be applied for the interface with bus line of process control systems and multiplexers.

(4) Clocked gate

When a delay circuit or a switching circuit is required, the transmission gate is usually used. However, this circuit has a disadvantage that the pattern becomes more complicated with increased area when the circuit is to be integrated in LSI. The one which overcomes this disadvantage keeping the characteristics of conventional transmission gate is the clocked gate (clocked inverter) shown in Fig. 3-3.

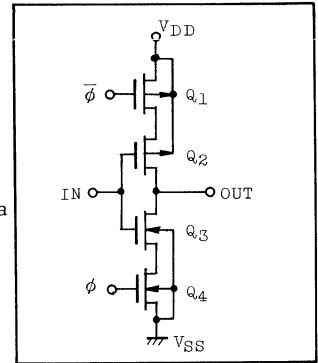


Fig. 3-3 Clocked Gate

Q_2 and Q_3 are normal configuration of inverter, however by serially inserting Q_1 and Q_4 in the circuit, the function of normal inverter can be obtained when Q_1 and Q_4 are "ON" (ϕ ="H") and the output has high impedance when Q_1 and Q_4 are "OFF" (ϕ ="L").

Although this circuit does not have the functions of analog switch, all the other functions of transmission gate are provided.

If the concept of this clocked inverter is expanded, clocked NAND and clocked NOR can be realized.

(5) Exclusive OR/Exclusive NOR

Exclusive OR is also called coincidence circuit which gives the output of "L" when all the inputs are at "H" or "L" level and gives the output of "H" when at least one of inputs differs from others.

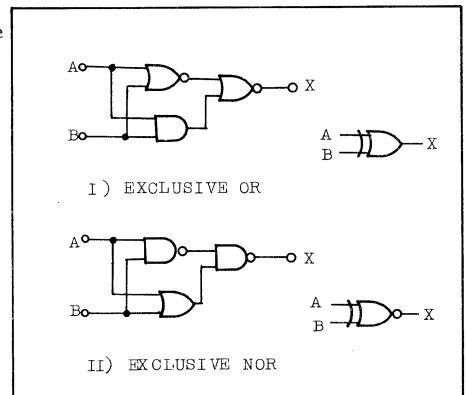


Fig. 3-4 Exclusive OR/NOR

Exclusive NOR is the one with the inverted output of the above exclusive OR and gives the output of "H" when all the inputs coincide at "H" or "L" level.

Fig. 3-4 illustrates the configurations of these circuits.

(6) D-type flip-flop/ J-K type flip-flop

These will be explained in the chapter of Flip-Flops.

4. Maximum Ratings and Recommended Operating Conditions

4.1 Maximum ratings

The maximum ratings are specified for each C²MOS product. Not only for C²MOS, the maximum ratings are the values which should not be exceeded in order to guarantee the life and the reliability of integrated circuits, and usually considered to be the absolute maximum ratings.

The absolute maximum ratings are the values which may not be exceeded even for a short instance and none of any rating values may not be exceeded. When the circuits are used exceeding the maximum ratings, their characteristics may not be recovered and in extreme cases permanent damage may be resulted.

Therefore, when a circuit is designed, extreme attention should be paid to variations of supply voltages, characteristics of connected components, surges of input/output signal lines, environment temperature, etc. Table 4-1 lists the common maximum ratings of B series C²MOS.

When the maximum ratings of each product differ from the common ratings, the former takes precedence.

Table 4-1 Common Maximum Ratings of B Series C²MOS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temp. Range	T _{stg.}	-65 ~ 150	°C
Lead Temp./Time	T _{sol.}	260°C·10 sec	

(1) DC Supply voltage

This is DC supply voltage applied between V_{DD} terminal and V_{SS} terminal. Usually biased to satisfy V_{DD} > V_{SS} and the reverse bias due to the undershoot of DC power supply, etc. should be limited to -0.5 volts. If higher voltage than this value is given in the condition of V_{SS} > V_{DD}, the parasitic diode D₇ shown in Fig. 2-4 is forward biased causing excessive current to flow from V_{SS} to V_{DD} and in extreme cases, the element may be damaged.

The upper limit of 20 volts is established based on the breakdown voltages of parasitic diodes and transistors of various circuits, and the value should never be exceeded. If voltage applied exceeding the rating, CMOS device may reach to the secondary breakdown region of latch-up, etc. from the primary breakdown region. Since V_{SS} is set to GND (0 volts) in most cases, the voltage of V_{DD} terminal should be considered to be in the range of -0.5 ~ 20 volts.

(2) Input voltage and output voltage

The electrostatic protection diodes are inserted in the input as shown in Fig. 2-3 and Fig. 2-4. These diodes are not installed to absorb the current fed from outside but installed to protect the input oxide film from

the destruction caused by electrostatic charge. Therefore, the input voltage is limited to the range that input protection diodes are not forward biased. The lower limit is $V_{SS} - 0.5$ volts and the upper limit is $V_{DD} + 0.5$ volts.

The output terminal is used usually to drive CMOS and other electronic components and although any voltage is not applied from outside, situations where the voltage transiently varies due to the external surge or driving of a capacitive load or an inductive load may possibly exist. If the output voltage exceeds the range of $V_{SS} - V_{DD}$ in this case, D4 and D6 of Fig. 2-4 are forward biased causing excessive current to flow from the output to V_{DD} or from V_{SS} to the output.

As this current possibly causes primary damage of opening the output line and secondary damage of latch-up, the output voltage is similarly as the input specified as a rating to be in the range of $V_{SS} - 0.5$ volts - $V_{DD} + 0.5$ volts to prevent the parasitic diode to be forward biased.

(3) DC Input current

This item may seem to be contradictory with the rating of input voltage (2), but this indicates the critical value at which the input protection diodes and other elements will not be destroyed or degraded when voltages exceeding the ratings are applied due to surges caused by interfaces. Therefore it is not recommended to design circuits which flow DC current through the input protection diodes. Even when it can not be avoided to apply voltage causing current to flow to the input, the current should be limited to 1 mA or less.

(4) Power dissipation

As far as CMOS is used in a normal manner, the power dissipation is extremely small not causing any problems concerning the allowable loss. However, when LED is driven or big current is driven by the buffer, power is consumed in CMOS. For C²MOS, the power dissipation is specified to be 300 mW* per package. (* ; Except Mini Flat Package.)

Since the power dissipation in the internal circuit can be neglected for C²MOS in most cases comparing with that of the output stage, the power dissipation can be calculated only considering the output stage.

(5) Storage temperature range

This indicates the ambient temperature at which degradation of characteristics or reliability is not resulted even if the products are exposed in the environment for long time without applying the supply voltage. In the case of C²MOS, the storage temperature range of -65°C ~ 150°C is specified as the rating.

(6) Lead temperature and time

These are conditions which should be limited when soldered after mounting C²MOS on the printed circuit board. Regardless whether a solder pot is used or a soldering iron is used, the lead temperature should be limited up to 260°C and soldering should be completed within 10 sec. When a solder pot is used, the area which is allowed to dip into solder is up to the stopper of IC lead frame.

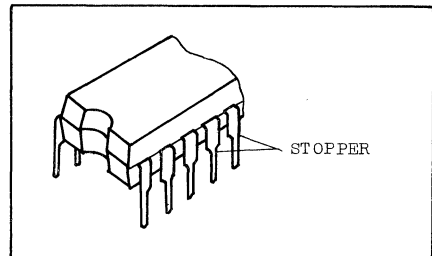


Fig.4-1 External appearance

4.2 Recommended operating conditions

These are the ranges where the operations of C²MOS IC are guaranteed and when the ranges are exceeded the operations are not guaranteed even if such ranges are inside of the maximum ratings. Therefore, it is important to use the products inside of these ranges.

Table 4-2 Common Recommended Operating Conditions of C²MOS(V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp. Range	Topr	-40	-	85	°C

Table 4-2 lists the common recommended operating conditions of B series C²MOS. When the recommended operating conditions of each product differ from the common recommended operating conditions, the former takes precedence.

(1) DC supply voltage

Wide range of operating DC supply voltage, 3 volts ~ 18 volts from V_{SS} is guaranteed for B series C²MOS. The lower limit of 3 volts is determined by V_T of P-channel and N-channel FETs and when the voltage becomes lower than this value, V_{GS} gets so small that the normal operations of CMOS can not be expected. The upper limit of 18 volts is determined by the breakdown voltage.

(2) Operating temperature range

This is the temperature range where the normal operations and characteristics of IC are guaranteed. The operations of B series C²MOS are guaranteed in the wide range of -40°C ~ 80°C.

Table 5-1 Static Electrical Characteristics of TC4001BP (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	10	7.0	-	7.0	5.5	-	7.0	-	V	
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
			10	-	3.0	-	4.5	3.0	-	3.0		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.0V, 13.5V |I _{OUT}| < 1μA	15	-	4.0	-	6.75	4.0	-	4.0	V	
			5	-	1.5	-	2.25	1.5	-	1.5		
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

5. Static Electrical Characteristics and Dynamic Electrical Characteristics

5.1 Static Electrical characteristics

Table 5-1 lists the static electrical characteristics of TC4001BP.

Excluding the products with special specifications, the guaranty of static electrical characteristics and the specifications are standardized, so that each characteristic of TC4001BP (QUAD 2-INPUT NOR GATE) will be explained here.

(1) High-level output voltage/low-level output voltage (V_{OH}/V_{OL})

Fig. 5-1 illustrates the test circuits of V_{OH}/V_{OL} . Each input terminal is connected to V_{SS} or V_{DD} to get the specified logic level at the output. When the output level can not be determined in the cases of counters, etc. the output logic is determined by applying pulses in advance. Since the load conditions are $I_{OH}=-1\mu A$ and $I_{OL}=1\mu A$, and the measurement is taken in the region where I_{DS} of FET is extremely small, usually $V_{OH} \neq V_{SS}$, and $V_{OL} \neq V_{SS}$.

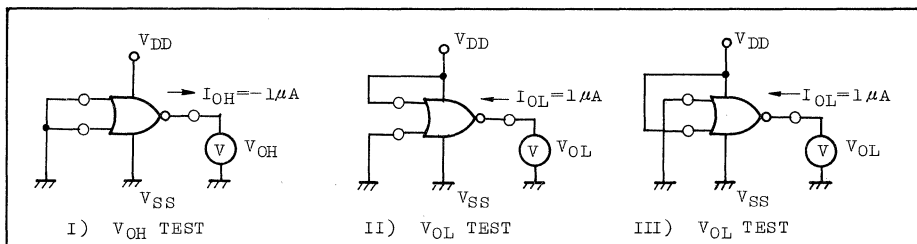


Fig. 5-1 Test Circuits of V_{OH}/V_{OL}

In the cases of interfacing CMOSs each other, the input/output conditions will be approximately equal to the above values. This fact indicated that the switching operation gives the ideal swing from V_{SS} for "L" level of logic signal to V_{DD} for "H" level in CMOS circuits.

(2) Output high current / Output low current (I_{OH}, I_{OL})

Fig. 5-2 illustrates the test circuits of I_{OH}/I_{OL} . The input conditions are set in the same manner as for measuring V_{OH}/V_{OL} . In this case, connecting a constant supply voltage to the output to be measured, the current flowing out (I_{OH}) through P-channel FET is measured for high level

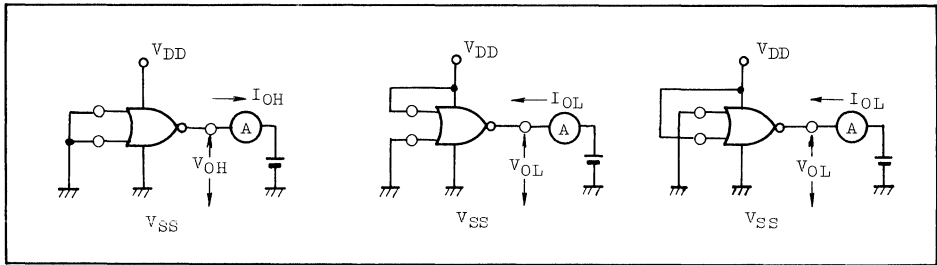


Fig. 5-2 Test Circuits of I_{OH}/I_{OL}

output and the current flowing in through N-channel FET is measured for low level output. These currents are guaranteed at one point in the non-saturation region (also called triode region) of each FET, and the minimum values are guaranteed in the specification table for both I_{OH} and I_{OL} . These can be a guidance to achieve current driving by CMOS output.

(3) Input high voltage / Input low voltage (V_{IH}/V_{IL})

Fig. 5-3 illustrates the test circuits of V_{IH}/V_{IL} . V_{IH} and V_{IL} are the voltages which can be recognized as "H" level and "L" level at the input of IC being measured, and the minimum value is guaranteed for V_{IH}

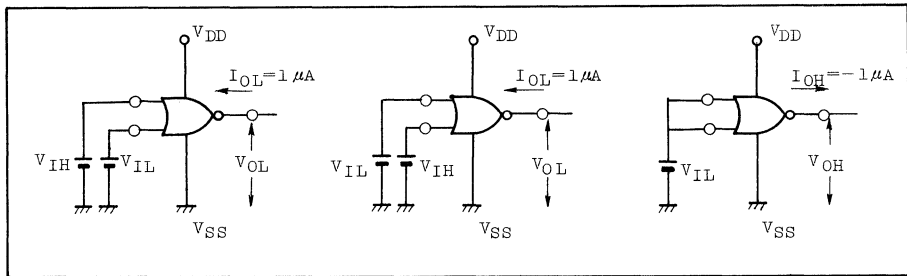


Fig. 5-3 Test Circuits of V_{IH}/V_{IL}

and the maximum value is guaranteed for V_{IL} . Whether or not IC being measured has correctly recognizes the input level is confirmed by the fact that the output level is at the specified level (higher than V_{OH} or lower than V_{OL} listed in the measurement conditions).

(4) High-level input current/low-level input current (I_{IH}/I_{IL})

The input current in the range of the ratings of CMOS is considered to be the sum of the reverse current of input protection diode and the surface leakage current. Since both of these leakage currents are extremely small at the normal temperature $\{10^{-5} \sim 10^{-4}(\mu A)\}$, the operating maximum voltage is applied for the tests. However, the specified value of $\pm 0.3\mu A$ (maximum) is guaranteed considering stability of automatic testing. Other inputs except one being measured are usually connected to V_{SS} for testing V_{IH} and to V_{DD} for testing V_{IL} .

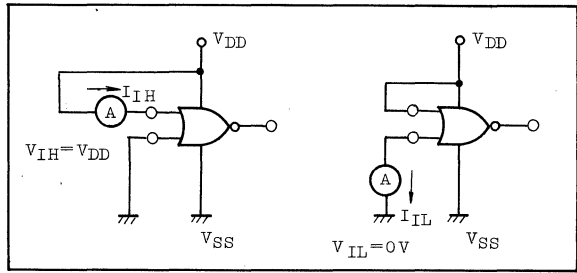


Fig. 5-4 Test Circuit of I_{IH}/I_{IL}

(5) Quiescent device current (I_{DD})

When CMOS input holds V_{DD} level or V_{SS} level, as described in the paragraph of Features of CMOS, P-channel FET or N-channel FET is always turned off. So, the quiescent device current is total of the reverse leakage currents at PN junctions in the chip. This value is also extremely small at room temperature reaching only 1 nA (10^{-9} A) (standard value at $T_a=25^\circ C$, $V_{DD}=5V$) for gate IC. Since this quiescent device current is guaranteed over all possible combinations of logic conditions of input pins, the combinations will be of very large number and usually such quiescent

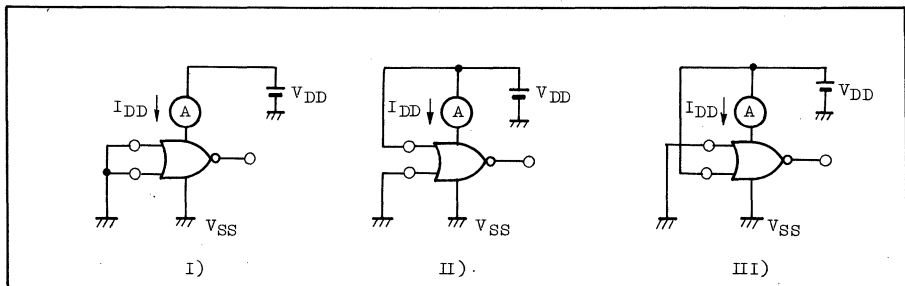


Fig. 5-5 Test Circuit of I_{DD}

device current is guaranteed at the point where the distribution is higher than the actual situations taking a certain degree of margins for test precision and test method.

Fig. 5-5 illustrates examples of test circuits of I_{DD} . Since I_{DD} with both of two inputs holding "H" can be estimated by measuring at the conditions ii) and iii), the test is omitted in many cases.

(6) 3-State output leakage current (I_{DH}/I_{DL})

This characteristic is not required for TC4001BP but it is required for the products having 3-state output and the products with open drain to specify the leakage current when the output is placed in the high impedance state.

I_{DH} is the leakage current when the signal of "H" level is applied to the OFF output and I_{DL} is the leakage current when the signal of "L" level is applied.

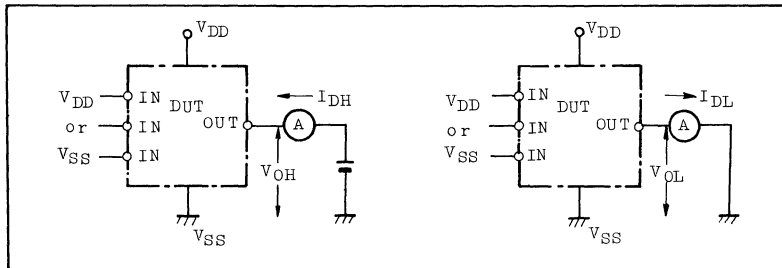


Fig. 5-6 Test Circuit of I_{DH}/I_{DL}

Fig. 5-6 illustrates the test circuits of 3-state output leakage. Naturally, the inputs are connected to generate the high impedance state at the output to be measured.

5.2 Dynamic electrical characteristics

The dynamic electrical characteristics are to guarantee the transient characteristics of C^2MOS and specified with the load capacitance of 50pF at the ambient temperature of 25°C.

As the test circuits and the test waveforms are described in the technical material for each product, only the basic characteristics are explained here committing the detail explanations.

(1) Conditions of applying input pulse

Unless otherwise specified, pulse swinging completely from V_{SS} to V_{DD} shall be applied as the input waveform. The rise time and the fall time are the time required for the waveform to vary from 10% to 90%, and both of t_r and t_f are adjusted to 20ns. (Fig. 5-7)

(2) Output transition time (t_{TLH}/t_{THL})

The output transition time are the time required for the waveform swining from V_{OH} to V_{OL} to vary from 10% to 90%. (Fig. 5-8)

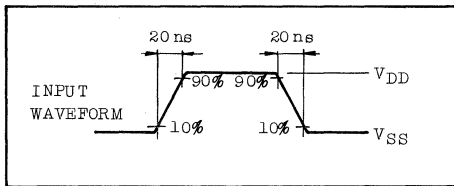


Fig. 5-7 Input Conditions

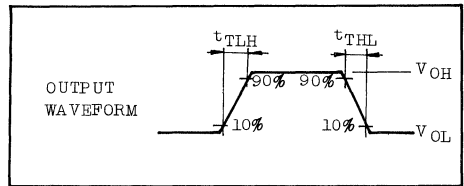


Fig. 5-8 t_{TLH}/t_{THL}

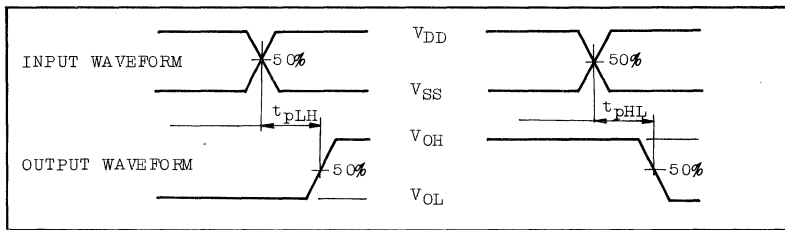


Fig. 5-9 t_{PLH}/t_{PHL}

(3) Propagation delay time (t_{PLH}/t_{PHL})

These are the propagation delays from the time when signal is given to the input of IC being measured until the output responds. The time delay from varying the input level to the output to respond varying from "L" to "H" is called t_{PLH} and on the contrary the time delay required for the output to vary from "H" to "L" is called t_{PHL} . In practice, however, since the circuit threshold voltage of CMOS is $1/2 \cdot V_{DD}$ (theoretical value), the time delay is specified to be the time period between

50% point of the input waveform to 50% point of the output waveform .
(Fig. 5-9)

It may be easy to understand concerning the gate ICs since the measurement conditions are less complicated, but MSI has higher number of input/output terminals and the delay time is specified designating the input pins and the output pins.

(4) Minimum pulse width (t_w)

The counters and the registers have the reset and the preset inputs to determine the initial state in many cases.

The minimum pulse width is the critical value of pulse width with which these terminals recognize it as the normal signal, and since the maximum value of distribution is specified, it is required to apply pulse with the width wider than the value. The pulse width is specified by the time period between 50% point of the leading edge and 50% point of the trailing edge.

(5) Maximum clock frequency (f_{CL})

This is the maximum clock frequency at which the flip-flops and the counters perform normal operations, and the minimum value of distribution is specified. It is required to design applications with the condition of the minimum value or lower of the value specified.

Unless otherwise specified, the duty cycle of clock input is 50%.

(6) Maximum clock input rise time/fall time (t_{rCL}/t_{fCL})

When the clock input waveform of a sequential circuit, such as flip-flop or counter becomes dull, the possibility of racing or mis-counting (abnormal counting operations) arises. The critical values of t_{rCL} and t_{fCL} are specified in the catalog and the clock inputs having rise time and fall time shorter than the minimum value are required.

(7) Minimum data set-up time (t_{SU})

The outputs of flip-flops and shift registers are determined by the conditions of data inputs at the time of clock input transition. Therefore, if the transitions of clock and data input occur at the same time, the output may not be definite, so that the data inputs require to be settled before the transition of clock input, and this required settling time is called minimum data set-up time.

The maximum value of distribution is specified in the catalog and it is required to keep the set-up time longer than this value for applications.

5. Cautions on Handling

By reason of its configuration, C^2MOS IC behaves itself in the manner different from Bipolar Logic centering around the conventional TTL. Although C^2MOS IC has many advantages over TTL, unsuitable method of use may result in the failure of full use of these advantages. In this chapter explanation is made on the cautions in handling C^2MOS IC and the cautions in designing circuits by using C^2MOS IC.

6.1 Configuration of C^2MOS necessary to know before handling and designing

C^2MOS IC input is connected to the gate electrode of MOS configuration having extremely thin oxide. As shown in Fig. 6-1, MOS configuration is de-

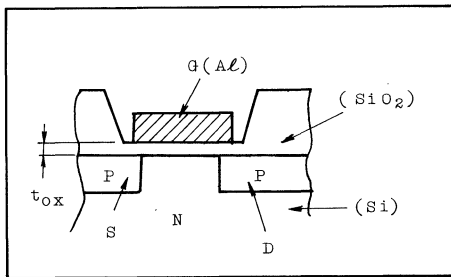


Fig. 6-1 MOS Configuration
(Example of P-Channel MOS)

defined in general as the sandwich configuration consisting of metal, oxide and semiconductor.

The thickness (t_{ox}) of oxide insulator located directly under the gate electrode is usually as thin as $0.1\sim 0.2\mu$; therefore, even when the voltage of 100V-200V is applied between gate and N-sub-

strate the electric field strength of oxide insulator just under the gate reaches as large as $10^7V/cm$, causing dielectric breakdown by discharge.

For protecting the gate from the above-mentioned dielectric breakdown.

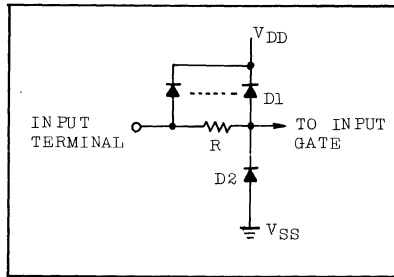


Fig. 6-2 Input Protection Circuit

As an example, the static electricity remaining in the fibers by the friction of fibers and needle of injustrical sewing machine for synthetic fibers or that generated by men and women walking on a carpet may reach several kV-- some dozen kV, though the voltage differs depending on relative humidity and surface condition.

The above-mentioned static electricity is stored in the storing case of fibers or in human body, which is equivalent to the fact that the above-mentioned voltage is charged to the electrostatic capacity or human body

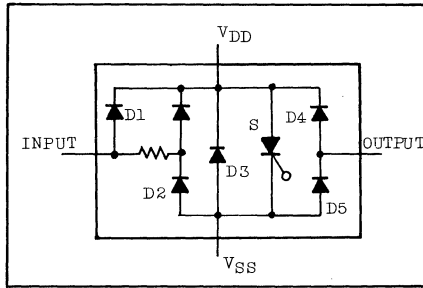


Fig.6-3 Parasitic circuit of C²MOS IC

However, when the voltage exceeding the max. rating is applied between each terminal, excessively large current flows to these diodes.

Fig. 6-3 shows the parasistic circuit formed between each terminal of C²MOS IC. In same figure, D₁ and D₂ are the input protective diodes, D₃ is the diode formed by P-well diffusion, D₄ is the diode by the drain formation

TOSHIBA C²MOS IC is provided at each input terminal with the protective circuit consisting of diode and resistor as shown in Fig. 6-2. According to the same figure, the voltage applied to the input terminal is clamped by D₁ and D₂ at V_{DD} and V_{SS}, whereby the input gate is protected. However, the input protective circuit has its limit.

capacity (200 ~ 300PF). When this electric charge discharges to C²MOS input, it is transformed into the energy sufficient to break down C²MOS input.

In addition to the input protective diode, parasitic diodes are formed between each terminal in C²MOS IC, and all these diodes are of inverse bias at the

of P-channel MOS FET, and D_5 is the diode by the drain formation of N-channel MOS FET. S is the parasitic thyristor formed between each diffusion area.

For example, when the voltage exceeding the range of $V_{SS} \sim V_{DD}$ is applied to C^2MOS input or output and the excessively large current flows to these diodes, firstly the fusing of input and output wiring or power supply wire will occur and secondly, short-circuit phenomenon between $V_{DD} \sim V_{SS}$ (this is generally called the Latch-up, resulting in fusing of power supply wire as the destruction mode) will be induced by the "ON" working of parasitic thyristor.

Therefore, it is necessary to use the voltage on input and output terminals within the rating without fail.

7. Cautions on Handling C^2MOS IC

7.1 Transportation and storing

The input and output of C^2MOS IC which is not actually installed are in the state of high impedance. It is, therefore, necessary to protect the C^2MOS IC from the external electric stress, such as the discharge from ambient charged body, the induction from space electric field, etc.

Therefore, in transporting and storing C^2MOS IC, it is necessary to use the conductive mat, metal box, the box lined with aluminum foil, etc. so that each terminal of IC may become the same electric potential.

TOSHIBA C^2MOS IC is inserted in a magazine given no-charging treatment at the time of shipment, do not take it out from the magazine unnecessarily. Especially, avoid to use plastic or vinyl container which is apt to charge static electricity.

Store the IC at the location where it is not exposed to the direct sunlight. Pay careful attention to store at the location of the relative humidity which should be neither extremely high nor extremely low.

7.2 Acceptance inspection

In case of conducting acceptance test on C^2 MOS IC, first of all it

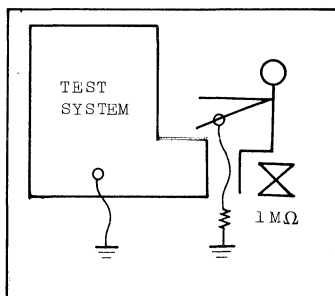


Fig. 7-1 Grounding

is necessary to ascertain that there is no transient phenomenon as overshoot or undershoot etc. between each terminal of test system by using synchroscope. Next, conduct test by using the calibration IC for ascertaining that there is no error in the test program. In the case of giving test pulses, it is necessary to give input signal after turning on the power supply.

It is necessary to take out the IC on the grounded work table. In conducting the test, ground the test system and inspector. For preventing the electric shock accident by the electricity leak from electric equipment, ground the inspector through approx. $1M\Omega$ resistor without fail.

Be sure to turn off the power supply when IC is inserted in IC socket or IC is drawn out of the socket. The accident of test system may give fatal damage to IC. It is, therefore, advisable to carry out the self-diagnostic program in advance before test.

7.3 Assembling

As mentioned in 2.2, in case of installing C^2 MOS IC on the printed base board, it is necessary to make protection from the static electricity by grounding electric equipment, work tables (desks), and work men. It is advisable to ground a work table by putting metal plate or aluminum foil on the surface. Refrain as practicable as possible from wearing chemical fiber work cloth. Electricity leak from electric equipment shall be prevented by reason of safety. So, it is necessary to periodically check to see that there is no leak in the electric equipment.

In case of shaping the lead frame for installing IC, it is recommended that pincette and other jigs be used for preventing the stress from being imposed on the root.

It is ideal that the jigs are grounded.

7.4 Soldering and cleaning

In case of carrying out soldering by using soldering iron and soldering tank, perform the soldering work within 10 seconds at the temperature 260°C below. It is confirmed that TOSHIBA C²MOS IC has no problem on reliability even in case the temperature stress is given to the stopper or lead at 260°C for 10 seconds.

Use the soldering iron with no leak on its tip. It is advisable to use A class soldering iron, the dielectric resistance of which is over 10 MΩ.

In using the soldering tank, it is necessary to ground the tank for preventing the unstable electric potential. After soldering IC to a printed base board, for removing flux and others, accelerating cleaning method is adopted in many cases by using detergent and ultrasonic wave.

In this case, full attention should be given to the selection of solvent so that the cleaning may have no influence on the outer case and mark of C²MOS IC. In general, it is advisable to use FUREON series.

In the ultrasonic cleaning, consideration should be given to the cleaning method so that the main body may form a shadow to the oscillator. This is for preventing IC and base board from the stress by resonance. At the same time, consideration should be given to the cleaning time which shall be within 30 seconds

7.5 Adjustment and test

In conducting adjustment and test of set on completion of printed base board, before turning on the power supply it is advisable to ascertain that there are no errors in polarity and others of power supply, etc. As to the printed base board, ascertain that there are no solder bridge, cracks, etc. Usually, the C²MOS system requires only a small supply current, so that the abnormality of system can be checked, from the excessive supply current. In case of conducting test by using the commercially available constant-voltage power supply, it is recommended that the current limit be imposed on the power supply.

For the system consisting of several sheets of printed base boards, the printed base boards should be drawn out of and insert in the mother board for checking the system. In this case, the work shall be made after turning off the power supply.

In observing each part of printed base board with an oscilloscope at the time of test, it is necessary to be careful so that the tip of probe may not contact other signal wires and supply wire. In case the location to be observed is decided in advance, it is one of the methods to stand the test pin for exclusive use. Do not lead out this test pin directly from the signal wire. It is advisable to protect C²MOS circuit from static electricity and erroneous connection by inserting over 10K Ω resistance in series.

In case of conducting test at high temperature and low temperature, it is necessary to ground the thermostatic oven. The set in the oven should be installed on the conductors.

8. Mini Flat Package (MFP) C²MOS

8.1 Features and Applications

When compared with existing DIP, Toshiba MFP C²MOS IC has the following features:

- o Small in size and a space factor at time of installation can be made small.
- o Installation to thin type equipment is possible
- o It is possible to assemble to both sides of a printed base board.

In addition, when compared with use of IC chip, MFP C²MOS IC has the following features:

- o Easy to handle and reliability is improved.
- o It becomes easy to automate the assembly process.
- o Easy to replace defective parts.
- o Electrical characteristics guaranteed at the same level as DIP assure safe use.
- o Dimensions are in accordance with EIAJ General Provisions.

TOSHIBA MFP C²MOS IC Family can be used for not only hybrid IC but also various equipment having limited printed base board area, set weight, thickness, etc. In addition, it will become possible to use MFP C²MOS IC Family on equipment in the fields to which the application was not feasible so far.

- o Hybrid ICs
- o Portable VTRs
- o Video cameras
- o Portable measuring instruments
- o Electric/electronic instruments for motor cars
- o Small-sized business machines

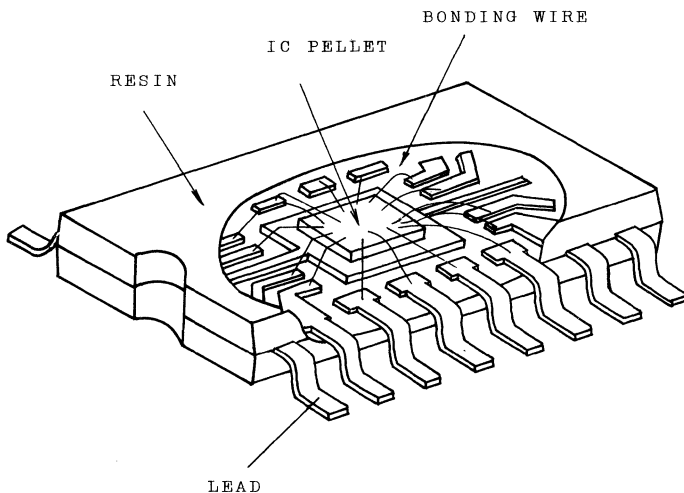
- o Hand-held computers
- o Remote & radio control equipment
- o Various equipment
- o Cameras
- o Telephones
- o Others

3.2 Structure

Shown in Fig. 8-1 is the internal structural diagram of MFP C²MOS IC. IC chip is attached to the central section which is called the bed, and is connected to the lead frame from the electrode on the chip by Au wires. The enclosure is transfer molded by epoxy resin.

The lead frame is tinned, allowing the easy soldering in installing a substrate.

Fig. 8-1 Internal Structure (In case of 16-pin IC)

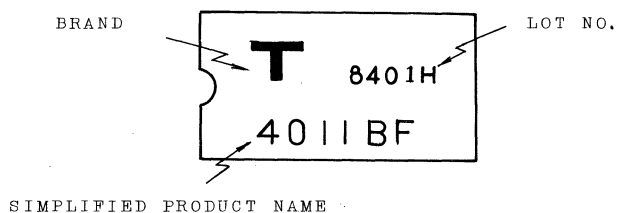


8.3 Product Name

MFP C²MOS IC product is named in accordance with general plastic type DIP product name, but the last character (alphabet) of product name is changed from "P" of plastic to "F" of Flat.

Example: TC4011BP → TC4011BF

However, "TC" is omitted for the marking on actual ICs for the limited space. Therefore, please order ICs under formal product names as exemplified in the above.



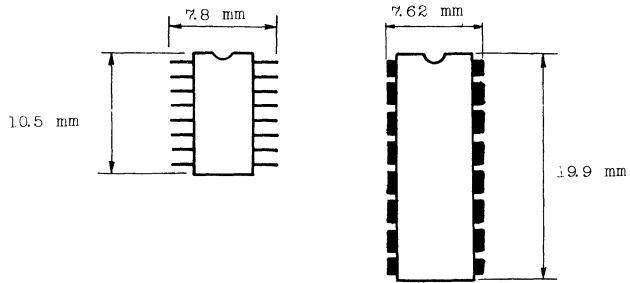
8.4 Comparison with Standard DIP (miniaturized effect)

Miniaturized effect of the mini flat package (MFP) when compared with the standard dual in-line package (DIP) is shown in Fig. 8-2.

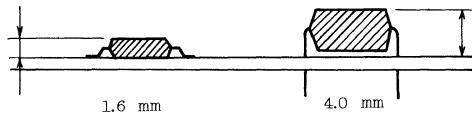
When MFP C²MOS IC is used, it is possible to make a printed base board small in size and light in weight to 1/2 in occupied space, 1/2.5 in height and 1/5.5 in weight.

Fig. 8-2 Comparison of DIP and MFP C²MOS IC

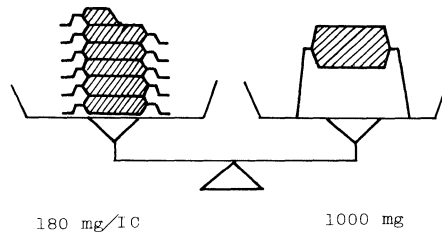
Occupied space (typ.) of printed base board



Height (typ.)



Weight (typ.)



8.5 Maximum Ratings and Electrical Characteristics

(1) Maximum ratings

The maximum ratings of MFP C²MOS IC are the same as those of ordinary DIP products except power dissipation (P_D).

(2) Electrical characteristics

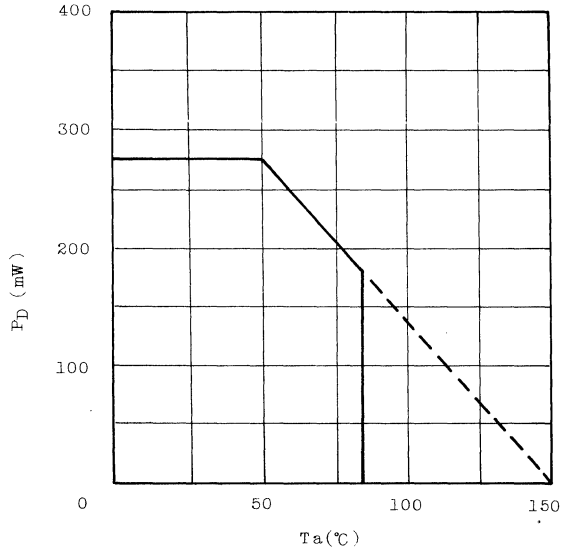
The electrical characteristics of MFP C²MOS IC are the same as those of ordinary DIP products.

(3) Power dissipation (P_D)

The enclosure of MFP C²MOS IC is small, and the power dissipation during the natural radiation is as less as 180 mW (at 85°C). Shown in Fig. 8-3 is the power dissipation characteristic of MFP C²MOS IC. Since heat radiation from leads to a substrated becomes large when actually mounted, the power dissipation may be larger than that of a single unit. It is, however, necessary to examine the actual heat radiation of MFP C²MOS IC thoroughly with it actually mounted.

However, power consumption of MFP C²MOS IC when not in operation is minimum for its structure and even when in operation, it is possible to suppress power consumption below several tens mW unless an extremely severe method of use is employed, for instance, to drive large current by its output. Therefore, except special cases, it is considered not necessary to take much care of power dissipation.

Fig. 8-3 Power Dissipation of MFP C²MOS IC (14/16 pins)



8.5 Mounting Method

To mount MFP C²MOS IC, the conventional mini-mold transistor/super mini-mold transistor mounting methods can be applied. Various mounting methods are available for selective use according to purpose.

(1) Reflow soldering method

The reflow soldering method is the most general method for mounting chip components (resistor, capacitor, transistor, etc.) on a substrate and needless to say, can be applied to MFP C²MOS IC.

In the reflow soldering, a preliminary soldering and flux are applied to a printed base board in advance. Further, a printed base board may be applied with solder paste selectively in the screen printing. In the preliminary soldering, flux may be applied to the terminal side of IC instead of a printed base with a brush or sponge.

ICs are temporarily fixed at fixed locations by flux or solder paste. If it is desirable to temporarily fix ICs more quickly, fix ICs by applying a small amount of bonding agent on their back sides.

Then, when a substrate with component parts fixed temporarily is passed over a hot plate or through a tunnel kiln, or conveyor type heater, the solder preliminary applied is melted (reflow) and the soldering is made. Maximum allowable on resin and lead part is 260°C, and allowable time period is 10 second.

(2) Wave soldering method

Wave soldering is the most popular method to assemble dual inline devices.

In order to apply this method to MFP, following procedure is usually taken.

A package is fixed on the printed circuit board using an adhesive. After handling the board upside down, that board is putted on the flowing solder, Maximum allowable temperature of solder is 260°C, and allowable time period of dipping is 10 second.

During this soldering, the circumference of the molded package is completely filled with solder.

As the thermal shock of a package is worth than the other method, shorter soldering time and lower solder temperature is recommended. Pre-heating is also effective before wave soldering process in order to reduce the thermal shock.

(3) Method by soldering iron

A package is fixed by flux, bonding agent, etc. using a soldering iron with the thin finished tip and a thin solder of 0.5mm ϕ or below. The soldering work with a soldering iron shall be performed within 10 seconds at 260°C or 3 seconds at 350°C or below. This method is not suited to mass production but is used for experiment and repair.

(4) Conductive paste method

This method uses conductive paste instead of solder for installing component parts.

This paste is epoxy resin with gold or silver mixed. First, apply paste to the contact section, arrange component parts and leave them for 1 to 3 hours at 100 to 150°C for curing.

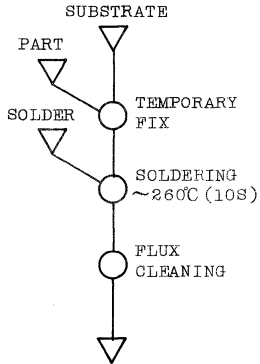
However, when compared with the method using solder, this method has the weakness in reliability of adhesion and therefore, it is necessary to take the utmost care.

Shown in Fig. 8-4 are examples of flowcharts in various mounting methods.

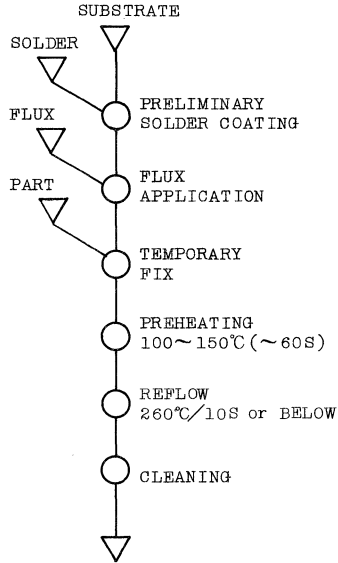
Fig. 8-5 shows the Maximum temperature profile at soldering process.

Fig. 8-4 Various Mounting Flowcharts

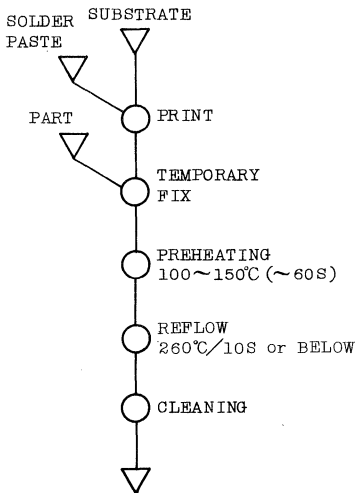
Soldering Iron Method



Reflow Method
(Preliminary Soldering)



Reflow Method
(Solder Paste)



Wave Soldering
(Flow Soldering)

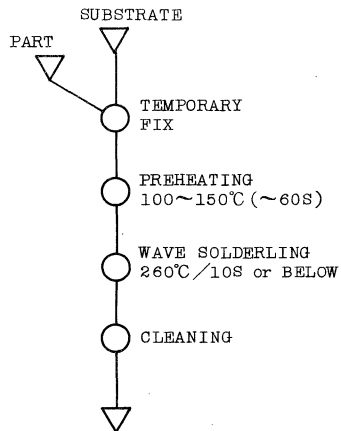
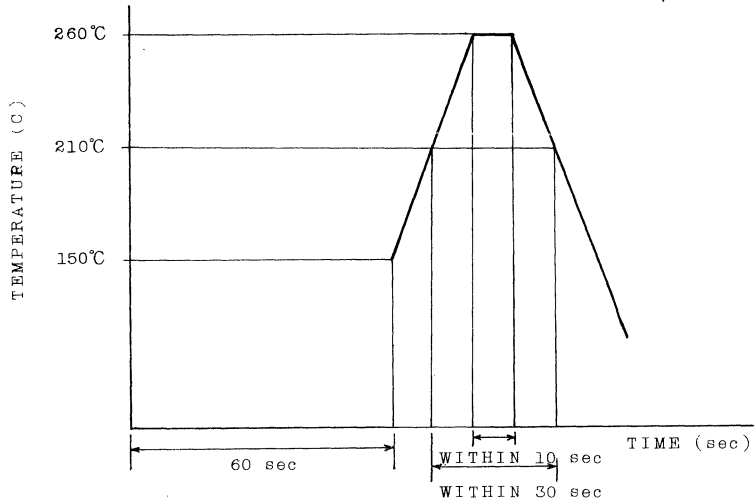


Fig. 8-5 Maximum Temperature Profile at Soldering

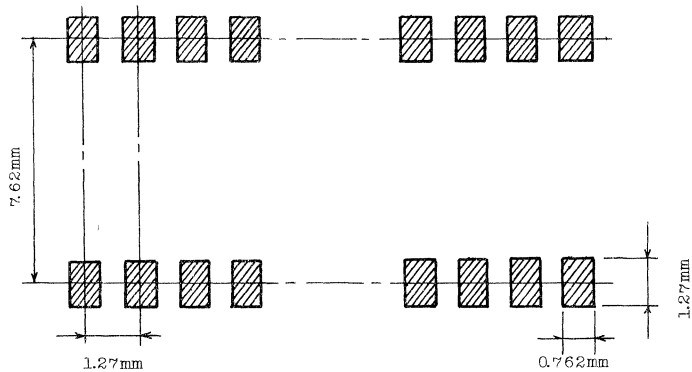


8.7 Mount Pad Dimensions (for 300 mil type)

An example of size of mount pads for MFP C²MOS IC is shown in Fig. 8-6 for reference in designing printed base board.

This size is in accordance with EIAJ General Provisions.

Fig. 8-6 Diagram of Mount Pad Size



8.8 Cautions for Use

For effective use of MFP C²MOS IC it is necessary not only to strictly observe instructions (handling, static electricity, etc.) for use of ordinary DIP package C²MOS IC but also to pay attention to the following points.

(1) Temperature at time of soldering

IC is exposed to high temperature at time of soldering.

Basically, however, the soldering can be carried out at lead temperature 350°C for 3 sec or less in case of the soldering iron method, and at atmospheric temperatures on the resin surface 260°C for 10 sec or less and lead temperature 260°C for 10 sec or less in case of the reflow method, and flow soldering method.

However, except an unavoidable case it is desirable to use a method to complete soldering in a short time as could as possible. In case of infrared reflow method, the mold body temperature may be higher than the lead temperature. Therefore temperature control should be done observing mold body temperature.

(2) Type of flux and cleaning

Flux in activated resin composition is most extensively used for soldering. It is recommended to avoid use of chloric flux as reliability may be adversely affected by residual chlorine, etc. If sholdering flux is left, leads may be corroded, marks on IC may become hard to be read and other troubles may be cause, and it is therefore necessary to wash and remove flux completely. It is advisable to use FUREON Series solvents for cleaning.

(3) Formation of leads

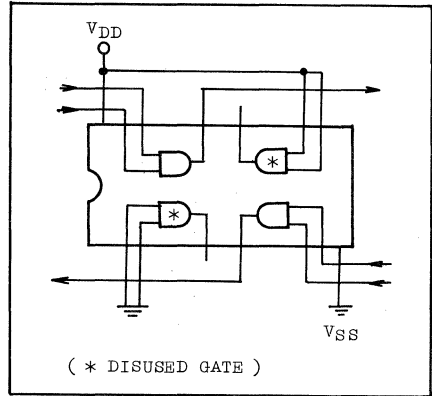
Leads of MFP C²MOS IC are formed in the L-shape to facilitate mounting to a flat substrate. If they are straightened, their strength can be reduced.

Further, if stress is applied to leads and they are deformed during they are handled, it is more difficult to reshape them to the original shape than ordinary DIP type IC.

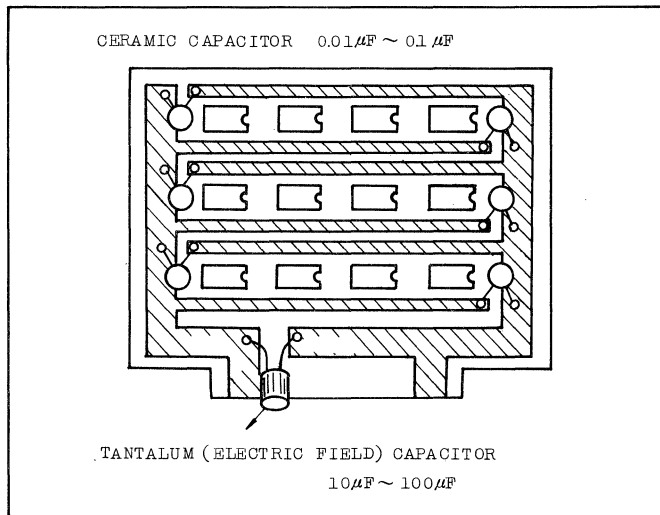
9. Cautions on Designing Circuits

9.1 Input processing

As the input of CMOS IC is very high impedance ($R_{IN} \approx 10^{12}\Omega$), the logic level is not constant in the open state. In this case, if the input is in the medium level, both P-channel and N-channel transistors are in the state of connection, whereby the unnecessary supply current flows.



Therefore, be sure to connect the unnecessary input line to V_{DD} , V_{SS} or other input/output wires, for which logic level is decided, as shown in Fig. 9-1. Unstable contact of soldered parts causes erroneous working of CMOS system or increase in supply current. Therefore, care should be taken to wiring.



9.2 Designing power supply

In general, CMOS is small in current dissipation as compared with other bipolar digital IC; therefore, it can be used by the small capacity power supply. By reason of its operation, however, CMOS consumes electric power in the form of spike. This makes it necessary to make the high-frequency impedance of power supply lower. Concretely speaking, it is necessary to make supply (V_{DD}) wire and GND (V_{SS}) wire thick and short and insert 0.01 μ F \sim 0.1 μ F capacitor as the high-frequency filters in the important areas between power supply and GND on the printed base board. As to the low-frequency filter, 10 μ F \sim 100 μ F/printed base board will do for the purpose. Fig. 9-2 shows an example of printed base boards.

And average supply current varies considerably depending on such factors as the working frequency, load on capacitor, supply voltage, rise and fall of input signals, etc. Therefore, particular attention is required in the case of driving by simple power supply of Zenor diode of battery driving. In case there are overshoot and undershoot at the transient time of power supply, arrangement shall be made by using filters, etc. so as to avoid exceeding the max. rating.

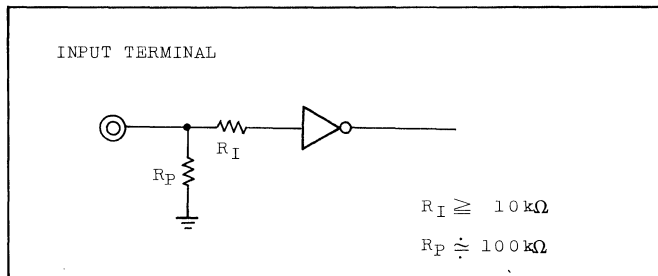


Fig.9-3 Input Processing of Printed Base Board

9.3 Input processing of printed base board

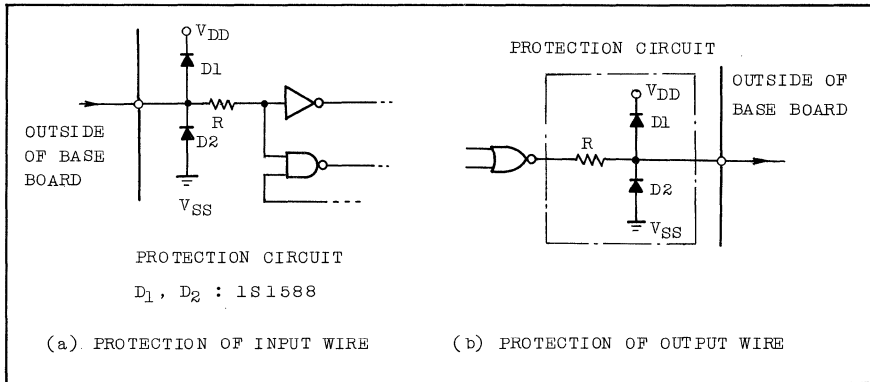


Fig.9-4 Protection of Input/Output Wires

When the input terminal of printed base board consists of C²MOS input only, like the individual CMOS device, the input terminal is in electrically floating condition, whereby there is a possibility of receiving damage by static electricity, etc. Therefore, as shown in Fig. 9-3, by inserting over 10k Ω resistance in series in advance, it is possible to protect C²MOS from the overcurrent.

And, it is more effective if the input terminal can be pulled up or down by approx 100k Ω resistance.

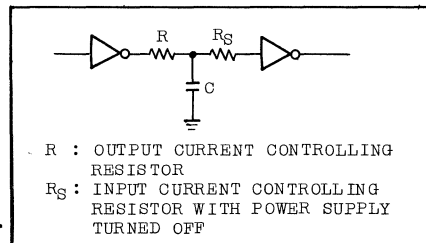


Fig.9-5 Method of Inserting Capacitor

9.4 Measures for noise and surg of signal input/output wire

In many cases the signal input wire coming in the printed base board and the control output wires coming out the printed base board are connected with other electronic parts. In general, it can be said that the signal wire is long in many cases. In case the surge is applied to these input/output wires by induction, there is a possibility of deterioration or breakdown of CMOS IC being caused by overcurrent (overvoltage). Therefore, in case the input/output signal wires are long and when the

high voltage wire exists in the outside printed base board, it is necessary to insert the protective circuit as shown in Fig.9-4. The method of separating the base board through photocoupler and lead relay contact is also effective.

In case of making test pin, it is advisable to make protection in advance as shown in Fig. 9-1 to Fig. 9-4.

9.5 Signal wire and capacitor to be connected to V_{DD} or V_{SS}

In case the capacitor is connected directly to signal wire for removing the delay and noise in signal, the capacitor up to 500pF in capacity can be connected directly, but capacitors larger in capacity shall be connected through such resistors as shown in Fig. 9-5. These resistors are used for restricting the flow of current to the parasitic circuit of CMOS input/output at the time of "ON" and "OFF" of power supply and for preventing CMOS output from short-circuiting for a long time. It can be said that 10k Ω or over will be suitable as the resistance value for both R and R_S .

9.6 Output short-circuiting

In C^2 MOS IC, buffer is added to the output, whereby it is possible to carry out the current driving of both source (I_{QH}) and sink (I_{QL}). Therefore, in case "H" level output wire is short-circuited with GND (V_{SS}) wire or "L" level output wire is short-circuited with V_{DD} wire, overcurrent flows to C^2 MOS output. In particular, if supply voltage is high, this current may cause the package to exceed the permissible power disipation; therefore, attention shall be given to prevention of the output short-circuit.

Of course, it is impossible to connect normal outputs together, but concerning the C^2 MOS which has three-state output, wired OR is permitted under the condition that more than two-wire outputs do not come to enable simultaneously.

9.7 Influence of input slow in rise or fall time

In case the waveform slow in rise time or fall time is applied to CMOS input, the output of gate IC, etc. may tend to oscillate in the neighborhood of V_{TH} (device threshold voltage) of input waveform. This is because, in the neighborhood of V_{TH} , CMOS gate becomes equivalently linear amplification, whereby the minute supply ripples and noise appear on the output after amplification.

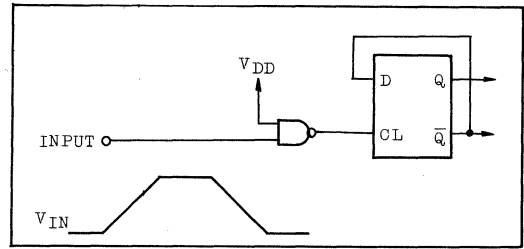


Fig.9-6 Example of Clock Input Shaped by Waveform

For suppressing the above phenomenon, consideration should be taken to insert the high-frequency filter capacitor between V_{DD} and V_{SS} of oscillating IC or to use Schmitt trigger IC. In particular, attention should be given to the clock input of sequence circuit. Fig. 9-6 shows an example of clock shaping.

9.8 Variation of various characteristics

(1) Circuit threshold voltage

The circuit threshold voltage of C^2MOS is designed for $1/2 V_{DD}$ ideally, but in reality the voltage is influenced directly by the variations of both P/N FETs because the voltage is decided by the voltage dividing effect of both P/N MOS FETs. As compared with the bipolar IC, therefore, the variation is considerably large. For example, differentiation circuit/integration circuit by CR and timer circuit are greatly influenced in terms of time by this variation, and in reality compensation effect is required by the use of variable resistors.

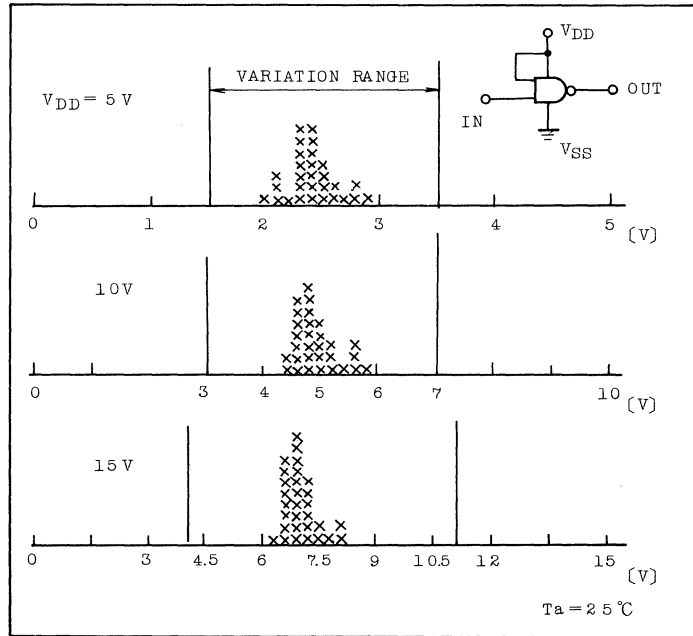


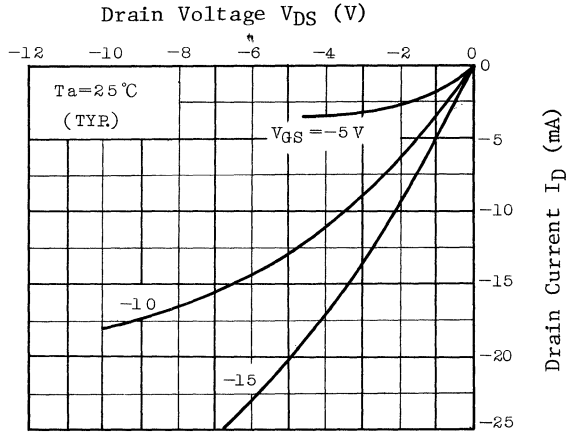
Fig.9-7 Variation Data of TC4011BP V_{TH}

Fig. 9-7 shows the variation data for TC4011BP circuit threshold voltage. As to other types, variations can be considered to be similar to TC4011BP.

(2) Output current

The variation of output current can be considered to be Max. $\pm 30\%$ to the standard value. Fig. 9-8 shows the output current characteristics (standard value) of TC4007UBP. So far as this figure is concerned, it follows that considerable drain current flow at the domain where V_{DD} is high. However, if output current is large, internal loss of FET becomes large at the same time, resulting in lowering the thermal reliability. In reality, therefore, it is suitable to use at the non-saturation domain up to $|V_{DS}| < 1.5V$.

P-Channel Drain Current Characteristics



N-Channel Drain Current Characteristics

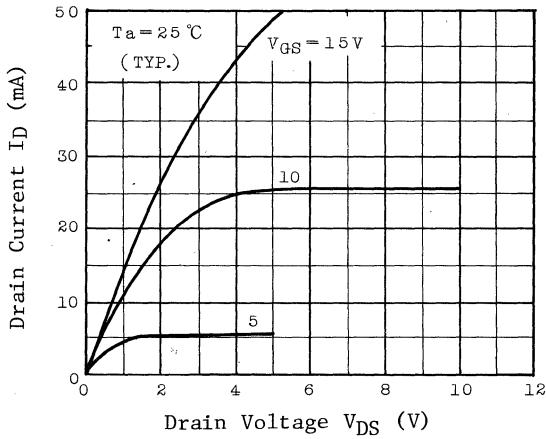


Fig. 9-8 Output Current Characteristics of TC4007UBP

(3) Switching time

Propagation delay times such as t_{PLH} , t_{PHL} , etc., toggle frequency of counter, etc. have max. $\pm 30\%$ variation to the standard value.

However, these parameters vary depending on the interface conditions of load capacitance, etc., therefore, it is necessary to consider fanout at the portion where operating speed is high.

9.9 Temperature parameters of various characteristics

(1) Device threshold voltage

The device threshold voltage is considerably stable to the temperature because the temperature coefficients of ON resistance of P-channel and N-channel FETs become the puls values. The temperature coefficients are approx. $-2 \sim -3$ mV/ $^{\circ}$ C at $V_{DD}=5V$ and approx. $-4 \sim -5$ mV/ $^{\circ}$ C at $V_{DD}=10V$.

(2) Output current

The output current has the minus temperature coefficients for both P/N FETs, which are approx. $-0.4\%/^{\circ}$ C. Namely, under the temperature condition of approx. 85° C the current value becomes small by about 25% as compared with the normal temperature (about 25° C). This is an important point in deciding the overdrive coefficient in case of driving transistor, etc. by current.

(3) Input current, Quiescent device current and 3-state output leakage current

These leak currents are theoretically the leak currents in the opposite direction of PN junction, and are extremely small in value at normal temperature. With the rise in temperature, however, the values increase at exponential function.

In reality, it is convenient to remember that with the rise in ambient temperature by 25° C the leak current increases by about 1 digit.

Howeve, in reality the input current is approx. $10^{-10} \sim 10^{-11}$ [A] at normal temperature and the quiescent device current is approx. 10^{-9} [A] at gate IC. These are the levels which have no problems on the practical use at high temperature.

(4) Propagation delay time and max. clock frequency

As the propagation delay time may be regarded as the time for charging and discharging the internal capacitance and load capacitance of ON resistance of FET, the propagation delay time is considered to be equivalent to the temperature coefficient of ON resistance. Therefore, the temperature coefficient becomes approx. $0.4\%/^{\circ}\text{C}$, while, in the neighborhood of 85°C , t_{PLH} and t_{PHL} increase by approx. 25% to the normal temperature value. on the contrary, the max. clock frequency decreases by approx. 25%.

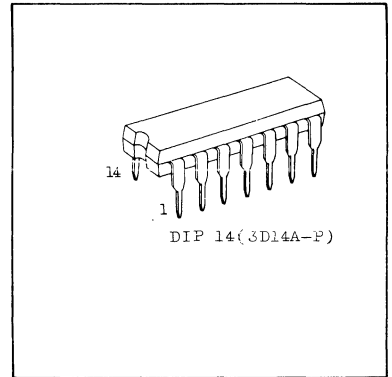
DATA SHEETS



TC4000BP DUAL 3-INPUT NOR GATE PLUS INVERTER

The TC4000BP is a combined gate which contains dual 3-input positive NOR gate plus inverter in one package.

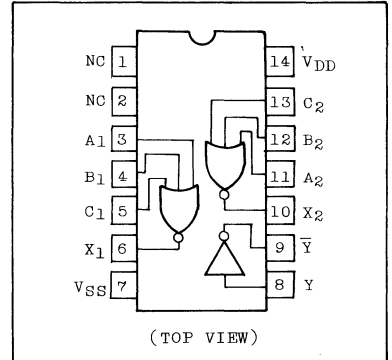
Since all the outputs of this gate are provided with the buffers of inverters, the input/output transmission characteristics have been improved and the noise immunity has been elevated. Thus, an increase in propagation delay time caused by an increase in load capacity is kept to a minimum.



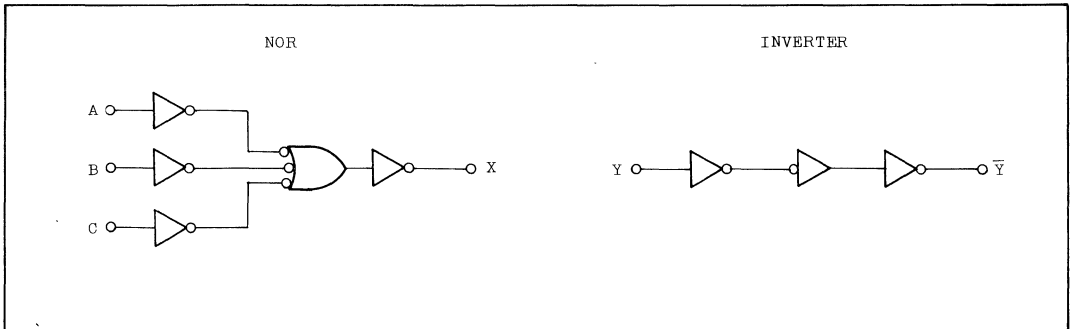
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC400BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

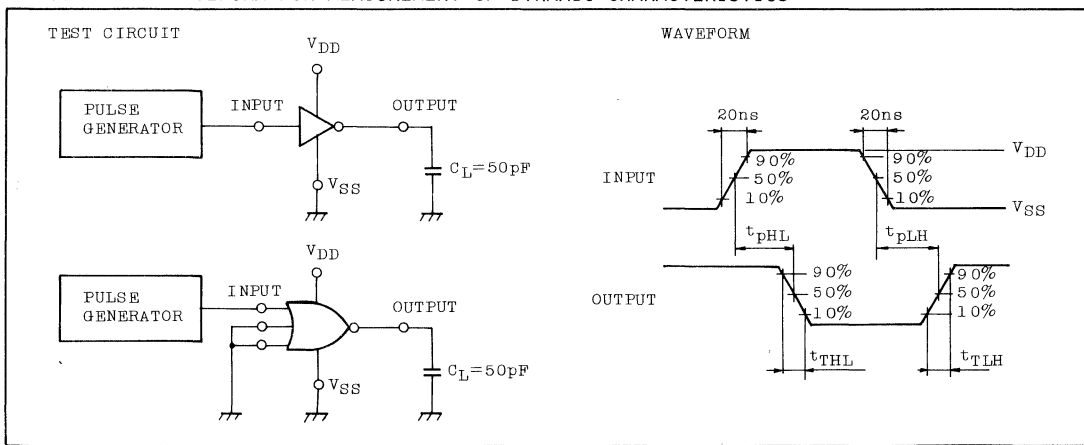
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10-5	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10-5	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

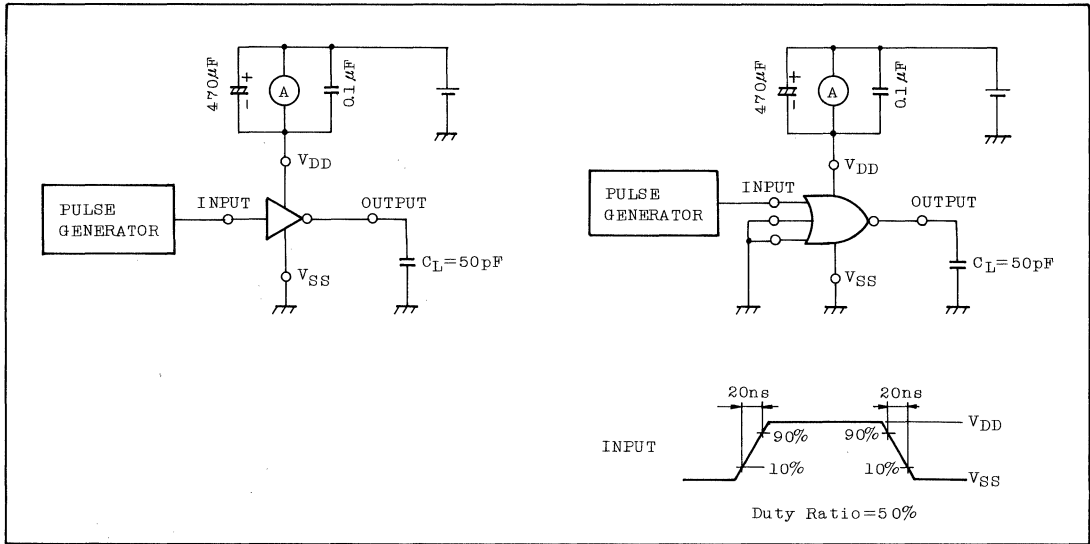
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
			5				
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
INVERTER	Propagation Delay Time (Low to High)	t _{pLH}	5	-	90	180	ns
			10	-	50	100	
			15	-	40	80	
	Propagation Delay Time (High to Low)	t _{pHL}	5	-	90	180	
			10	-	50	100	
			15	-	40	80	
NOR	Propagation Delay Time (Low to High)	t _{pLH}	5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
	Propagation Delay Time (High to Low)	t _{pHL}	5	-	100	200	
			10	-	50	100	
			15	-	40	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUITS AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

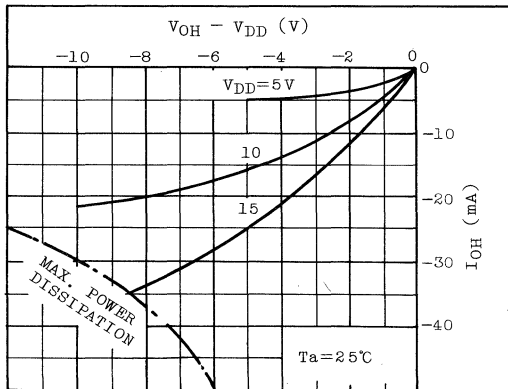


TC4000BP

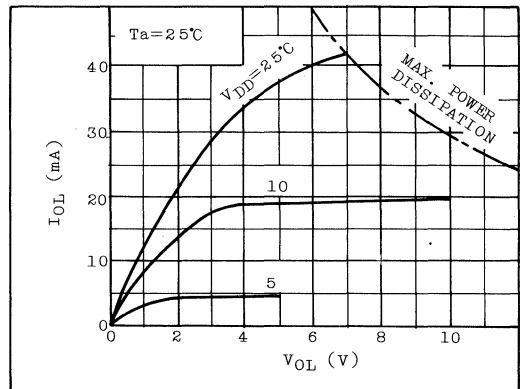
OPERATING SUPPLY CURRENT TEST CIRCUIT



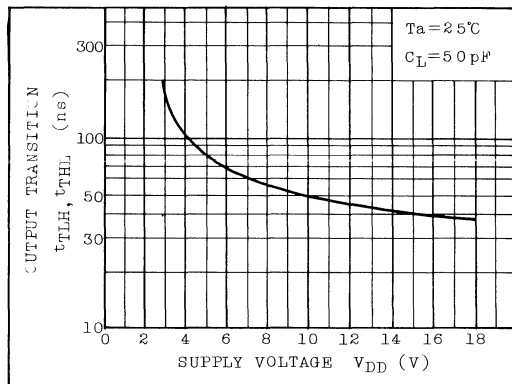
$I_{OH} - V_{OH}$ (TYP.)



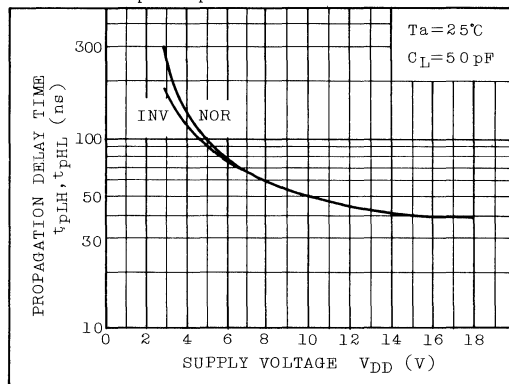
$I_{OL} - V_{OL}$ (TYP.)



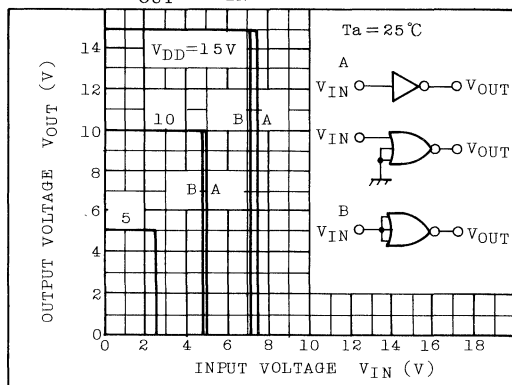
$t_{TLH}, t_{THL} - V_{DD}$ (TYP.)



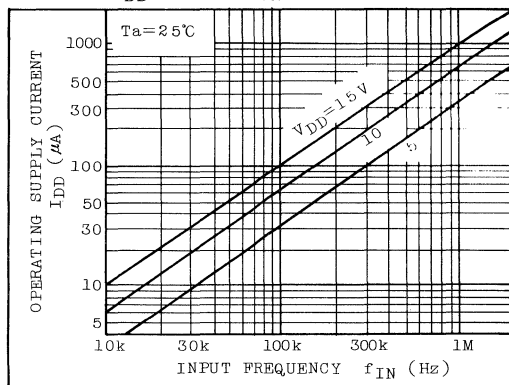
$t_{pLH}, t_{pHL} - V_{DD}$ (TYP.)



$V_{OUT} - V_{IN}$ (TYP.)



$I_{DD}/\text{GATE} - f_{IN}$ (TYP.)



TC4001BP/BF, TC4002BP/BF, TC4025BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4001BP/TC4001BF QUAD 2 INPUT NOR GATE
TC4002BP/TC4002BF DUAL 4 INPUT NOR GATE
TC4025BP/TC4025BF TRIPLE 3 INPUT NOR GATE

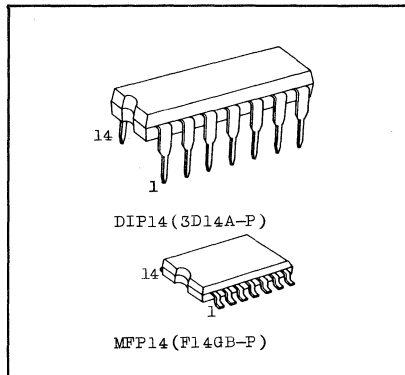
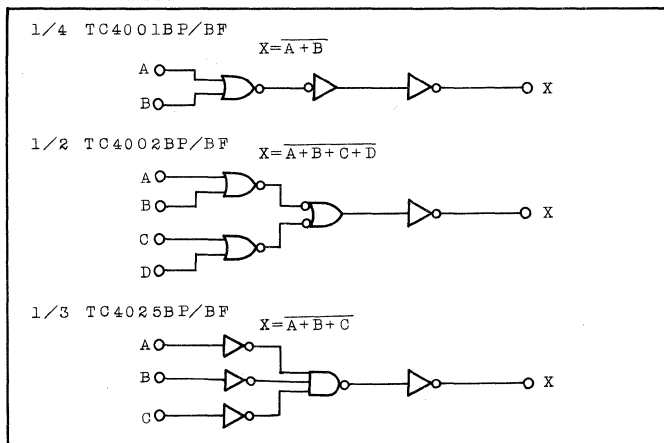
The TC4001BP/BF, the TC4025BP/BF and TC4002BP/BF are 2-input, 3-input, 4-input positive NOR gate, respectively.

Since the outputs of these gates are equipped with the buffers, the input/output transmission characteristics have been improved and the variation of transmission time due to an increase in the load capacity is kept minimum.

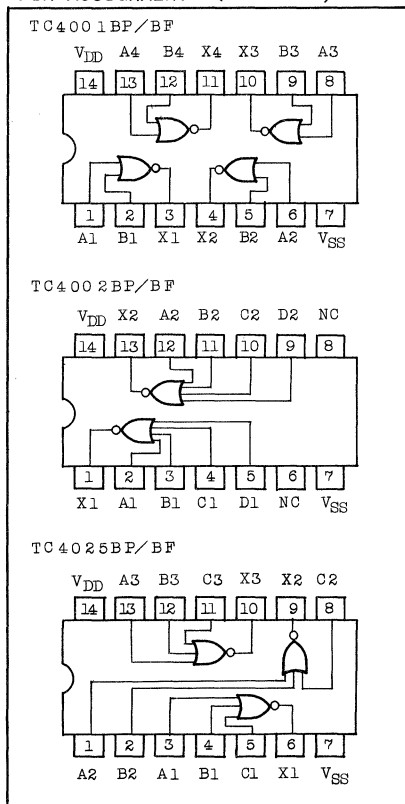
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

LOGIC DIAGRAM



PIN ASSIGNMENT (TOP VIEW)



TC4001BP/BF, TC4002BP/BF, TC4025BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTICS	SYMBOL		MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

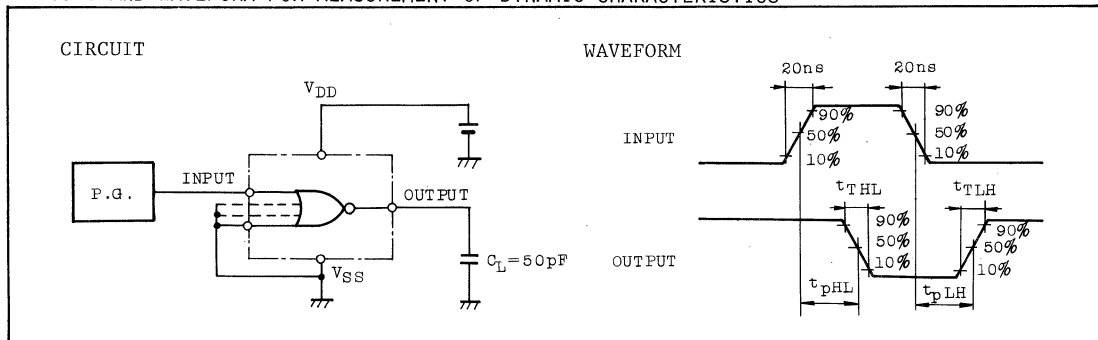
* All valid input combinations.

TC4001BP/BF, TC4002BP/BF, TC4025BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNITS
			5				
Output Transition Time (TC4002BP/BF)	t_{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4002BP/BF)	t_{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4001BP/BF), (TC4025BP/BF)	t_{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4001BP/BF), (TC4025BP/BF)	t_{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (TC4001BP/BF)	t_{pLH}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4001BP/BF)	t_{pHL}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time, (TC4002BP/BF)	t_{pLH}		5	-	100	250	
			10	-	40	120	
			15	-	30	90	
Propagation Delay Time, (TC4002BP/BF)	t_{pHL}		5	-	100	250	
			10	-	40	120	
			15	-	30	90	
Propagation Delay Time (TC4025BP/BF)	t_{pLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (TC4025BP/BF)	t_{pHL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Input Capacitance	CIN			-	5	7.5	pF

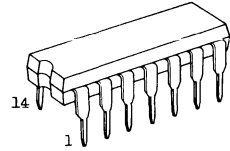
CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4001UBP QUAD 2 INPUT NOR GATE
TC4011UBP QUAD 2 INPUT NAND GATE

TC4001UBP and TC4011UBP are 2 input NOR gate and 2 input NAND gate respectively. The pin connections are same as TC4001BP and TC4011BP but the internal circuits consist of only basic NAND (NOR) circuit without the waveform shaping inverters.

Therefore, these are suitable for the applications in linear circuits such as oscillator circuits and amplifier circuits, and these have advantage in the applications of logical processing systems with faster operating speed.

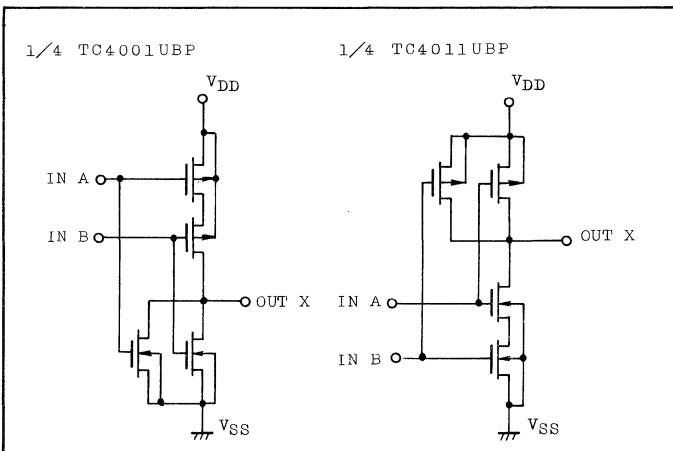


DIP14(3D14A-P)

ABSOLUTE MAXIMUM RATINGS

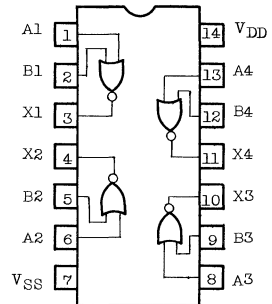
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

LOGIC DIAGRAM

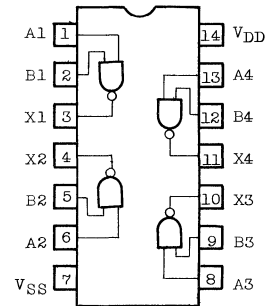


PIN ASSIGNMENT

TC4001UBP



TC4011UBP



(TOP VIEW)

TC4001UBP, TC4011UBP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	4.0	-	4.0	3.0	-	4.0	-	V	
			10	8.0	-	8.0	6.5	-	8.0	-		
			15	12.0	-	12.0	9.5	-	12.0	-		
			15	12.0	-	12.0	9.5	-	12.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.0	1.0	-	1.0	V	
			10	-	2.0	-	3.5	2.0	-	2.0		
			15	-	3.0	-	5.5	3.0	-	3.0		
			15	-	3.0	-	5.5	3.0	-	3.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

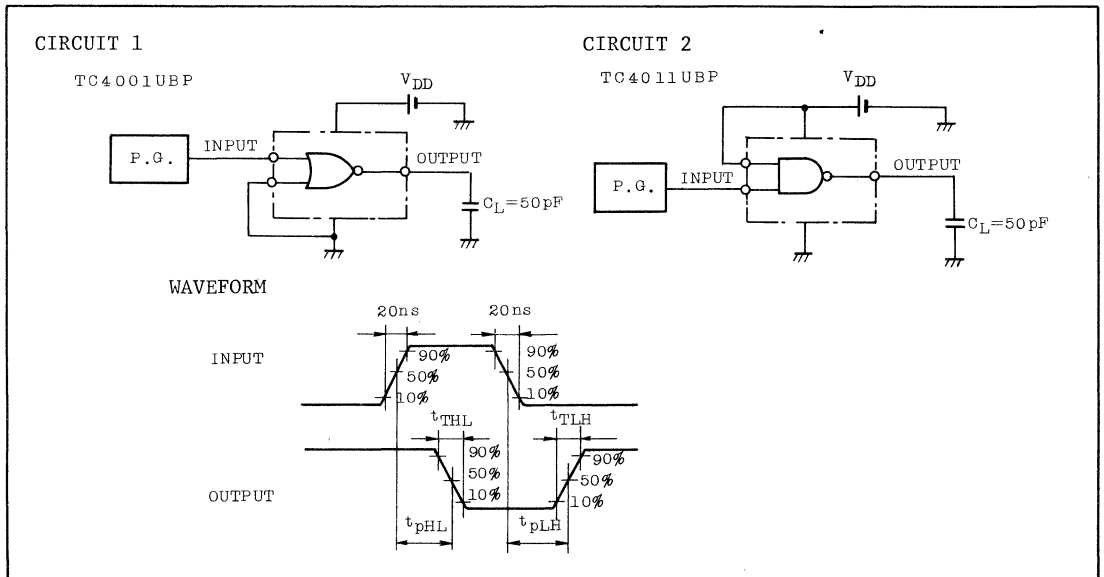
* All valid input combinations.

TC4001UBP, TC4011UBP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (TC4001UBP)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4001UBP)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4011UBP)	t _{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4011UBP)	t _{THL}		5	-	60	200	
			10	-	25	100	
			15	-	20	80	
Propagation Delay Time (TC4001UBP)	t _{pLH}		5	-	50	120	
	t _{pHL}		10	-	25	60	
			15	-	20	50	
Propagation Delay Time (TC4011UBP)	t _{pLH}		5	-	50	110	
	t _{pHL}		10	-	28	60	
			15	-	22	50	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTIC



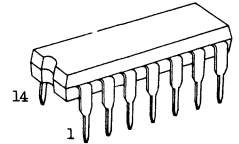
TC4006BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4006BP 18-STAGE STATIC SHIFT REGISTER

TC4006BP is static shift register of 18 bits maximum which consists of two 4 bit shift registers and two 5 bit shift registers, and the clock is supplied from the common **CLOCK** input for all the shift registers, Since 5 bit shift register is provided with 4 bit output D_{n+4} in addition to serial data output D_{n+5} , the shift register with arbitrary number of stages of 4,5,8,9,10,12,13,14,16,17 and 18 can be obtained by the combination of inputs and outputs of 4 bit and 5 bit shift registers.

Each register is shifted by the falling edge of **CLOCK**.

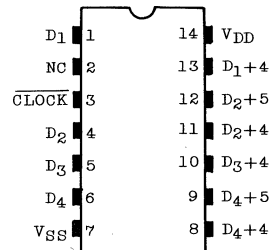


DIP 14(3D14A-F)

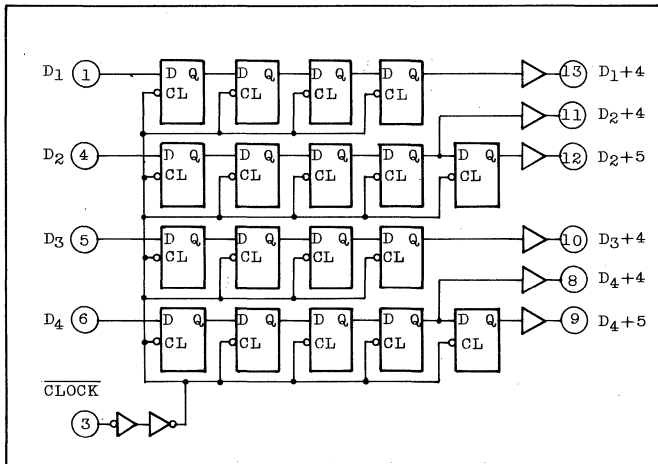
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE (SINGLE STAGE)

INPUTS		OUTPUT
D _n	$\overline{\text{CLOCK}}$	D _{n+1}
L		L
H		H
*		D _n

* Don't care

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

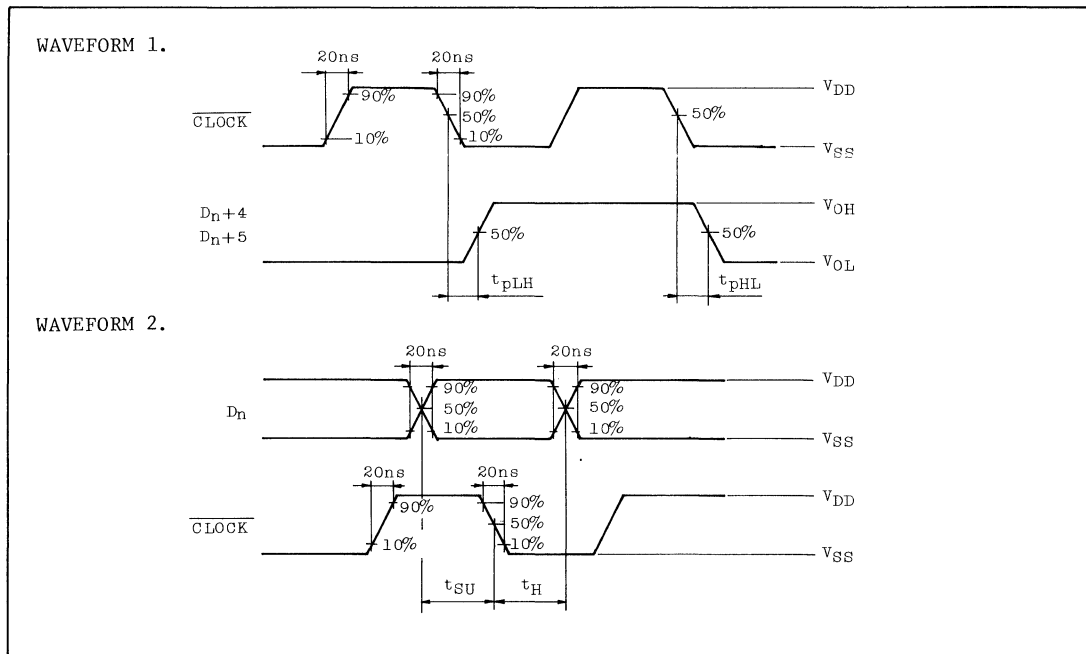
* All valid input combinations.

TC4006BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	tTLH		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	tTHL		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH} t _{pHL}		5	-	170	400	ns
			10	-	75	200	
			15	-	65	160	
Max. Clock Frequency	f _{CL}		5	2.5	8	-	MHz
			10	5	17	-	
			15	7	20	-	
Min. Clock Pulse Width	t _w		5	-	60	180	ns
			10	-	30	80	
			15	-	25	50	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	20	100	ns
			10	-	8	50	
			15	-	5	40	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	-2	60	ns
			10	-	4	40	
			15	-	5	30	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4007UBP/UBF

CMOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4007UBP/TC4007UBF DUAL COMPLEMENTARY PAIR PLUS INVERTER

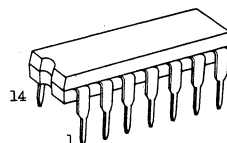
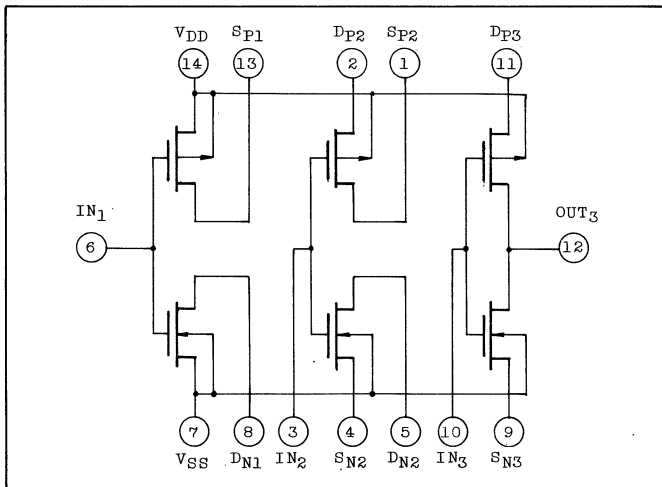
TC4007UBP/UBF contains three elements of P-channel enhancement type MOS FET and three elements of N-channel enhancement type MOS FET. One pair of P-channel and N-channel functions as inverter and remaining two pairs provide the respective outputs of source and drain separately. Depending on how connections are made, the versatile applications such as inverter, waveform shaping circuits, NAND(NOR) gates, linear amplifiers, clocked gates, transmission gates and high fan-out buffers are easily obtainable.

MAXIMUM RATINGS

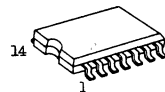
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VDD	VSS-0.5 ~ VSS+20	V
Input Voltage	VIN	VSS-0.5 ~ VDD+0.5	V
Output Voltage*	VOUT	VSS-0.5 ~ VDD+0.5	V
DC Input Current	IIN	±10	mA
Power Dissipation	PD	300(DIP)/180(MFP)	mW
Operating Ambient Temperature Range	TA	-40 ~ 85	°C
Storage Temperature Range	Tstg	-65 ~ 150	°C
Lead Temp./Time	Tsol	260°C · 10 sec	

* Applicable for DP, DN, SP, SN and OUT terminals.

LOGIC DIAGRAM

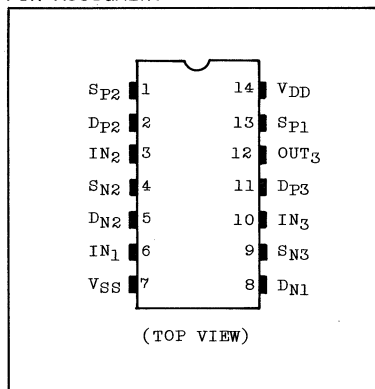


DIP14 (3D14A-P)



MFP14 (F14GB-P)

PIN ASSIGNMENT



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.5	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			5	4.0	-	4.0	3.0	-	4.0	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V |I _{OUT}| < 1μA	5	4.0	-	4.0	3.0	-	4.0	-	V	
			10	8.0	-	8.0	6.5	-	8.0	-		
			15	12.0	-	12.0	9.5	-	12.0	-		
			5	-	1.0	-	3.0	1.0	-	1.0		
Input Low Voltage	V _{IL}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V |I _{OUT}| < 1μA	5	-	1.0	-	3.0	1.0	-	1.0	V	
			10	-	2.0	-	3.5	2.0	-	2.0		
			15	-	3.0	-	5.5	3.0	-	3.0		
			5	-	0.25	-	0.001	0.25	-	7.5		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

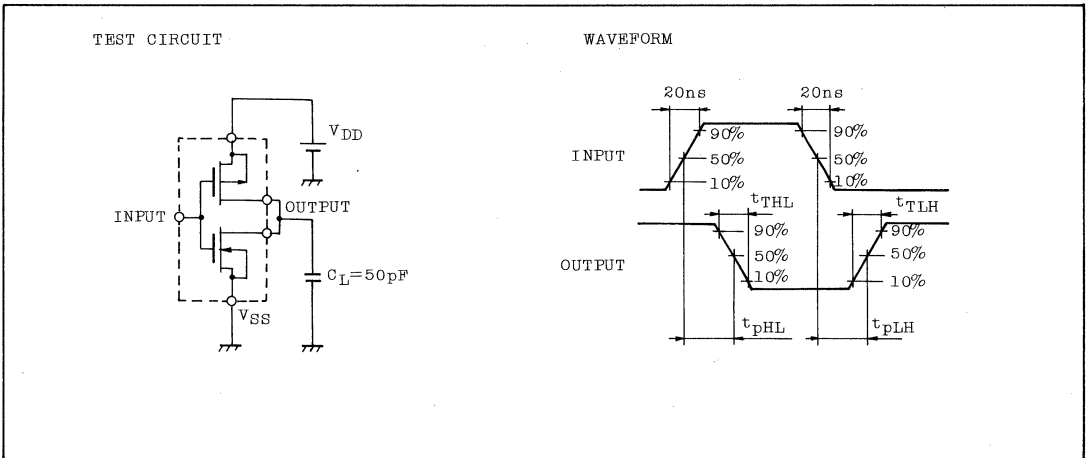
* All valid input combinations.

TC4007UBP/UBF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF, INVERTER)

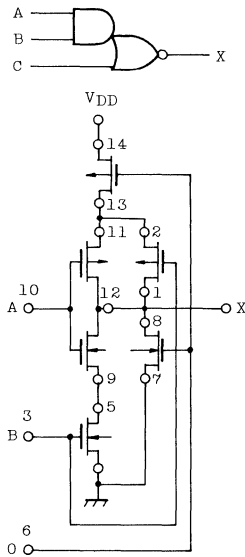
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	180	ns
			10	-	50	90	
			15	-	40	70	
Output Transition Time (High to Low)	t _{THL}		5	-	80	150	ns
			10	-	50	80	
			15	-	40	60	
Propagation Delay Time (Low to High)	t _{pLH}		5	-	55	110	ns
			10	-	25	60	
			15	-	20	50	
Propagation Delay Time (High to Low)	t _{pHL}		5	-	40	110	ns
			10	-	20	60	
			15	-	15	50	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

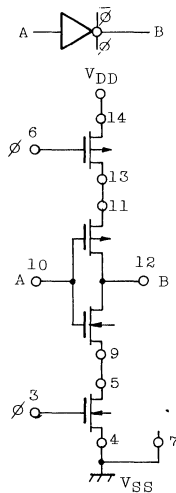


TYPICAL APPLICATION

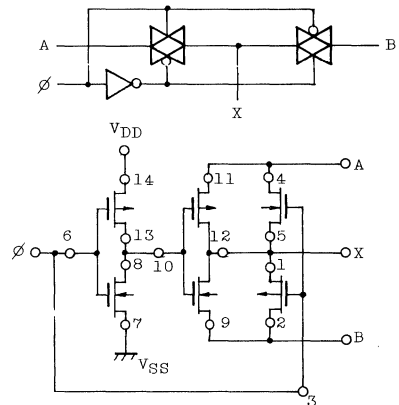
1. TREE LOGIC



2. CLOCKED INVERTER



3. ANALOG DATA SELECTOR



TC4008BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

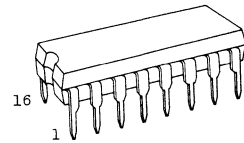
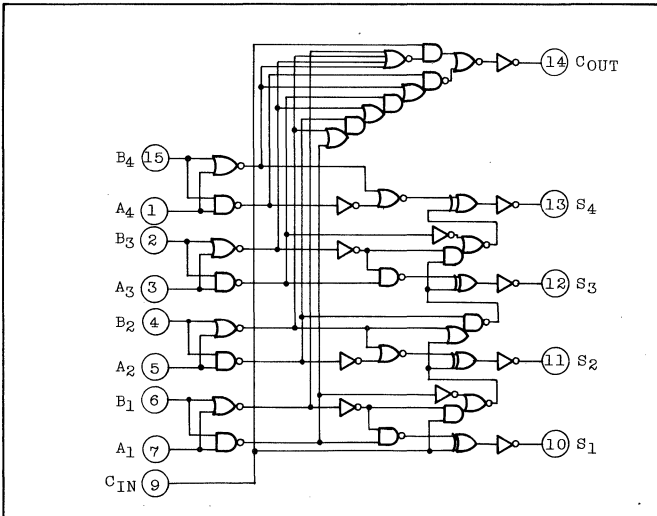
TC4008BP 4-BIT FULL ADDER

TC4008BP is full adder of 4 bit parallel processing type equipped with high speed parallel carry circuit. The sum of binary inputs applied to four augend data input lines (A₁-A₄), four addend data input lines (B₁-B₄) and carry input (C_{IN}) from the lower order is obtained in binary code from added data output (S₁-S₄) and carry output (C_{OUT}) to the higher order. Adders of 4 × n bits with cascade connections and add/subtract circuits with simple external circuits can be easily obtained.

MAXIMUM RATINGS

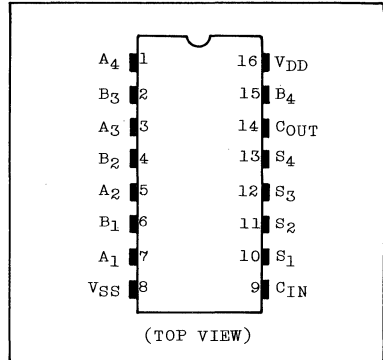
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM

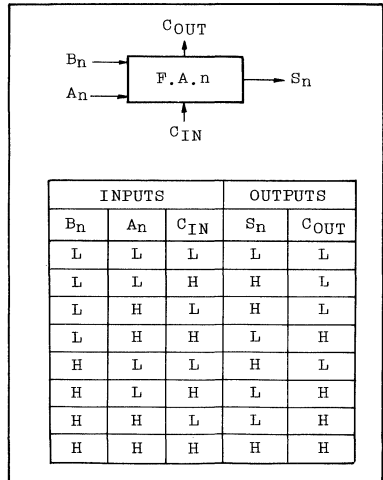


DIP 16(3D16A-P)

PIN ASSIGNMENT



TRUTH TABLE



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} ,V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} ,V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} ,V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} ,V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} ,V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

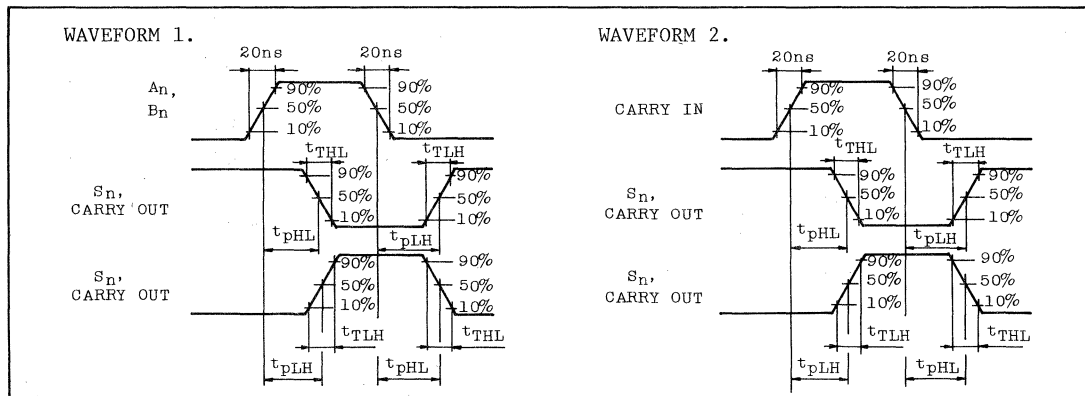
* All valid input combinations.

TC4008BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{GS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A _n , B _n - S _n)	t _{pLH} t _{pHL}		5	-	300	800	ns
			10	-	120	320	
			15	-	80	230	
Propagation Delay Time (A _n , B _n - CARRY OUT)	t _{pLH} t _{pHL}		5	-	270	400	ns
			10	-	110	180	
			15	-	75	130	
Propagation Delay Time (CARRY IN - S _n)	t _{pLH} t _{pHL}		5	-	260	740	ns
			10	-	100	310	
			15	-	70	230	
Propagation Delay Time (CARRY IN - CARRY OUT)	t _{pLH} t _{pHL}		5	-	120	200	ns
			10	-	50	100	
			15	-	40	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



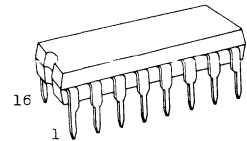
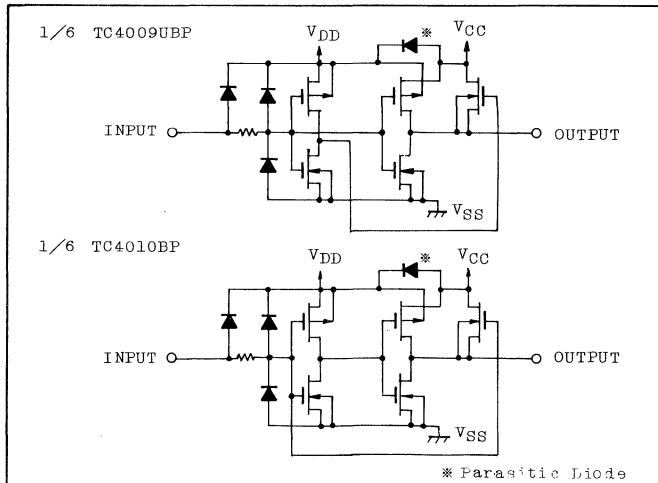
TC4009UBP HEX BUFFER/CONVERTER (INVERTING TYPE)
TC4010BP HEX BUFFER/CONVERTER (NON-INVERTING TYPE)

TC4009UBP and TC4010BP contain six circuits of buffers with the level shift function. TC4009UBP provides inverted outputs and TC4010BP provides non-inverted outputs. Large output current enables to directly drive one TTL/MDTL input. Furthermore, since the logical amplitude of V_{DD} - V_{SS} can be converted to the logical amplitude of V_{CC} - V_{SS} by supplying two separate power supplies with the condition of ($V_{DD} > V_{CC}$), these are suitable for the interface from C²MOS system operating with the power supply voltage of 5 volts or higher to TTL/MDTL system.

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
	V_{CC}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{CC}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Operating Ambient Temperature Range	T_A	-40 ~ 85	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C
Lead Temp./Time	T_{sol}	260°C · 10sec	

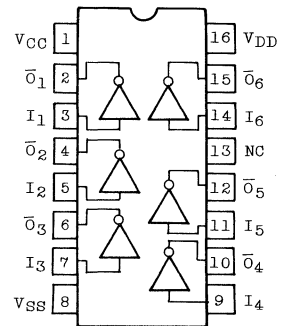
CIRCUIT DIAGRAM



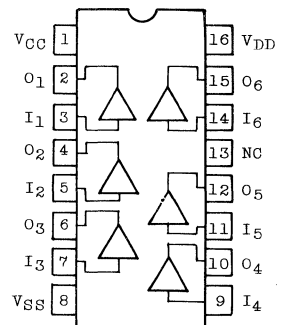
DIP 16(3DI6A-F)

PIN ASSIGNMENT

TC4009UBP



TC4010BP



(TOP VIEW)

TC4009UBP, TC4010BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
	V _{CC}		3	-	V _{DD}	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V, V_{DD}=V_{CC})

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.73	-	-0.65	-1.2	-	-0.58	-	mA
			5	-2.4	-	-2.1	-4.5	-	-1.9	-	
			10	-1.8	-	-1.65	-2.8	-	-1.35	-	
			15	-4.8	-	-4.3	-11	-	-3.5	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	3.8	-	3.2	7	-	2.9	-	mA
			10	9.6	-	8.0	13	-	6.6	-	
			15	25.0	-	24.0	47	-	20.0	-	
Input High Voltage (TC4009UBP)	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V |I _{OUT}| < 1μA	5	4.0	-	4.0	2.5	-	4.0	-	V
			10	8.0	-	8.0	5.0	-	8.0	-	
			15	12.0	-	12.0	7.5	-	12.0	-	
Input Low Voltage (TC4009UBP)	V _{IL}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V |I _{OUT}| < 1μA	5	-	1.0	-	1.7	1.0	-	1.0	V
			10	-	1.5	-	2.3	1.5	-	1.5	
			15	-	1.5	-	2.5	1.5	-	1.5	
Input High Voltage (TC4010BP)	V _{IH}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V, V_{DD}=V_{CC})

CHARACTERISTIC		SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Input Low Voltage (TC4010BP)		V _{IL}	V _{OUT} =0.5V	5	-	1.5	-	2.25	1.5	-	1.5	V
			V _{OUT} =1.0V	10	-	3.0	-	4.5	3.0	-	3.0	
			V _{OUT} =1.5V	15	-	4.0	-	6.75	4.0	-	4.0	
			|I _{OUT}| < 1μA									
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current		I _{DD}	**	5	-	1.0	-	0.002	1.0	-	30	μA
			V _{IN} =V _{SS} , V _{DD}	10	-	2.0	-	0.004	2.0	-	60	
			*	15	-	4.0	-	0.008	4.0	-	120	

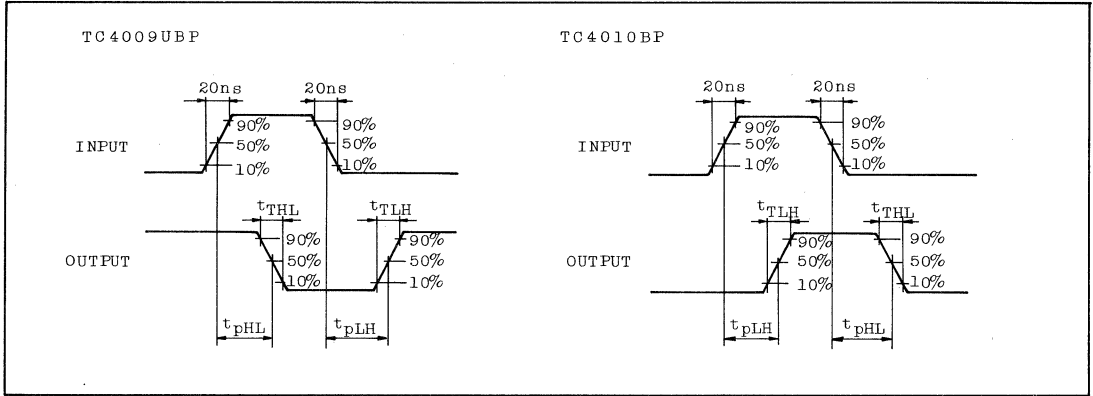
* All valid input combination. ** Include I_{CC}.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF, V_{DD}=V_{CC})

CHARACTERISTIC		SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
				10	-	30	150	
				15	-	20	110	
Output Transition Time (High to Low)		t _{THL}		5	-	25	70	ns
				10	-	15	40	
				15	-	12	30	
TC4009UBP	Propagation Delay Time (Low to High)	t _{pLH}		5	-	40	140	ns
				10	-	25	80	
				15	-	15	60	
TC4010BP	Propagation Delay Time (High to Low)	t _{pHL}		5	-	25	60	ns
				10	-	15	40	
				15	-	15	30	
TC4010BP	Propagation Delay Time (Low to High)	t _{pLH}		5	-	45	200	ns
				10	-	25	100	
				15	-	15	70	
TC4010BP	Propagation Delay Time (High to Low)	t _{pHL}		5	-	50	130	ns
				10	-	25	70	
				15	-	15	50	
Input Capacitance		C _{IN}	TC4009UBP		-	15	22.5	pF
			TC4010BP		-	5	7.5	

TC4009UBP, TC4010BP

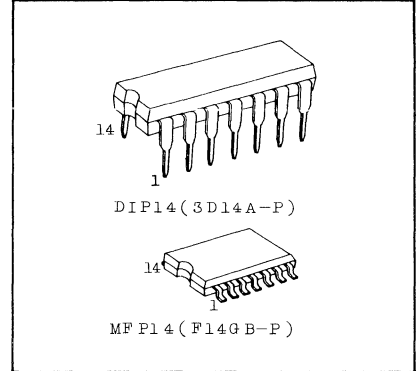
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4011BP/TC4011BF QUAD 2 INPUT NAND GATE
TC4012BP/TC4012BF DUAL 4 INPUT NAND GATE
TC4023BP/TC4023BF TRIPLE 3 INPUT NAND GATE

The TC4011BP/BF, TC4023BP/BF, and TC4012BP/BF are 2-input, 3-input, and 4-input positive logic NAND gates respectively.

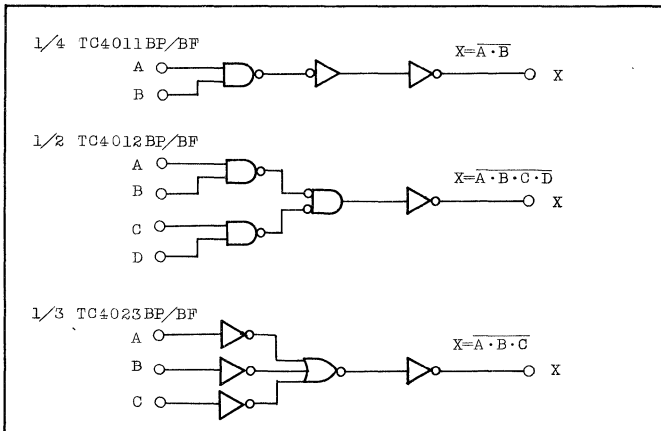
Since all the outputs of these gates are provided with the inverters as buffers, the input/output characteristics have been improved and the variation of propagation delay time due to the increase in load capacity is kept down to the minimum.



ABSOLUTE MAXIMUM RATINGS

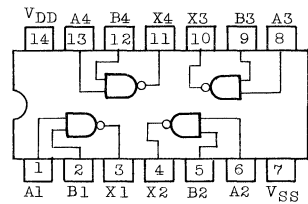
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

LOGIC DIAGRAM

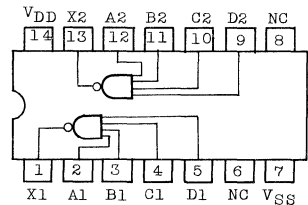


PIN ASSIGNMENT (TOP VIEW)

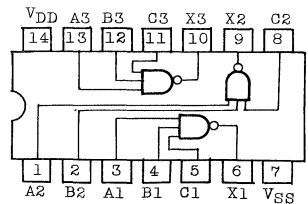
TC4011BP/BF



TC4012BP/BF



TC4023BP/BF



TC4011BP/BF, TC4012BP/BF, TC4023BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	0.61	-	0.51	1.2	-	0.42	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	3.5	-	3.5	2.75	-	3.5	-		
Input Low Voltage	V _{IL}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

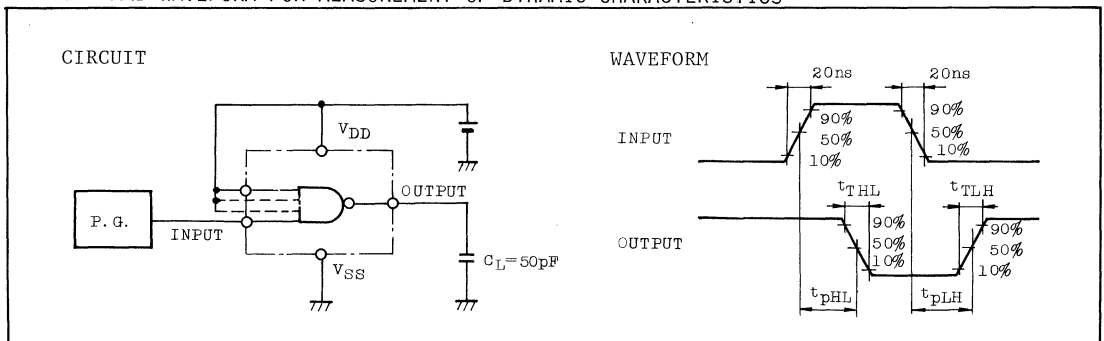
* All valid input combinations.

TC4011BP/BF, TC4012BP/BF, TC4023BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (TC4012BP/BF)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4012BP/BF)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4011BP/BF) (TC4023BP/BF)	t _{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4011BP/BF) (TC4023BP/BF)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (TC4011BP/BF)	t _{pLH}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4011BP/BF)	t _{pHL}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4012BP/BF)	t _{pLH}		5	-	95	250	
			10	-	45	120	
			15	-	30	90	
Propagation Delay Time (TC4012BP/BF)	t _{pHL}		5	-	95	250	
			10	-	45	120	
			15	-	30	90	
Propagation Delay Time (TC4023BP/BF)	t _{pLH}		5	-	90	250	
			10	-	45	100	
			15	-	35	80	
Propagation Delay Time (TC4023BP/BF)	t _{pHL}		5	-	90	250	
			10	-	45	100	
			15	-	35	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

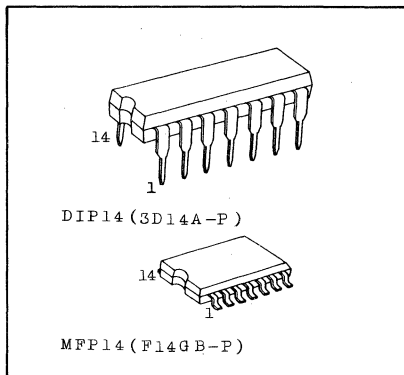


TC4013BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4013BP/TC4013BF DUAL D-TYPE FLIP FLOP

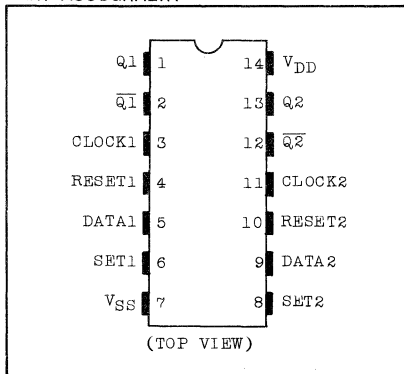
TC4013BP/BF contains two independent circuits of D type flip-flop. The input level applied to DATA input are transferred to Q and \bar{Q} output by rising edge of the clock pulse. When SET input is placed at "H", and RESET input is placed at "L", outputs become Q="H", and \bar{Q} ="L". When RESET input is placed at "H", and SET input is placed at "L", outputs become Q="L", and \bar{Q} ="H". When both of RESET input and SET input are at "H", outputs become Q="H" and \bar{Q} ="H".



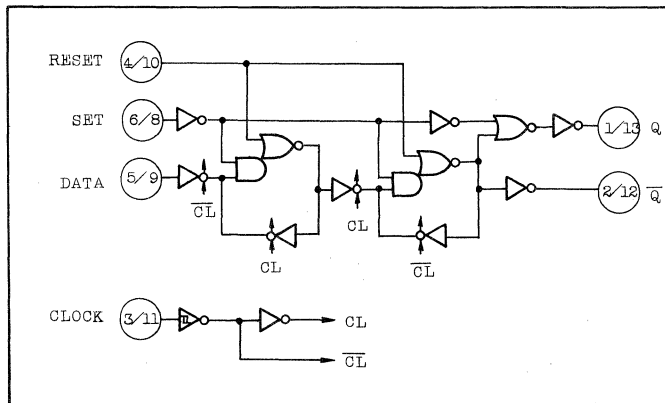
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _{opr}	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

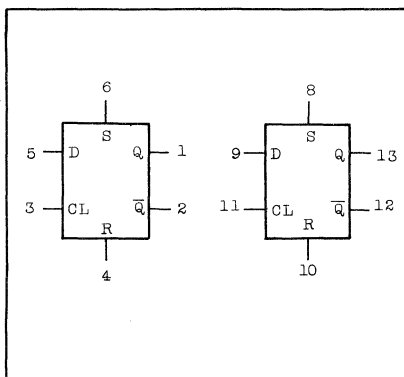
PIN ASSIGNMENT



LOGIC DIAGRAM



BLOCK DIAGRAM



TRUTH TABLE

INPUTS				OUTPUTS		*: Don't care Δ: Level Change •: No change
RESET	SET	DATA	CLOCKA	Q _{n+1}	Q̄ _{n+1}	
L	H	*	*	H	L	
H	L	*	*	L	H	
H	H	*	*	H	H	
L	L	L		L	H	
L	L	H		H	L	
L	L	*		Q _n •	Q̄ _n •	

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA
			10	1.5	-	1.3	3.2	-	1.1	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	

TC4013BP/BF

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA	
			10	-	2	-	0.004	2	-	60		
			15	-	4	-	0.008	4	-	120		

* All valid input combinations.

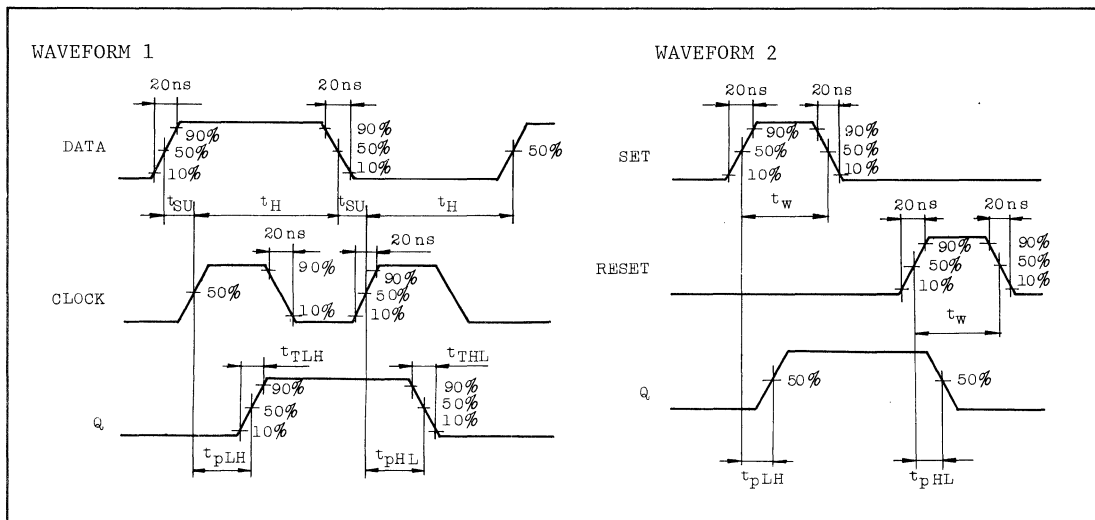
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - Q, \bar{Q})	t _{pLH} t _{pHL}		5	-	130	300	ns
			10	-	65	130	
			15	-	50	90	
Propagation Delay Time (SET, RESET - Q, \bar{Q})	t _{pLH}		5	-	110	300	
			10	-	50	130	
			15	-	40	90	
Propagation Delay Time (SET, RESET - Q, \bar{Q})	t _{pHL}		5	-	110	300	
			10	-	50	130	
			15	-	40	90	
Max. Clock Frequency	f _{CL}		5	3.5	8	-	MHz
			10	8	16	-	
			15	12	20	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Pulse Width (SET, RESET)	t _w		5	-	60	180	
			10	-	30	80	
			15	-	25	50	
Min. Clock Pulse Width	t _w		5	-	60	140	ns
			10	-	30	60	
			15	-	25	40	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
			5				
Min. Set-up Time (DATA - CLOCK)	t _{su}		5	-	-	40	ns
			10	-	-	20	
			15	-	-	15	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	20	40	
			10	-	10	20	
			15	-	6	15	
Min. Removal Time (SET, RESET - CLOCK)	t _{rem}		5	-	-	40	
			10	-	-	20	
			15	-	-	15	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4014BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

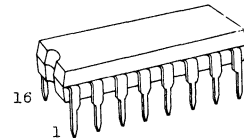
TC4014BP 8-STAGE STATIC SHIFT REGISTER (SYNCHRONOUS PARALLEL OR SERIAL INPUT/SERIAL OUTPUT)

TC4014BP is 8 stage shift register having PARALLEL IN/SERIAL OUT operation, which can also perform SERIAL IN/SERIAL OUT operation. In both parallel operation and serial operation, the input data is obtained on the output of each F/F by rising edge of CLOCK input. (SYNCHRONOUS PARALLEL OR SYNCHRONOUS SERIAL INPUT)

Switching of parallel operation and serial operation is achieved by P/ \bar{S} CONTROL input. PARALLEL operation is performed when P/ \bar{S} CONTROL is "H" and SERIAL operation is performed when it is "L".

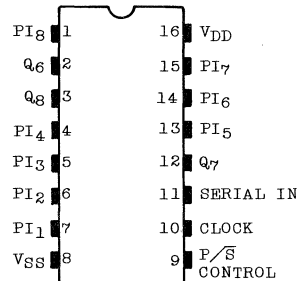
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	



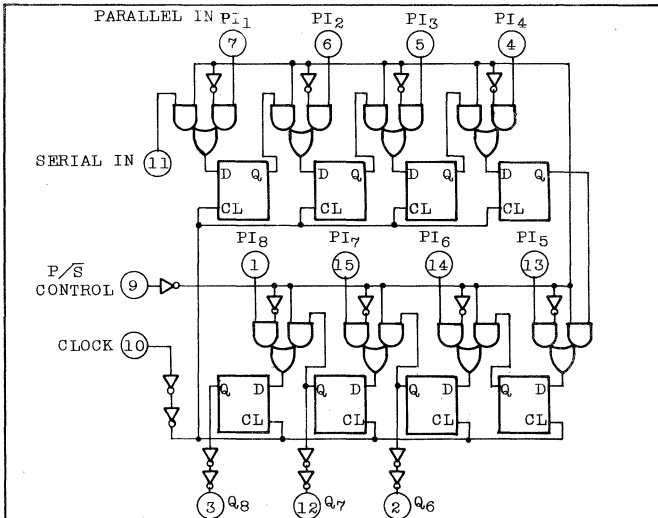
DIP 16(3D16A-F)

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

CLOCK	INPUTS				OUTPUTS Δ	
	P/ \bar{S}	PI ₁	PI _n	SI	Q ₁	Q _n
	L	*	*	L	L	Q _{n-1}
	L	*	*	H	H	Q _{n-1}
	H	L	L	*	L	L
	H	H	L	*	H	L
	H	L	H	*	L	H
	H	H	H	*	H	H
	*	*	*	*	No Change	

n ; 2~8
 Δ ; Q₁~Q₅=Internal
 $\Delta\Delta$; Level Change
 * ; Don't Care

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} ,V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} ,V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} ,V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} ,V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V,4.5V V _{OUT} =1.0V,9.0V V _{OUT} =1.5V,13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V,4.5V V _{OUT} =1.0V,9.0V V _{OUT} =1.5V,13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} ,V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

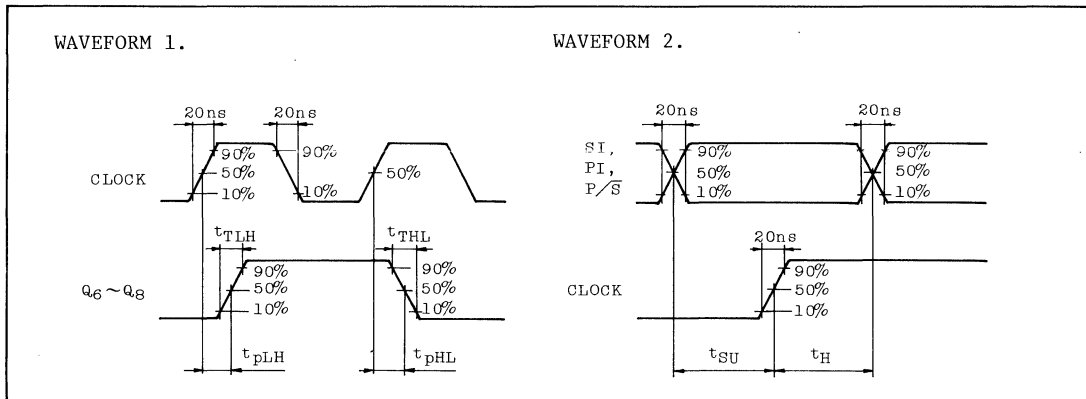
* All valid input combinations.

TC4014BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	160	320	ns
			10	-	70	160	
			15	-	50	120	
Max. Clock Frequency	f _{CL}		5	3	7.5	-	MHz
			10	6	20	-	
			15	8.5	26	-	
Min. Clock Pulse Width	t _w		5	-	65	180	ns
			10	-	25	80	
			15	-	20	50	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Set-Up Time (SI - CLOCK)	t _{SU}		5	-	40	120	ns
			10	-	15	80	
			15	-	10	60	
Min. Set-Up Time (PI - CLOCK)	t _{SU}		5	-	35	80	ns
			10	-	15	50	
			15	-	10	40	
Min. Set-Up Time (P/S - CLOCK)	t _{SU}		5	-	80	180	ns
			10	-	30	80	
			15	-	20	60	
Min. Hold Time (SI, PI, - CLOCK) P/S	t _H		5	-	-10	60	ns
			10	-	-2	30	
			15	-	0	20	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



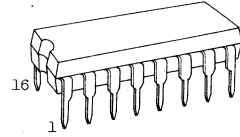
TC4015BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

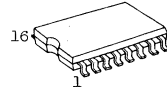
TC4015BP/TC4015BF DUAL 4-STAGE STATIC SHIFT REGISTER (With Serial Input/Parallel Output)

TC4015BP/BF contains two circuits of 4 stage shift registers and the independent output is derived from each stage. As all the D type flip-flops of every stage have common RESET input, asynchronous clear operation can be achieved by an external signal at arbitrary timing. The flip-flop of each stage is triggered by rising edge of CLOCK input.

RESET input of "H" level resets the contents of all the stages to "L" regardless of CLOCK and DATA inputs and all of data outputs Q1 through Q4 become "L". This can be used for converting serial data to parallel one and for ring counters of any numbering systems.



DIP16(3D16A-P)

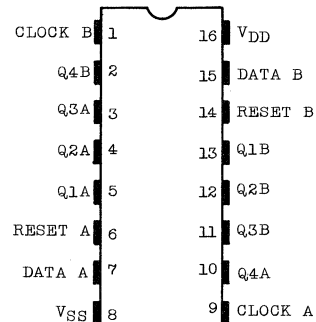


-MFP16(P16GC-P)

ABSOLUTE MAXIMUM RATINGS

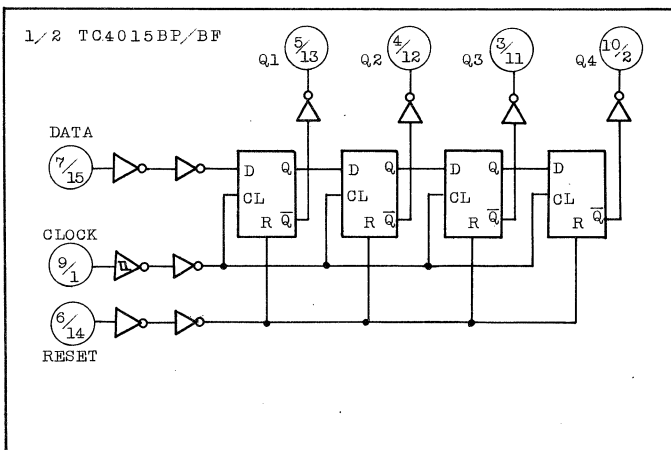
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

INPUTS			OUTPUTS			
CLOCK Δ	DATA	RESET	Q1	Q2	Q3	Q4
	L	L	Q1	Q2	Q3	Q4
	H	L	H	Q1	Q2	Q3
	*	L	NO CHANGE			
*	*	H	L	L	L	L

Δ : LEVEL CHANGE
* : DON'T CARE

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.2	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.2	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	12.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
		V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-	V	
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

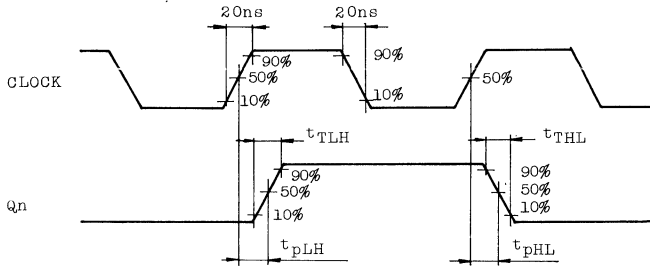
TC4015BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

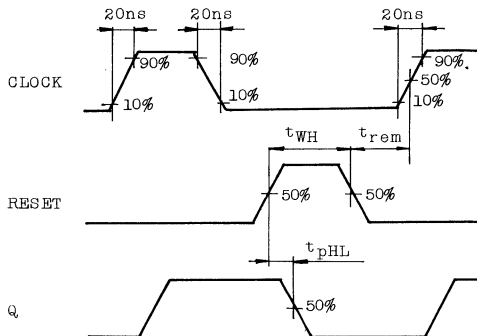
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD	MIN.	TYP.	MAX.	UNITS
			(V)				
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	130	320	
			10	-	60	160	
			15	-	50	120	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	90	400	
			10	-	45	200	
			15	-	40	160	
Max. Clock Frequency	f _{CL}		5	3	8	-	MHz
			10	6	17	-	
			15	8.5	20	-	
Min. Clock Pulse Width	t _W		5	-	35	180	ns
			10	-	25	80	
			15	-	20	50	
Min. Pulse Width (RESET)	t _{WH}		5	-	50	200	
			10	-	25	80	
			15	-	20	60	
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	8	70	
			10	-	4	40	
			15	-	0	30	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	6	60	
			10	-	5	30	
			15	-	4	20	
Min. Removal Time (RESET - CLOCK)	t _{rem}		5	-	0	80	
			10	-	0	30	
			15	-	0	20	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5 10 15	No Limit			μs
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

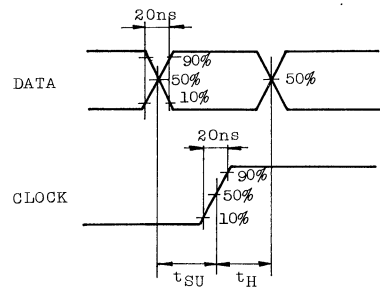
WAVEFORM 1



WAVEFORM 2



WAVEFORM 3



TC4016BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4016BP/TC4016BF QUAD BILATERAL SWITCH

TC4016BP/BF contains for circuits of independent bidirectional switches. When control input CONT is placed at "H" level, the impedance between the input and output of switch becomes low and when CONT is placed at "L" level, it becomes high. This can be used for switching analog and digital signals.

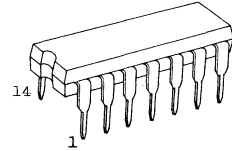
Resistance during ON, R_{ON}

$$2.5 \times 10^2 \Omega (\text{TYP.}) \dots\dots V_{DD} - V_{SS} = 10V$$

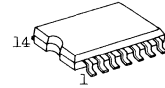
$$1.5 \times 10^2 \Omega (\text{TYP.}) \dots\dots V_{DD} - V_{SS} = 15V$$

Resistance during OFF, R_{OFF}

$$R_{OFF} (\text{TYP.}) > 10^9 \Omega$$



DIP14 (3D14A-P)

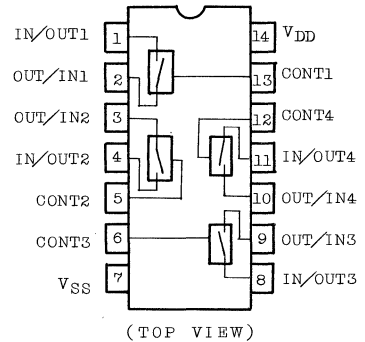


MFP14 (F14GB-P)

ABSOLUTE MAXIMUM RATINGS

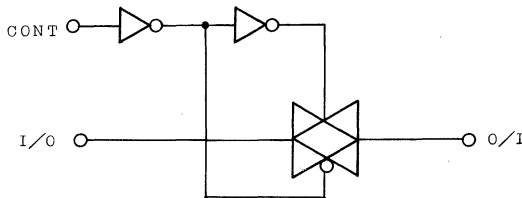
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Control Input Voltage	V_{CIN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Switch I/O Voltage	$V_{I/O}$	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Control Input Current	I_C	± 10	mA
Power Dissipation	P_D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



LOGIC DIAGRAM

(1/4 TC4016BP/BF)



TRUTH TABLE

CONTROL	IMPEDANCE BETWEEN IN/OUT - OUT/IN *
H	$1 \sim 20 \times 10^2 \Omega$
L	$> 10^9 \Omega$

* SEE STATIC ELECTRICAL CHARACTERISTICS

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input/Output Voltage	V _{IN} /V _{OUT}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (In case not specifically appointed, V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{SS} (V)	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Control Input High Voltage	V _{IH}	|I _{is}|=10μA		5	3.5	-	3.5	2.4	-	3.5	-	V	
				10	7.0	-	7.0	4.8	-	7.0	-		
				15	11.0	-	11.0	7.2	-	11.0	-		
Control Input Low Voltage	V _{IL}	|I _{is}|=10μA		5	-	1.0	-	1.7	1.0	-	1.0	V	
				10	-	1.0	-	1.7	1.0	-	1.0		
				15	-	1.0	-	1.7	1.0	-	1.0		
On-State Resistance	R _{ON}	V _{IN} =5V V _{IN} =2.5V V _{IN} =0.25V		5	-	-	-	300	-	-	-	Ω	
				10	-	-	-	2000	-	-	-		
				15	-	-	-	300	-	-	-		
		V _{IN} =10V V _{IN} =5V V _{IN} =0.25V		10	-	600	-	180	660	-	840		
				10	-	600	-	300	660	-	840		
				10	-	600	-	130	660	-	840		
		V _{IN} =15V V _{IN} =7.5V V _{IN} =0.25V		15	-	370	-	140	400	-	520		
				15	-	370	-	160	400	-	520		
				15	-	370	-	100	400	-	520		
		V _{IN} =5V V _{IN} =±0.25V V _{IN} =-5V		-5	5	-	600	-	180	660	-		840
				-5	5	-	600	-	300	660	-		840
				-5	5	-	600	-	130	660	-		840
V _{IN} =7.5V V _{IN} =±0.25V V _{IN} =-7.5V		-7.5	7.5	-	370	-	140	400	-	520			
		-7.5	7.5	-	370	-	160	400	-	520			
		-7.5	7.5	-	370	-	100	400	-	520			
ΔOn-State Resistance (Between Any 2 Switches)	R _{ON} ^Δ			-5	5	-	-	7	-	-			
				-7.5	7.5	-	-	5	-	-			
Input/Output Leakage Current	I _{OFF}	V _{IN} =18V, V _{OUT} =0V V _{IN} =0V, V _{OUT} =18V		18	-	±100	-	±0.1	±100	-	±1000	nA	
				18	-	±100	-	±0.1	±100	-	±1000		
Quiescent Device Current	I _{DD}	V _{IN} =V _{DD} , V _{SS} *		5	-	0.25	-	0.001	0.25	-	7.5	μA	
				10	-	0.5	-	0.001	0.5	-	15		
				15	-	1.0	-	0.002	1.0	-	30		
Input Current	I _{IH}	V _{IH} =18V		18	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
	I _{IL}	V _{IL} =0V		18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0		

* All valid input combinations.

TC4016BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{SS} (V)		MIN.	TYP.	MAX.	UNITS
			V _{SS} (V)	V _{DD} (V)				
Propagation Delay Time (IN - OUT)	t_{pLH} t_{pHL}	$C_L=50pF$	0	5	-	24	45	ns
			0	10	-	11	15	
			0	15	-	8	12	
Propagation Delay Time (CONTROL - OUT)	t_{pLH} t_{pHL}	$R_L=1k\Omega$ $C_L=50pF$	0	5	-	35	70	ns
			0	10	-	20	40	
			0	15	-	17	30	
Max. Control Input Repetition Rate	f_{MAX} (CONT)	$R_L=1k\Omega$ $C_L=50pF$	0	5	-	10	-	MHz
			0	10	-	12	-	
			0	15	-	12	-	
-3dB Cutoff Frequency	f_{MAX} (I - O)	$R_L=1k\Omega$	-5	5	-	24	-	MHz
		$R_L=2k\Omega$			-	23	-	
		$R_L=10k\Omega$			-	22	-	
		$R_L=100k\Omega$			-	22	-	
		$R_L=1M\Omega$ $C_L=15pF$ (*1)			-	22	-	
Total Harmonic Distortion	-	$R_L=10k\Omega$ $f=1MHz$ (*2)	-5	5	-	0.16	-	%
-50dB Feedthrough Frequency	-	$R_L=1k\Omega$ (*3)	-5	5	-	600	-	kHz
-50dB Crosstalk Frequency	-	$R_L=1k\Omega$ (*4)	-5	5	-	1	-	MHz
Crosstalk (CONTROL - OUT)	-	$R_{IN}=1k\Omega$ $R_{OUT}=10k\Omega$ $C_L=15pF$	0	5	-	50	-	mV
			0	10	-	100	-	
			0	15	-	150	-	
Input Capacitance	C_{IN}	Control Input			-	5	7.5	pF
		Switch I/O			-	5	-	
Feed through Capacitance	C_{IN-OUT}				-	0.5	-	

*1 Sine wave of $\pm 2.5V_{p-p}$ shall be used for V_{is} and the frequency of $20 \log_{10} \frac{V_{os}}{V_{is}} = -3dB$ shall be f_{MAX} .

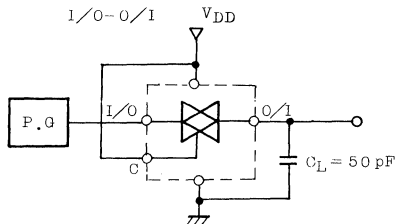
*2 V_{is} shall be sine wave of $\pm 2.5V_{p-p}$.

*3 Sine wave of $\pm 2.5V_{p-p}$ shall be used for V_{is} and the frequency of $20 \log_{10} \frac{V_{os}}{V_{is}} = -50dB$ shall be feed-through.

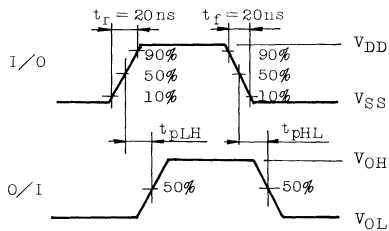
*4 Sine wave of $\pm 2.5V_{p-p}$ shall be used for V_{is} and the frequency of $20 \log_{10} \frac{V_{os}}{V_{is}} = -50dB$ shall be crosstalk.

CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

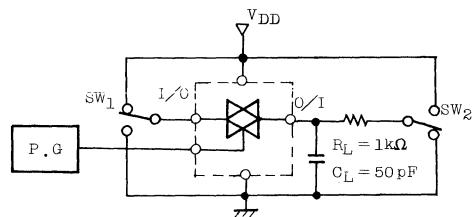
1. t_{pLH} , t_{pHL}



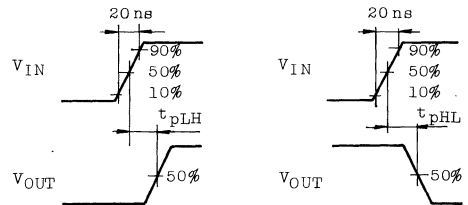
WAVEFORM



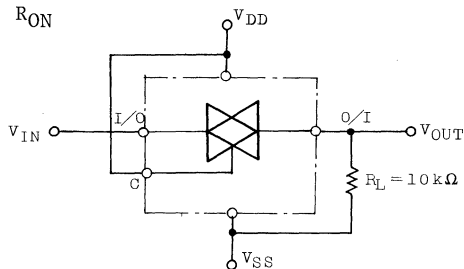
2. t_{pLH} , t_{pHL} (CONTROL - OUT)



WAVEFORM

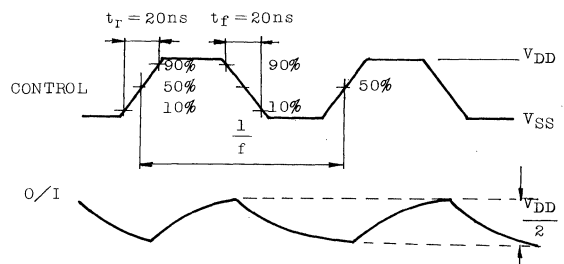
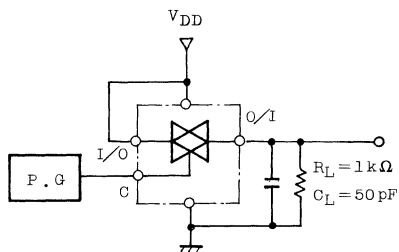


3. R_{ON}



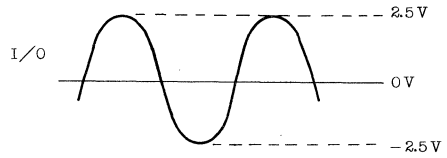
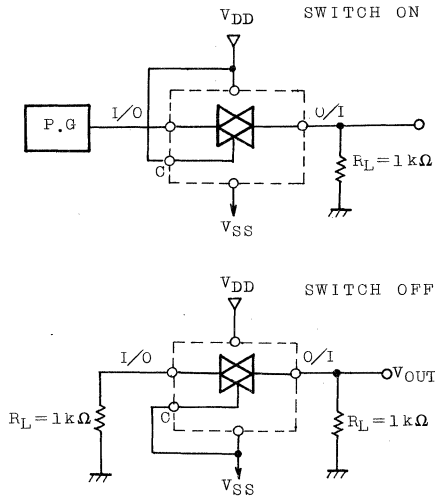
$$R_{ON} = 10 \times \frac{(V_{IN} - V_{OUT})}{V_{OUT}} \text{ (k}\Omega\text{)}$$

4. $f_{MAX}(C)$

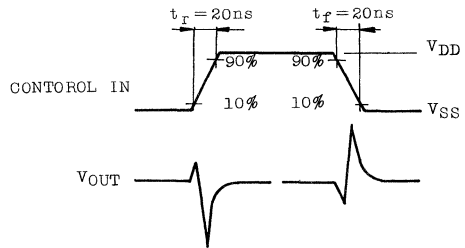
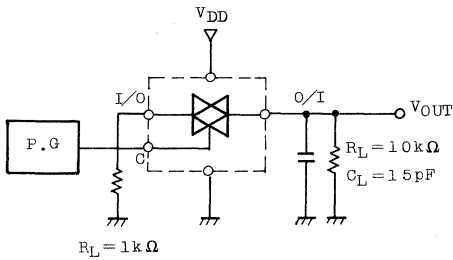


CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

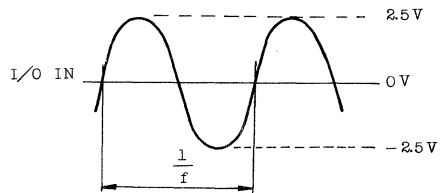
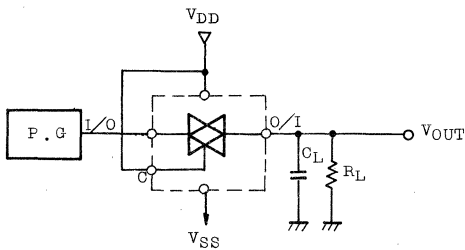
5. CROSSTALK BETWEEN ANY TWO SWITCHES



6. CROSSTALK, CONTROL TO INPUT



7. TOTAL HARMONIC DISTORTION, $f_{MAX}(I-O)$, FEEDTHROUGH



TC4017BP/TC4017BF DECADE COUNTER/DIVIDER

TC4017BP/BF is decimal Johnson counter consisting of 5 stage D-type flip-flop equipped with the decoder to convert the output to decimal.

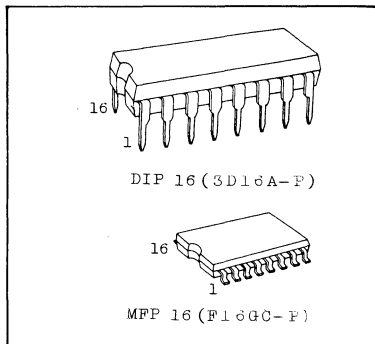
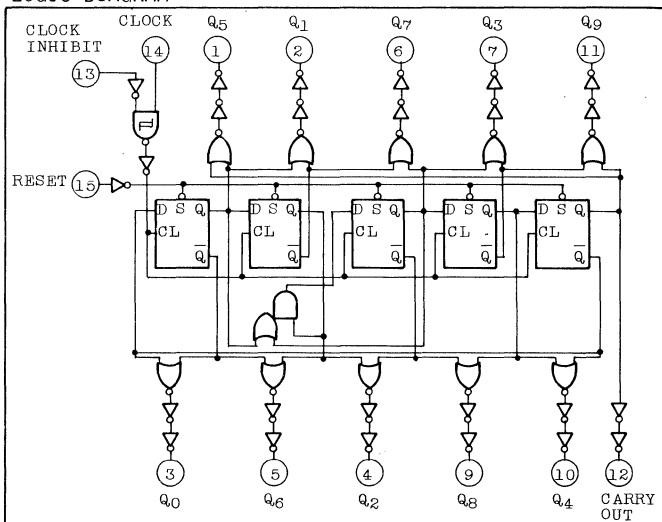
Depending on the number of count pulses fed to CLOCK or CLOCK INHIBIT one output among 10 output lines "Q₀" through "Q₉" becomes "H" level.

The counter advances its state at rising edge of CLOCK (CLOCK INHIBIT="L") or falling edge of CLOCK INHIBIT (CLOCK="H"). RESET input to "H" level resets the counter to Q₀="H" and Q₁ through Q₉="L" regardless of CLOCK and CLOCK INHIBIT.

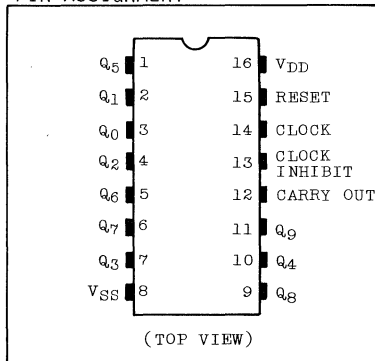
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP)/180 (MFP)	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



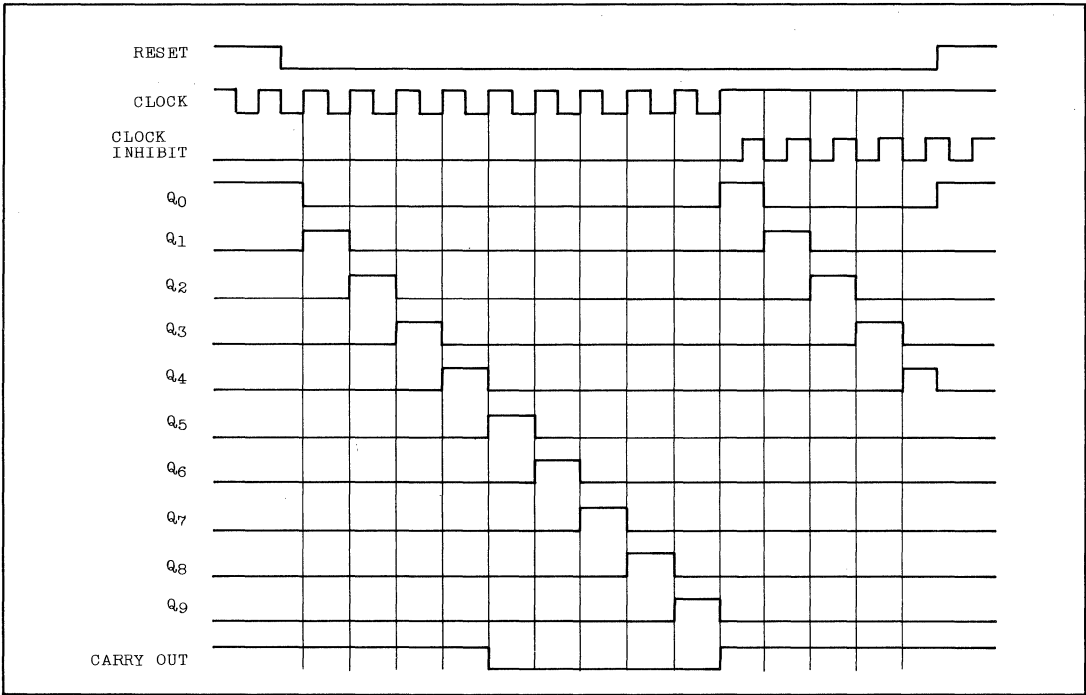
TRUTH TABLE

INPUTS			SELECTED OUTPUT
CLOCK Δ	CLOCK INHIBIT Δ	RESET	
*	*	H	Q ₀
*	H	L	Q _n (NC)
L	*	L	Q _n (NC)
↓	L	L	Q _{n+1}
↓	L	L	Q _n (NC)
H	↓	L	Q _n (NC)
H	↓	L	Q _{n+1}

Δ ; Level Change
 * ; Don't Care
 NC ; No Change
 CARRY OUT { "H" ... Q₀~Q₄="H"
 "L" ... Q₅~Q₉="H"

TC4017BP/BF

TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}		3	-	18	V
Input Voltage	V_{IN}		0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H"Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L"Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combination.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	

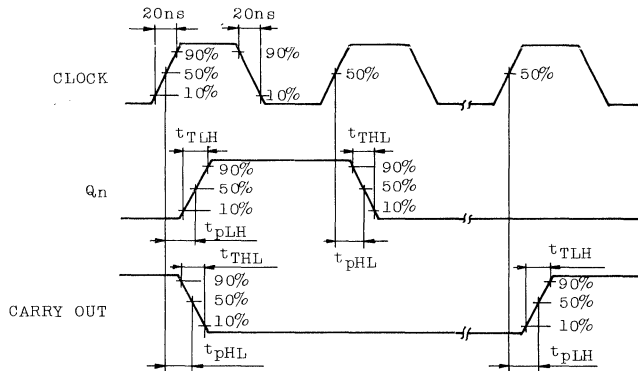
TC4017BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

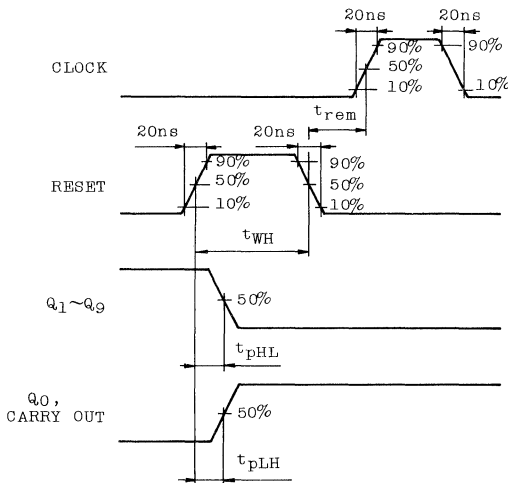
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time (CLOCK - Qn)	t _{pLH} t _{pHL}		5	-	325	650	ns
			10	-	135	270	
			15	-	85	170	
Propagation Delay Time (CLOCK - CARRY OUT)	t _{pLH} t _{pHL}		5	-	280	600	
			10	-	110	250	
			15	-	75	160	
Propagation Delay Time (RESET - Qn RESET - CARRY OUT)	t _{pLH} t _{pHL}		5	-	265	530	
			10	-	115	230	
			15	-	85	170	
Max. Clock Frequency	f _{CL}		5	2.5	6	-	MHz
			10	5	12	-	
			15	6.7	13.5	-	
Min. Clock Pulse Width	t _w		5	-	85	200	ns
			10	-	40	90	
			15	-	35	60	
Min. Pulse Width (RESET)	t _{WH}		5	-	50	260	
			10	-	20	110	
			15	-	15	60	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Set-up Time (CLOCK INHIBIT - CLCOK)	t _{SU}		5	-	30	230	ns
			10	-	15	100	
			15	-	10	70	
Min. Removal Time (RESET - CLOCK)	t _{rem}		5	-	-55	400	ns
			10	-	-20	275	
			15	-	-15	150	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

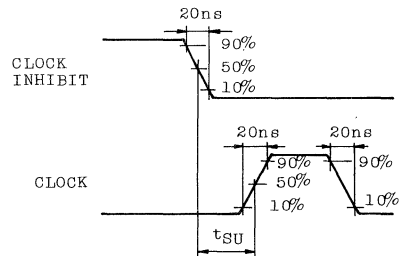
WAVEFORM 1.



WAVEFORM 2.



WAVEFORM 3.



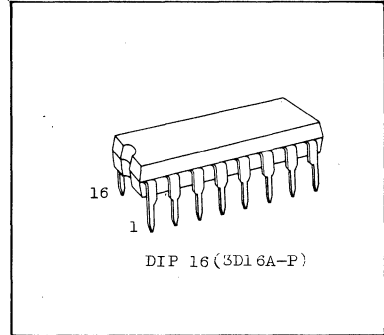
TC4018BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4018BP PRESETTABLE DIVIDE-BY-"N" COUNTER

TC4018BP is frequency division counter consisting of 5 bit Johnson counter having capability of frequency division by the factors of $1/2$, $1/4$, $1/6$, $1/8$ and $1/10$ by connecting outputs \bar{Q}_1 through \bar{Q}_5 to DATA input. Similarly by connecting the outputs of \bar{Q}_1 through \bar{Q}_5 to DATA input through gates, frequency division by the factors of $1/3$, $1/5$, $1/7$ and $1/9$ can be achieved.

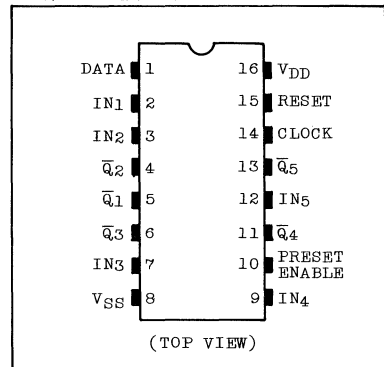
RESET and PRESET are asynchronous type and when RESET="H", all of \bar{Q}_1 through \bar{Q}_5 are "H". When PRESET ENABLE="H", \bar{Q}_n is complement of IN_n . The counter advances its state by rising edge of clock input.



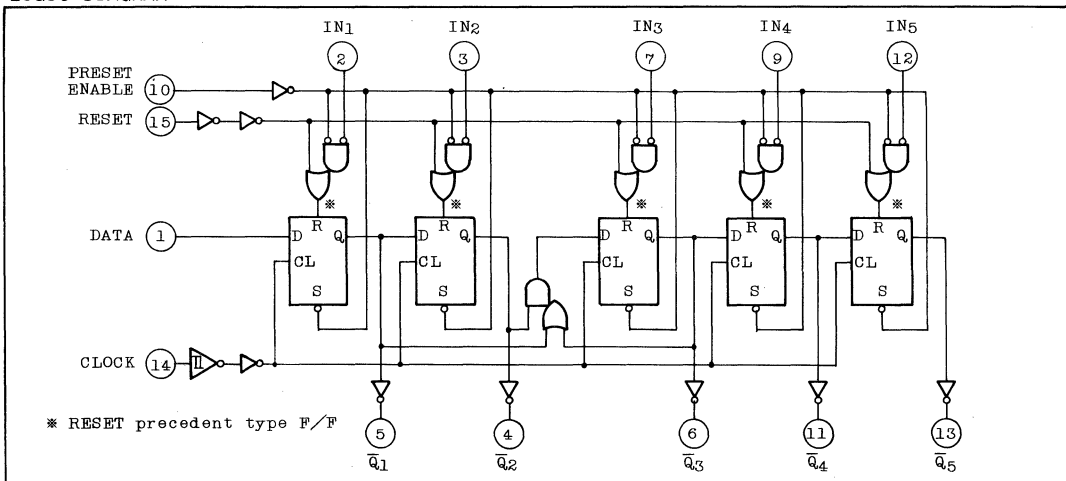
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec.	

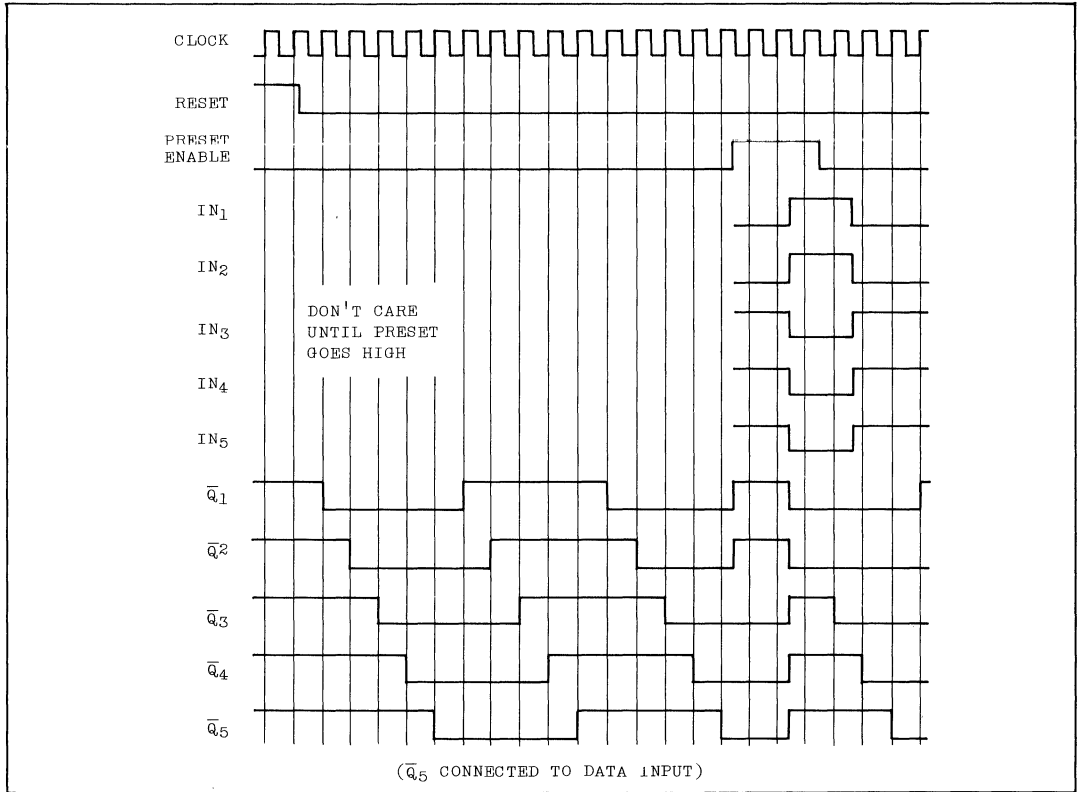
PIN ASSIGNMENT



LOGIC DIAGRAM



TIMING CHART



FUNCTION SELECTION, TRUTH TABLE

FUNCTION SELECTION			TRUTH TABLE				
COUNTER MODE	CONNECT DATA INPUT (Pin 1) to :	COMMENTE	CLOCK	RESET	PE	IN _n	Q _n
10 (Division)	Q ₅	-		L	L	*	Q _n △
8 "	Q ₄			L	L	*	D _n
6 "	Q ₃		*	L	H	L	H
4 "	Q ₂		*	L	H	H	L
2 "	Q ₁		*	H	*	*	H
9 "	Q ₅ , Q ₄	USE AND GATE					
7 "	Q ₄ , Q ₃						
5 "	Q ₃ , Q ₂						
3 "	Q ₂ , Q ₁						

* Don't care
 △ No Change

TC4018BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

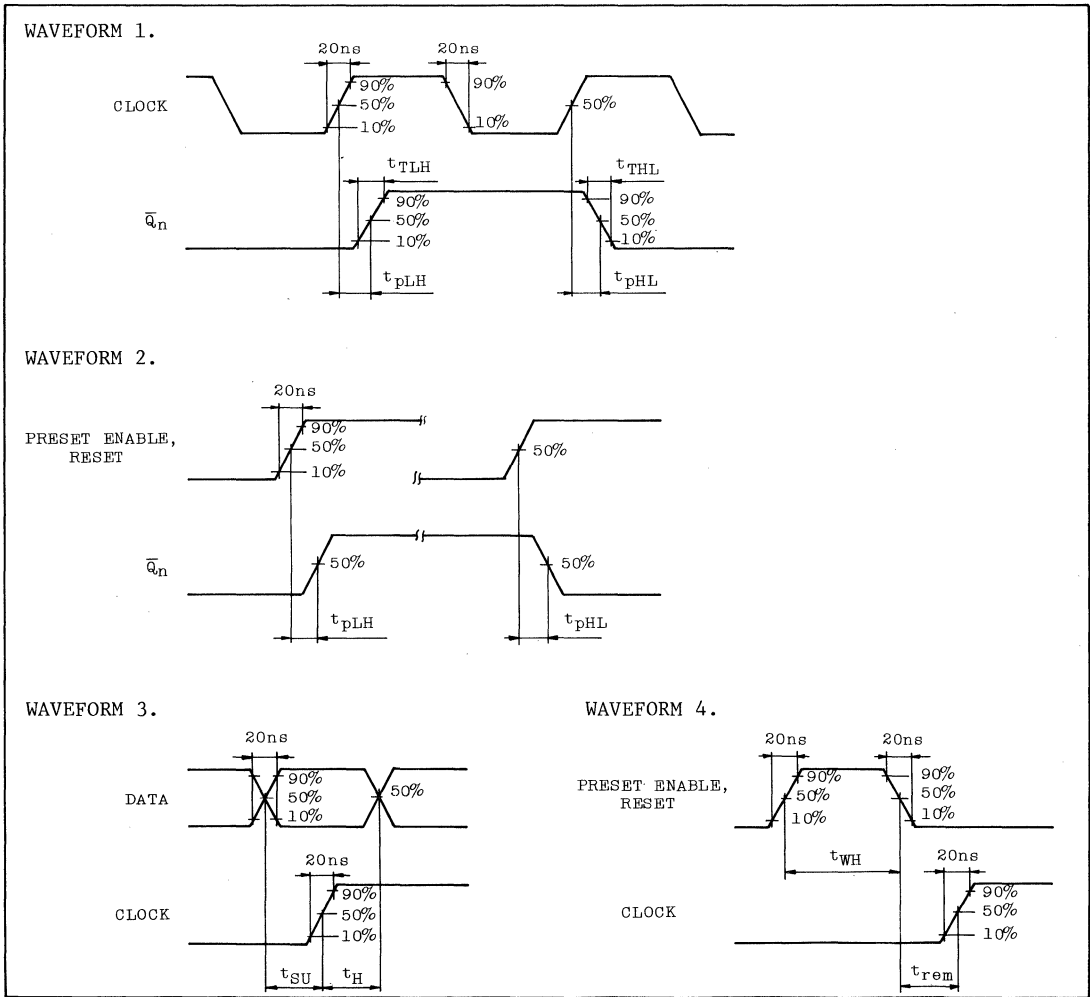
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - \bar{Q})	t _{pLH} t _{pHL}		5	-	280	560	ns
			10	-	110	220	
			15	-	80	160	
Propagation Delay Time (PRESET - \bar{Q}) (ENABLE - \bar{Q})	t _{pLH} t _{pHL}		5	-	300	600	
			10	-	110	250	
			15	-	80	180	
Propagation Delay Time (RESET - \bar{Q})	t _{pLH}		5	-	300	600	
			10	-	110	250	
			15	-	80	180	
Max. Clock Frequency	f _{CL}		5	2	4	-	MHz
			10	5.5	11	-	
			15	8	16	-	
Min. Clock Pulse Width	t _w		5	-	125	250	ns
			10	-	45	90	
			15	-	30	60	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	35	70	ns
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	-20	140	ns
			10	-	-5	80	
			15	-	-5	60	
Min. Removal Time (PE, RESET - CLOCK)	t _{rem}		5	-	35	80	ns
			10	-	15	30	
			15	-	10	20	

TC4018BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width (PRESET ENABLE, RESET)	t _{WH}		5	-	110	220	ns
			10	-	40	80	
			15	-	30	60	
Input Capacitance	C _{IN}			-	5	7.5	pF

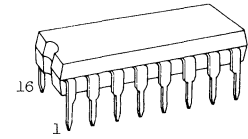
WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



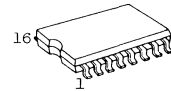
TC4019BP/TC4019BF QUAD AND/OR SELECT GATE

TC4019BP/BF is four circuit AND-OR SELECT GATE. The basic circuit consists of two 2 input AND gates and an OR gate receiving two outputs from the AND gates. The input signals applied to A_n and B_n ($n=1 \sim 4$) are selected by the common selection input to all the four circuits, KA and KB and the outputs are obtained at D_n .

This is suitable for data selectors and multiplexers of 4 bits 2 channels.



DIP16(3D16A-P)

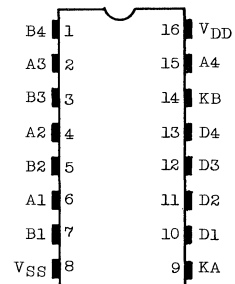


MFP16(F16GC-P)

ABSOLUTE MAXIMUM RATINGS

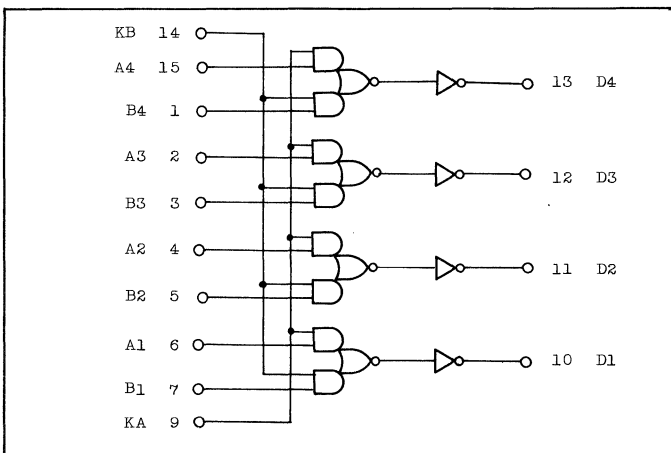
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Input Voltage	V_{IN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Output Voltage	V_{OUT}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

INPUTS				OUTPUT
KA	KB	A_n	B_n	D_n
H	L	H	*	H
H	L	L	*	L
L	H	*	H	H
L	H	*	L	L
L	L	*	*	L
H	H	L	L	L
H	H	L	H	H
H	H	H	L	H
H	H	H	H	H

L : LOW LEVEL
H : HIGH LEVEL
* : DON'T CARE

TC4019BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

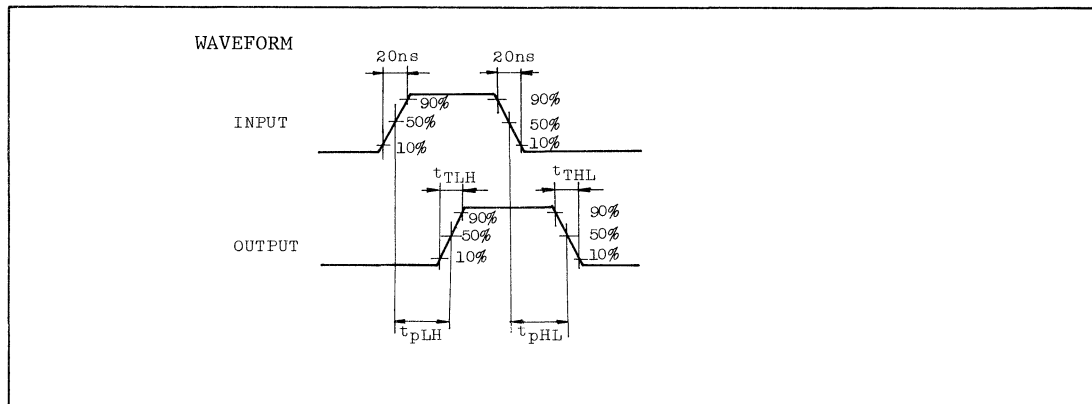
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

* All valid input combinations

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
Output Transition Time (High to Low)	t _{THL}		15	-	30	80	
			5	-	75	300	
Propagation Delay Time (A, B - D)	t _{pLH}		10	-	40	120	
	t _{pHL}		15	-	30	100	
Propagation Delay Time (KA, KB - D)	t _{pLH} t _{pHL}		5	-	75	300	
			10	-	40	120	
			15	-	30	100	
Input Capacitance	C _{IN}	An, Bn Input		-	5	7.5	pF
		KA, KB Input		-	12	20	

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4020BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC



TC4020BP/TC4020BF 14 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS

TC4020BP/BF is 14 stage ripple carry binary counter having asynchronous clear function. The counter advances its counting stage by falling edge of $\overline{\text{CLOCK}}$ input. When RESET input is placed "H", all the circuits are reset regardless of $\overline{\text{CLOCK}}$ input making all the outputs (Q1, Q4 ~ Q14) to be "L". This is most suitable for frequency dividers, control circuits and timing circuits.

ABSOLUTE MAXIMUM RATINGS

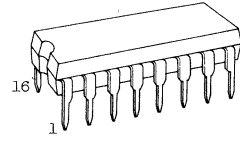
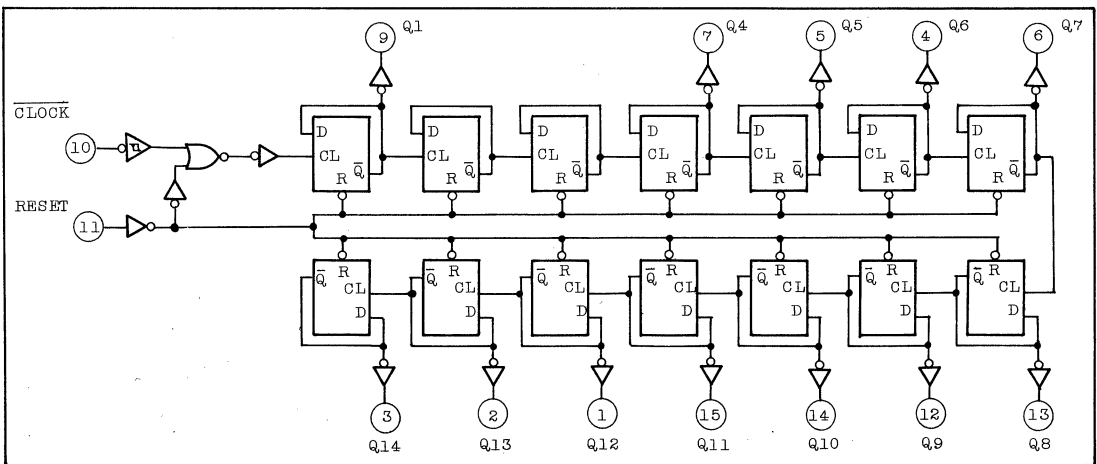
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

TRUTH TABLE

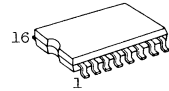
$\overline{\text{CLOCK}} \Delta$	RESET	OUTPUT STATE
*	H	ALL OUTPUTS="L"
	L	NO CHANGE
	L	ADVANCE TO NEXT STATE

Δ : LEVEL CHANGE, *: DON'T CARE

LOGIC DIAGRAM

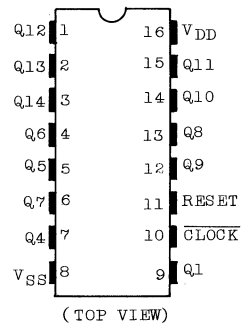


DIP16 (3D16A-P)



MFP16 (F16GC-P)

PIN ASSIGNMENT



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.52	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

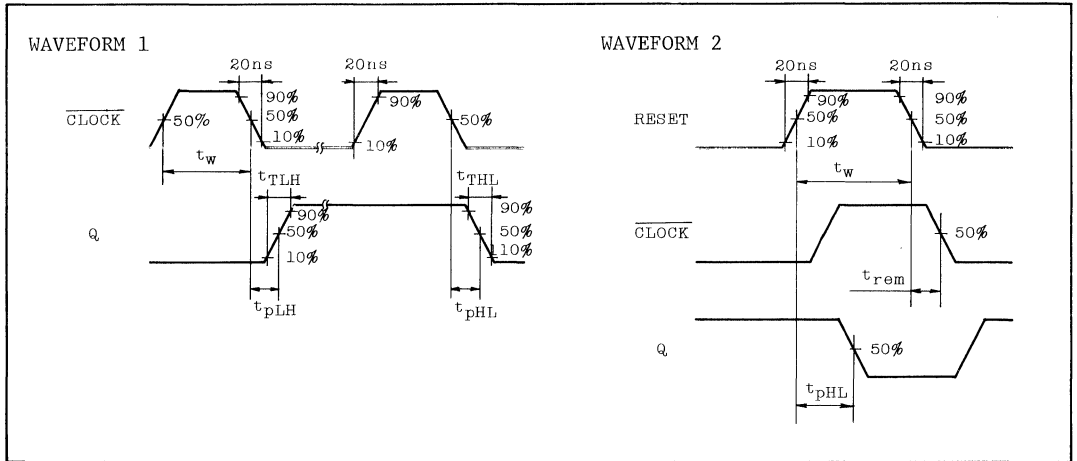
* All valid input combinations.

TC4020BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD(V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{pLH}		5	-	160	360	
			10	-	80	160	
			15	-	65	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{pHL}		5	-	160	360	
			10	-	80	160	
			15	-	65	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q14)	t _{pLH}		5	-	1000	2000	
			10	-	500	1000	
			15	-	400	800	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q14)	t _{pHL}		5	-	1000	2000	
			10	-	500	1000	
			15	-	400	800	
Propagation Delay Time (RESET -Q)	t _{pHL}		5	-	150	280	
			10	-	70	120	
			15	-	50	100	
Max. Clock Frequency	f _{CL}		5	3.5	10	-	MHz
			10	8	20	-	
			15	12	25	-	
Min. Clock Pulse Width	t _w		5	-	50	140	ns
			10	-	20	60	
			15	-	15	40	
Min. Pulse Width (RESET)	t _w		5	-	100	200	
			10	-	40	80	
			15	-	30	60	
Min. Removal Time (RESET - $\overline{\text{CLOCK}}$)	t _{rem}		5	-	-	350	
			10	-	-	150	
			15	-	-	100	
Max. Clock Input Rise Time	t _{rCL}		5	No Limit				μs
Max. Clock Input Fall Time	t _{fCL}		10				
			15				
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4021BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4021BP 8-STAGE STATIC SHIFT REGISTER (ASYNCHRONOUS PARALLEL INPUT OR SYNCHRONOUS SERIAL INPUT/SERIAL OUTPUT)

TC4021BP is 8 stage parallel in/serial out shift register, which can be used also for serial in/serial out operations.

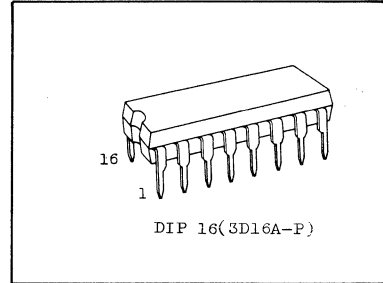
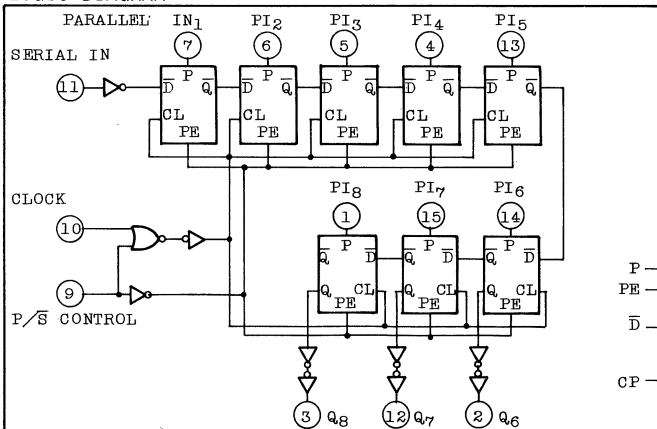
In the case of parallel operation, the data of PARALLEL IN is input to each F/F asynchronously with CLOCK and the output is obtained. In the case of serial operation, each F/F is triggered by rising edge of CLOCK. (ASYNCHRONOUS PARALLEL OR SYNCHRONOUS SERIAL INPUT)

Switching of PARALLEL operation and SERIAL operation is achieved by P/S CONTROL input. When P/S CONTROL input is "H", PARALLEL operation is designated and when it is "L", SERIAL operation is designated.

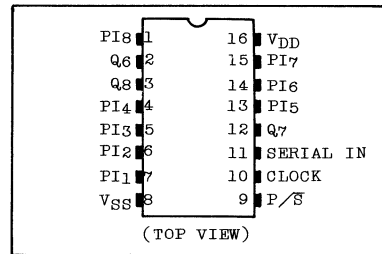
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

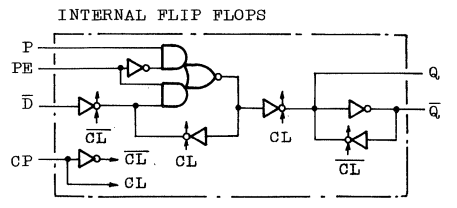
INPUTS					OUTPUTS Δ	
CLOCK Δ	P/S	PI ₁	PI _n	SI	Q ₁	Q _n
	L	*	*	L	L	Q _{n-1}
	L	*	*	H	H	Q _{n-1}
	L	*	*	*	No Change	
*	H	L	L	*	L	L
*	H	L	H	*	L	H
*	H	H	L	*	H	L
*	H	H	H	*	H	H

n ; 2~8

Δ ; Q₁~Q₅ Internal

$\Delta\Delta$; Level Change

* ; Don't Care



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

TC4021BP

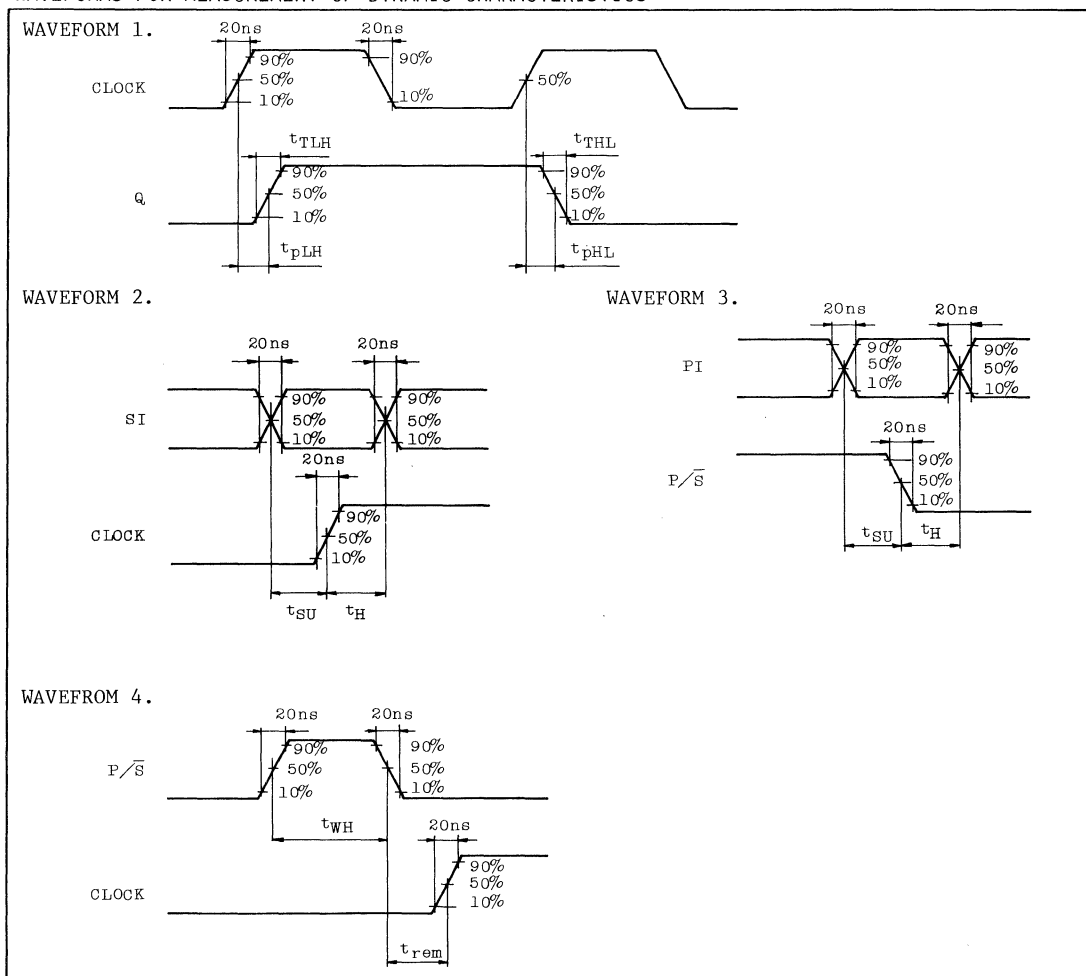
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	150	320	ns
			10	-	65	160	
			15	-	45	120	
Propagation Delay Time (P/S - Q)	t _{pLH} t _{pHL}		5	-	230	460	ns
			10	-	90	180	
			15	-	60	120	
Max. Clock Frequency	f _{CL}		5	3	6.5	-	MHz
			10	6	18	-	
			15	8.5	24	-	
Min. Clock Pulse Width	t _w		5	-	80	180	ns
			10	-	30	80	
			15	-	20	50	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Set-up Time (SI - CLOCK)	t _{SU}		5	-	40	120	ns
			10	-	20	80	
			15	-	15	60	
Min. Set-up Time (PI - P/S)	t _{SU}		5	-	25	50	ns
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (SI - CLOCK) (PI - P/S)	t _H		5	-	35	70	ns
			10	-	20	40	
			15	-	15	30	
Min. Pulse Width (P/S - CONTROL)	t _{WH}		5	-	90	180	ns
			10	-	30	80	
			15	-	10	50	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Removal Time (P/ \bar{S} - CLOCK)	t _{rem}		5	-	45	280	ns
			10	-	20	140	
			15	-	15	100	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4022BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

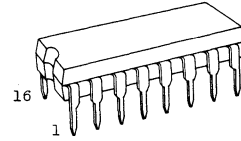
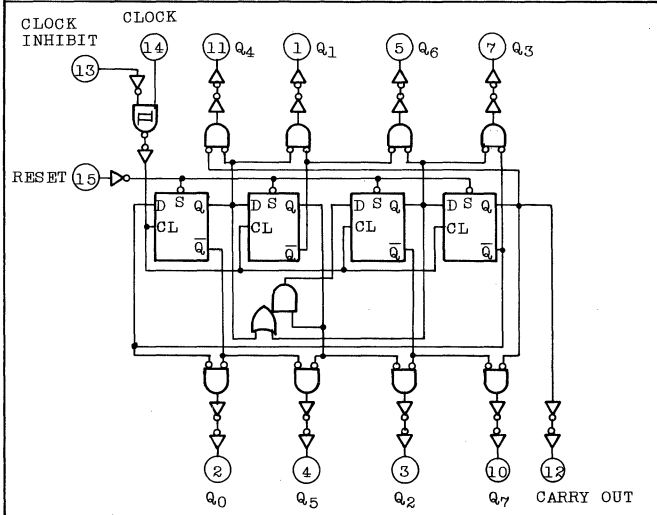
TC4022BP OCTAL COUNTER/DIVIDER

TC4022BP is octal Johnson counter consisting of 4 stage D-type flip-flops and equipped with decoder which convert the output to octal.
Depending on the number of count pulses applied to CLOCK or CLOCK INHIBIT input, one of eight outputs Q₀ through Q₇ becomes "H". The counter advances its counting state by rising edge of CLOCK when CLOCK INHIBIT="L" and by falling edge of CLOCK INHIBIT when CLOCK="H".
RESET input with "H" level resets the counter to Q₀="H" and Q₁~Q₇="L" regardless of CLOCK and CLOCK INHIBIT.

MAXIMUM RATINGS

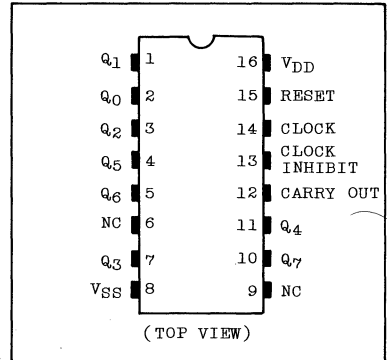
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Ambient Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



DIP 16 (3D16A-P)

PIN ASSIGNMENT



TRUTH TABLE

INPUTS			SELECTED OUTPUT
CLOCK Δ	CLOCK INHIBIT Δ	RESET	
*	*	H	Q ₀
*	H	L	Q _n (NC)
L	*	L	Q _n (NC)
\downarrow	L	L	Q _n + 1
\uparrow	L	L	Q _n (NC)
H	\downarrow	L	Q _n (NC)
H	\uparrow	L	Q _n + 1

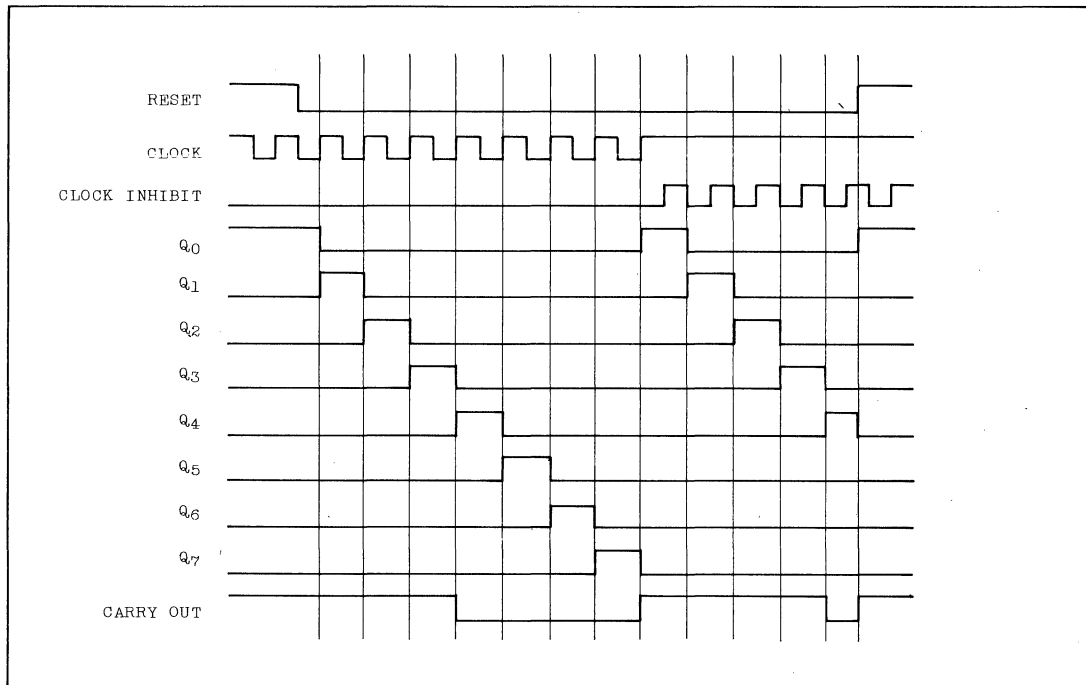
Δ ; Level Change

* ; Don't Care

NC ; No Change

CARRY OUT { "H" ... Q₀~Q₃="H"
"L" ... Q₄~Q₇="H"

TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}		3	-	18	V
Input Voltage	V_{IN}		0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

TC4022BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

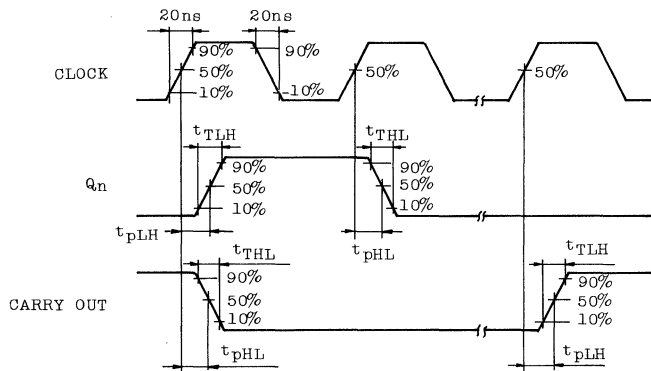
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

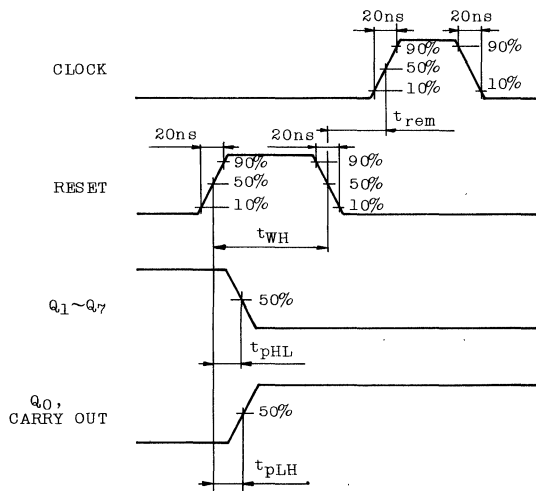
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT	
Propagation Delay Time (CLOCK - Q _n)	t _{pLH} t _{pHL}		5	-	325	650	ns	
			10	-	135	270		
			15	-	85	170		
Propagation Delay Time (CLOCK - CARRY OUT)	t _{pLH} t _{pHL}		5	-	280	600		
			10	-	110	250		
			15	-	75	160		
Propagation Delay Time (RESET - Q RESET - CARRY OUT)	t _{pLH} t _{pHL}		5	-	265	530		
			10	-	115	230		
			15	-	85	170		
Max. Clock Frequency	f _{CL}		5	2.5	6	-	MHz	
			10	5	12	-		
			15	6.7	13.5	-		
Min. Clock Pulse Width	t _w		5	-	85	200	ns	
			10	-	40	90		
			15	-	35	60		
Min. Pulse Width (RESET)	t _{WH}		5	-	50	200		
			10	-	20	110		
			15	-	15	60		
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}		5	No Limit				μs
			10					
			15					
Min. Set-up Time (CLOCK INHIBIT - CLOCK)	t _{SU}		5	-	30	230	ns	
			10	-	15	100		
			15	-	10	70		
Min. Removal Time (RESET - CLOCK)	t _{rem}		5	-	-55	400	ns	
			10	-	-20	275		
			15	-	-15	150		
Input Capacitance	C _{IN}			-	5	7.5	pF	

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

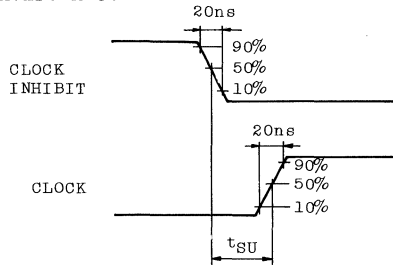
WAVEFORM 1.



WAVEFORM 2.



WAVEFORM 3.



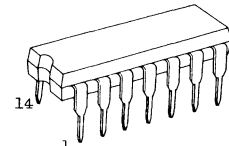
TC4024BP/TC4024BF 7 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS

TC4024BP/BF is 7 stage ripple carry type binary counter having asynchronous clear function.

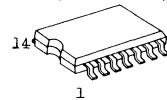
The counter advances its counting state by falling edge of $\overline{\text{CLOCK}}$ input.

When RESET input is placed at "H", all the internal flip-flops are reset making all the outputs Q1 through Q7 to be "L" regardless of $\overline{\text{CLOCK}}$ input.

This is suitable for frequency divider circuits and control circuits.



DIP14 (3D14A-P)

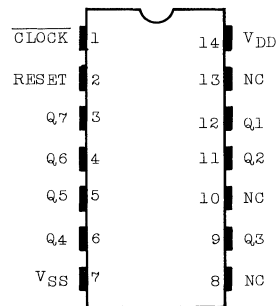


MFP14 (F14GB-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300 (DIP)/180 (MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10\text{sec}$	

PIN ASSIGNMENT



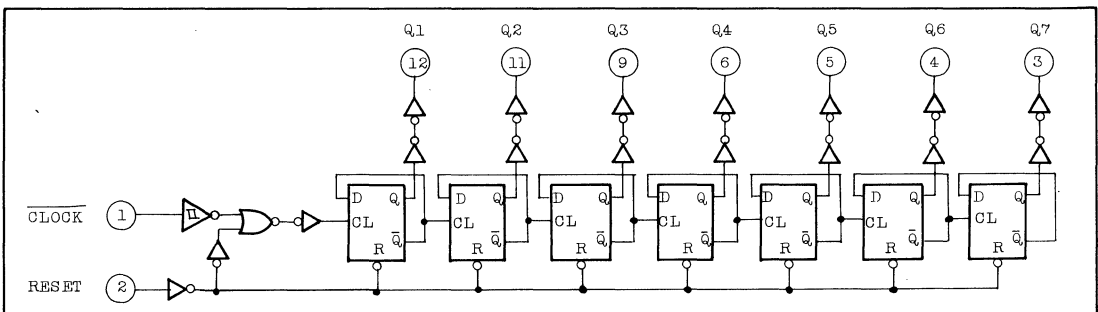
(TOP VIEW)

TRUTH TABLE

$\overline{\text{CLOCK}} \Delta$	RESET	OUTPUT STAGE
*	H	All Outputs = "L"
	L	No Change
	L	Advance to Next State

Δ : Level Change, *: Don't Care

LOGIC DIAGRAM



TC4024BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	15	-	0.015	20	-	600		

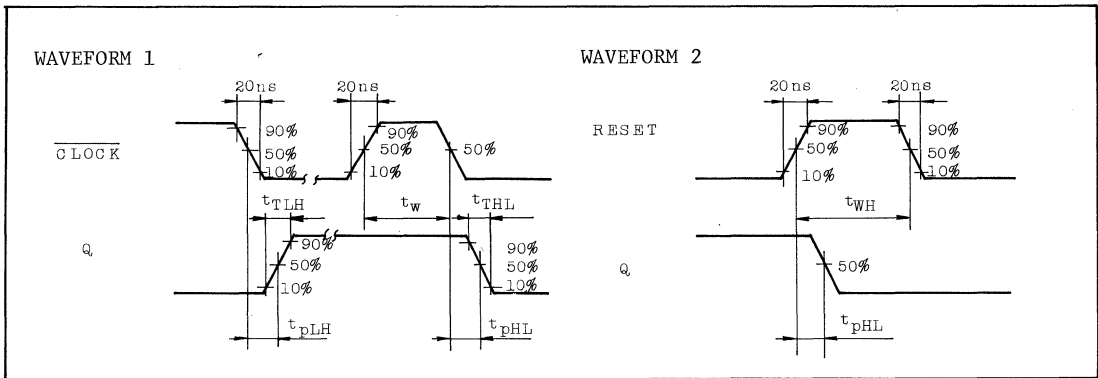
* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{pLH}		5	-	140	360	
			10	-	70	160	
			15	-	50	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{pHL}		5	-	140	360	
			10	-	70	160	
			15	-	50	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q7)	t _{pLH}		5	-	400	1200	
			10	-	160	520	
			15	-	115	430	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q7)	t _{pHL}		5	-	400	1200	
			10	-	160	520	
			15	-	115	430	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	140	280	
			10	-	70	120	
			15	-	50	100	
Max. Clock Frequency	f _{CL}		5	3.5	14	-	MHz
			10	8	30	-	
			15	12	40	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL}		5	No Limit			μs
	t _{fCL}		10				
	15						
Min. Clock Pulse Width	t _w		5	-	40	140	ns
			10	-	20	60	
			15	-	15	40	
Min. Pulse Width (RESET)	t _{WH}		5	-	40	200	
			10	-	20	80	
			15	-	15	60	
Minimum Removal Time	t _{rem}		5	-	0	350	
			10	-	0	150	
			15	-	0	100	
Input Capacitance	C _{IN}			-	5	7.5		pF

TC4024BP/BF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

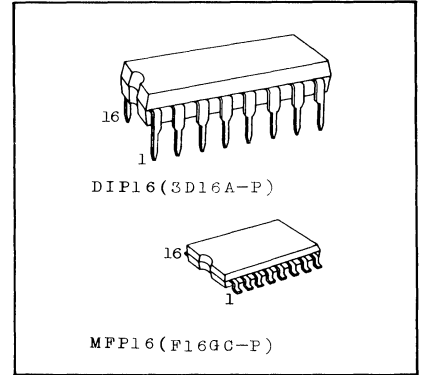


TC4027BP/TC4027BF DUAL J-K MASTER-SLAVE FLIP-FLOP

TC4027BP/BF is J-K master-slave flip-flop having RESET and SET functions.

In the case of J-K made, when the clock input is given with both RESET and SET at "L", the output changes at rising edge of the clock according to the states of J and K.

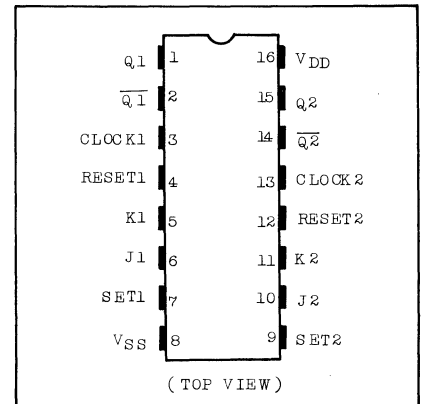
When SET input is placed at "H", and RESET input is placed at "L", outputs become Q="H", and \bar{Q} ="L".
When RESET input is placed at "H", and SET input is placed at "L", outputs become Q="L", and \bar{Q} ="H".
When both of RESET input and SET input are at "H", outputs become Q="H" and \bar{Q} ="H".



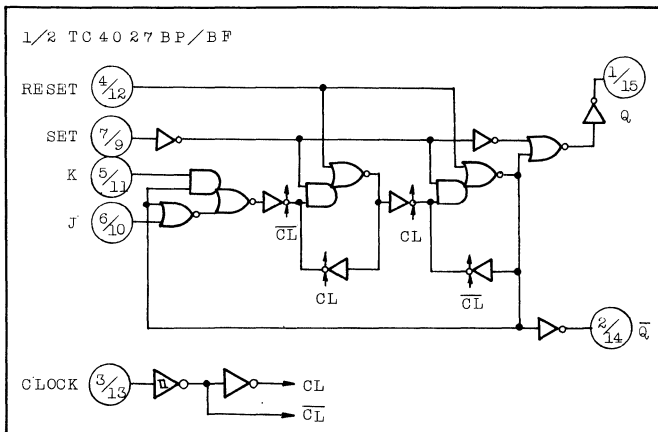
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _{opr}	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

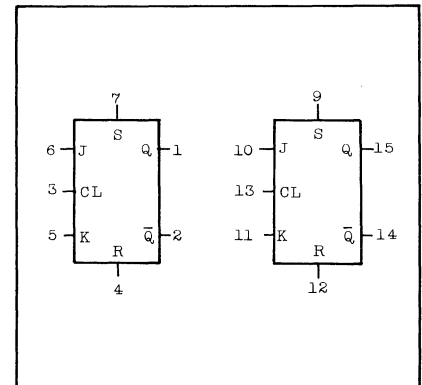
PIN ASSIGNMENT



LOGIC DIAGRAM



BLOCK DIAGRAM



TC4027BP/BF

TRUTH TABLE

INPUTS					OUTPUTS		* : DON'T CARE Δ : LEVEL CHANGE • : NO CHANGE •• : CHANGE
RESET	SET	J	K	CLOCKΔ	Q_{n+1}	\overline{Q}_{n+1}	
L	H	*	*	*	H	L	
H	L	*	*	*	L	H	
H	H	*	*	*	H	H	
L	L	L	L		Q_n •	\overline{Q}_n •	
L	L	L	H		L	H	
L	L	H	L		H	L	
L	L	H	H		\overline{Q}_n ••	Q_n ••	
L	L	*	*		Q_n •	\overline{Q}_n •	

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I_{OH}	$V_{OH}=4.6V$ $V_{OH}=2.5V$ $V_{OH}=9.5V$ $V_{OH}=13.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I_{OL}	$V_{OL}=0.4V$ $V_{OL}=0.5V$ $V_{OL}=1.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	0.61	-	0.51	1.2	-	0.42	-	mA
			10	1.5	-	1.3	3.2	-	1.1	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
Input High Voltage	V_{IH}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA	
			10	-	2	-	0.004	2	-	60		
			15	-	4	-	0.008	4	-	120		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

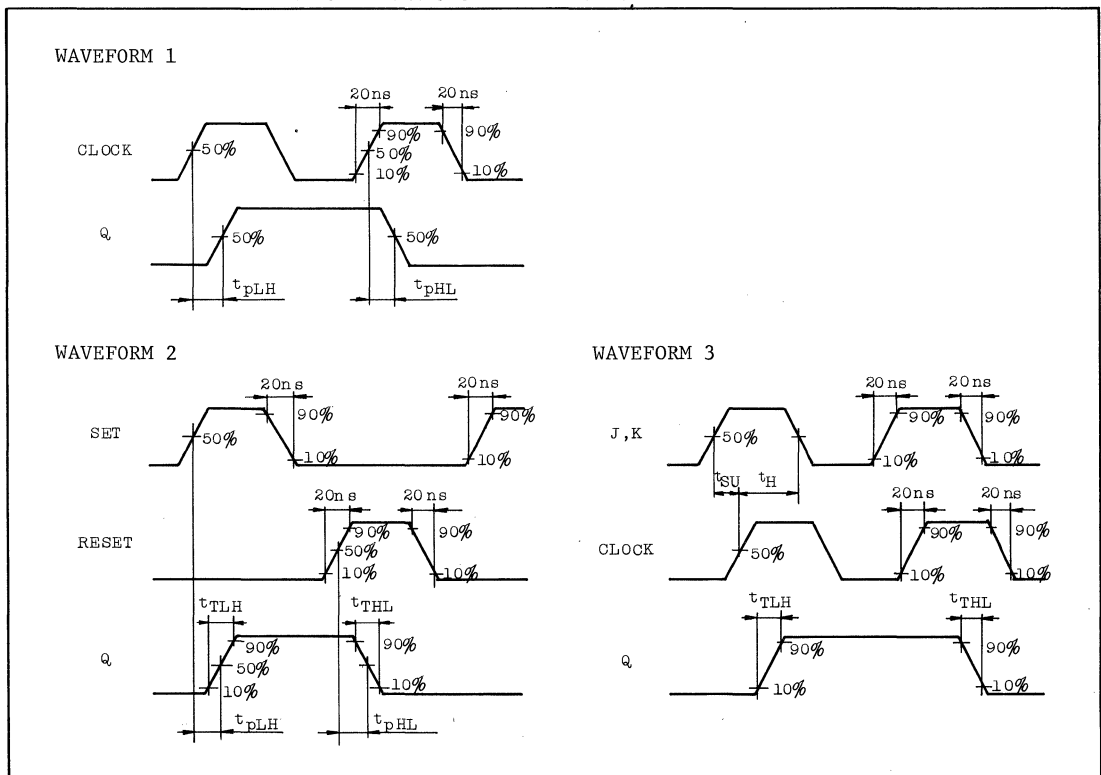
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - Q, \bar{Q})	t _{pLH} t _{pHL}		5	-	150	300	
			10	-	75	130	
			15	-	60	90	
Propagation Delay Time (SET, RESET - Q, \bar{Q})	t _{pLH} t _{pHL}		5	-	120	300	
			10	-	60	130	
			15	-	45	90	
Max. Clock Frequency	f _{CL}		5	3.5	8	-	MHz
			10	8	16	-	
			15	12	20	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Pulse Width (SET, RESET)	t _w		5	-	60	180	ns
			10	-	35	80	
			15	-	25	50	
Min. Clock Pulse Width	t _w		5	-	60	140	
			10	-	35	60	
			15	-	25	40	

TC4027BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			5				
Min. Set-up Time (J, K - CLOCK)	t _{SU}		5	-	30	140	ns
			10	-	10	50	
			15	-	5	35	
Min. Hold Time (J, K - CLOCK)	t _H		5	-	-	140	
			10	-	-	50	
			15	-	-	35	
Min. Removal Time (SET, RESET - CLOCK)	t _{rem}		5	-	-	40	
			10	-	-	20	
			15	-	-	15	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

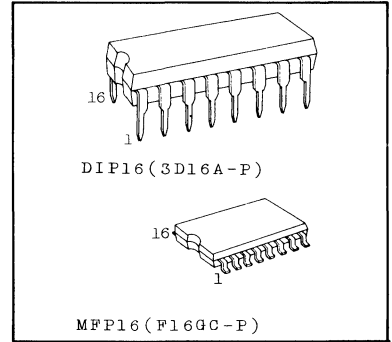


TC4028BP/TC4028BF BCD-TO-DECIMAL DECODER

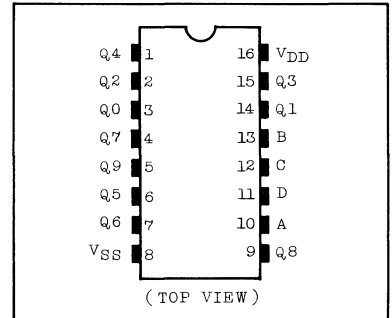
The TC4028BP/BF is a BCD-to-DECIMAL decoder which converts BCD signal into DECIMAL signal. Of ten outputs from Q0 to Q9, one output corresponding to input BCD code goes to the "H" level and all the others remain at the "L" level. When D is used as inhibit input by use of three input lines from A to C, this decoder can be served as a BINARY-to-OCTAL decoder.

MAXIMUM RATINGS

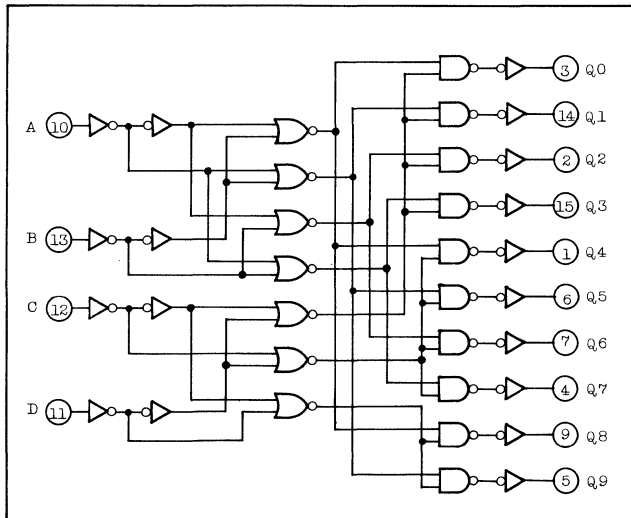
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	



PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

INPUTS				OUTPUTS									
D	C	B	A	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
L	L	L	L	H	L	L	L	L	L	L	L	L	L
L	L	L	H	L	H	L	L	L	L	L	L	L	L
L	L	H	L	L	L	H	L	L	L	L	L	L	L
L	L	H	H	L	L	L	H	L	L	L	L	L	L
L	H	L	L	L	L	L	L	H	L	L	L	L	L
L	H	L	H	L	L	L	L	L	H	L	L	L	L
L	H	H	L	L	L	L	L	L	L	H	L	L	L
L	H	H	H	L	L	L	L	L	L	L	H	L	L
H	L	L	L	L	L	L	L	L	L	L	L	H	L
H	L	L	H	L	L	L	L	L	L	L	L	L	H
H	L	H	L	L	L	L	L	L	L	L	L	L	L
H	L	H	H	L	L	L	L	L	L	L	L	L	L
H	H	L	L	L	L	L	L	L	L	L	L	L	L
H	H	L	H	L	L	L	L	L	L	L	L	L	L
H	H	H	L	L	L	L	L	L	L	L	L	L	L
H	H	H	H	L	L	L	L	L	L	L	L	L	L

H = HIGH LEVEL L = LOW LEVEL

TC4028BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC		TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{SS}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

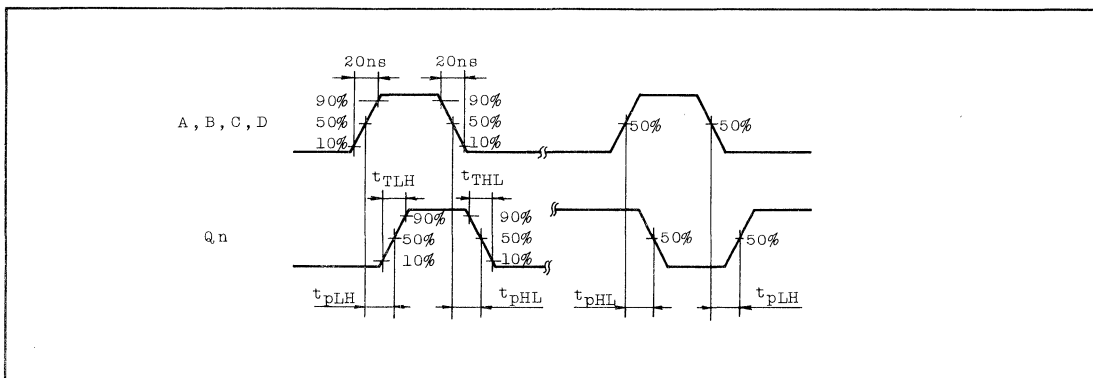
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD}	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			20	-	20	-	0.015	20	-	600	

*All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time	t _{pLH} t _{pHL}		5	-	110	350	ns
			10	-	55	160	
			15	-	40	120	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4029BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

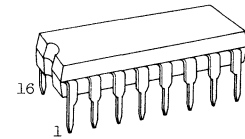
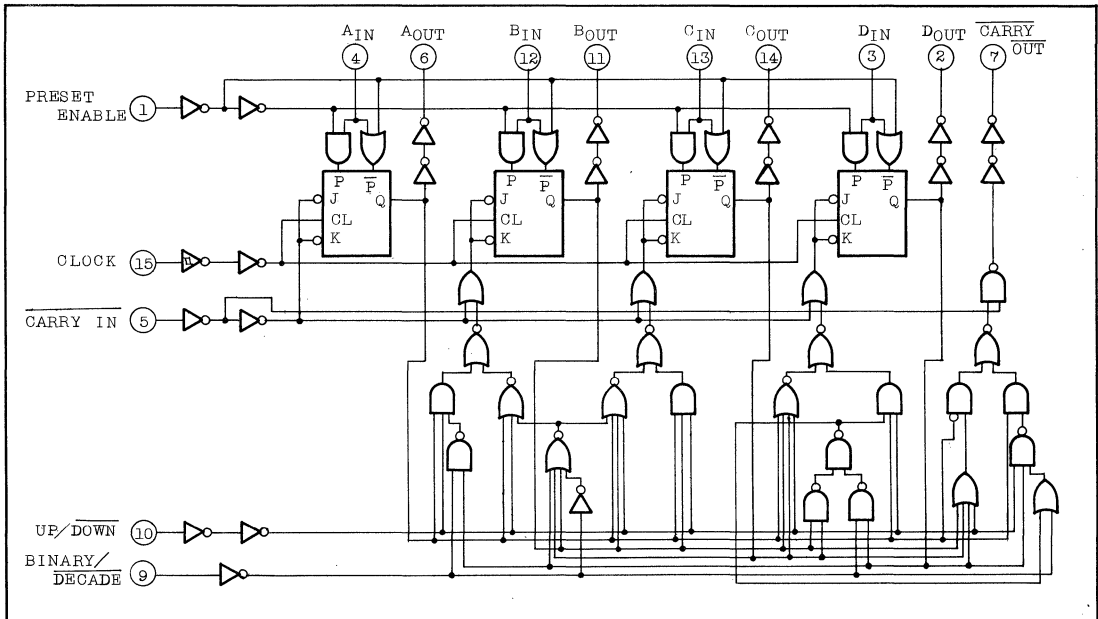
TC4029BP/TC4029BF PRESETTABLE UP/DOWN COUNTER

TC4029BP/BF is up/down counter having the capabilities of preset operation, parallel carry connection and decimal/binary switching. Switching of decimal counter and binary counter is controlled by BINARY/DECADE input ("H"-Binary and "L"-Decimal), and switching of UP/DOWN is controlled by UP/DOWN input ("H"-Count up and "L"-Count down). As PRESET ENABLE input at "H" level causes input information at A_{IN} through D_{IN} to be directly input to the flip-flops, any arbitrary count can be set. The counter advances its counting state by rising edge of CLOCK input.

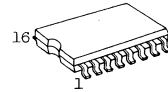
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10sec	

LOGIC DIAGRAM

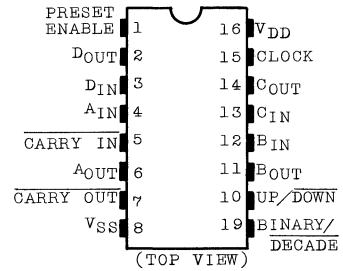


DIP16 (3D16A-P)



MFP16 (F16GC-P)

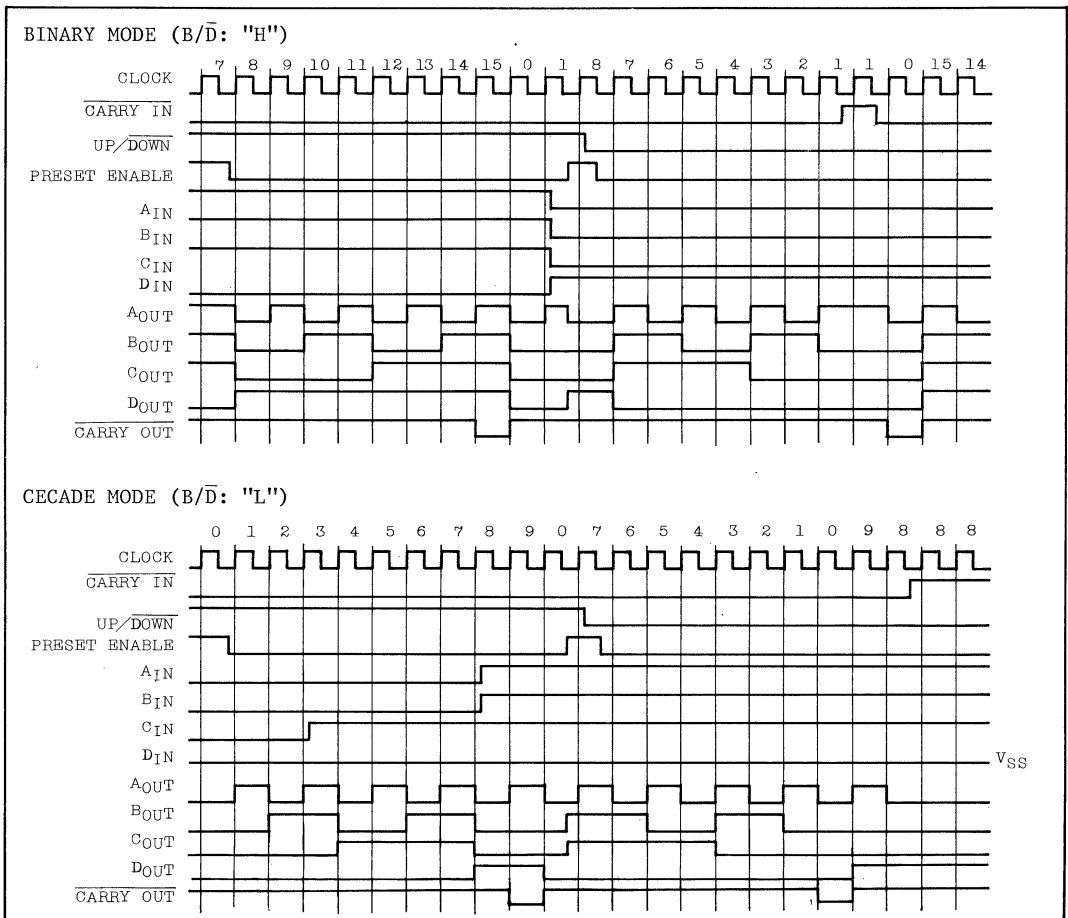
PIN ASSIGNMENT



TRUTH TABLE

CARRY IN	PRESET ENABLE	UP/DOWN	BINARY/DECADE	OPERATION	* Don't care
L	L	H	*	UP CONUT	
L	L	L	*	DOWN COUNT	
*	H	*	*	PRESET	
H	L	*	*	NO COUNT	
L	L	*	H	BINARY COUNT	
L	L	*	L	DECADE COUNT	

TIMING DIAGRAM



TC4029BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent	I _{DD}	V _{ID} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
Device Current			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

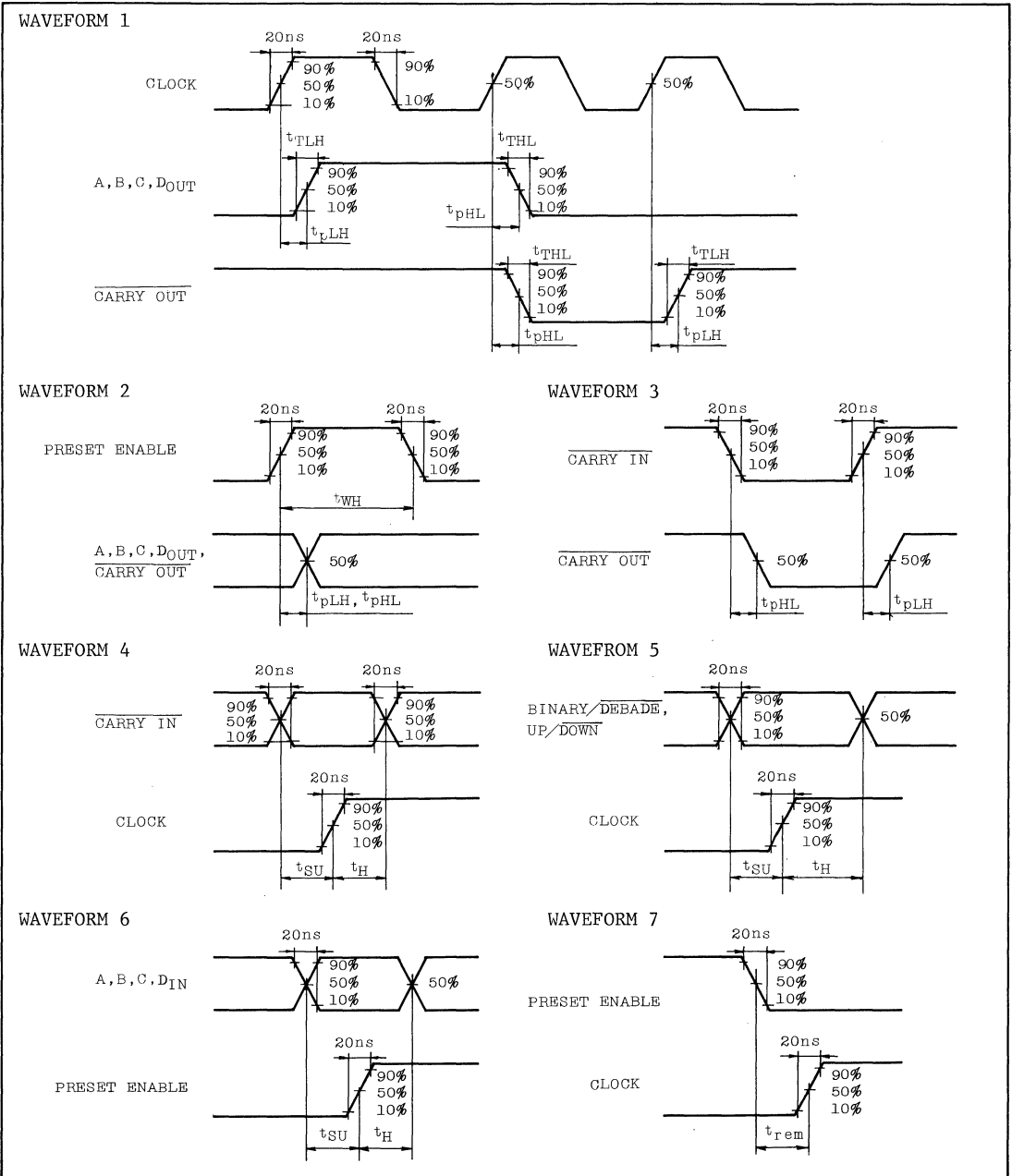
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
	10	-	35	100			
	15	-	30	80			
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - A, B, C, D _{OUT})	t _{pLH} t _{pHL}		5	-	180	470	
			10	-	85	200	
			15	-	65	160	
Propagation Delay Time (CLOCK - CARRY OUT)	t _{pLH} t _{pHL}		5	-	220	500	
			10	-	100	260	
			15	-	75	190	
Propagation Delay Time (PRESET ENABLE - A, B, C, D _{OUT})	t _{pLH} t _{pHL}		5	-	180	470	
			10	-	85	200	
			15	-	65	160	
Propagation Delay Time (PRESET ENABLE - CARRY OUT)	t _{pLH} t _{pHL}		5	-	240	640	
			10	-	110	290	
			15	-	80	210	
Propagation Delay Time (CARRY IN - CARRY OUT)	t _{pLH} t _{pHL}		5	-	85	340	
			10	-	45	100	
			15	-	35	80	
Min. Clock Pulse Width	t _w		5	-	40	130	
			10	-	20	70	
			15	-	15	50	

TC4029BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width (PRESET ENABLE)	t _{WH}		5	-	55	130	ns
			10	-	25	70	
			15	-	20	50	
Max. Clock Frequency	f _{CL}		5	2	5	-	MHz
			10	4	10	-	
			15	5.5	14	-	
Max. Clock Input Rise Time	t _{rCL}		5	No Limit			μs
Max. Clock Input Fall Time	t _{fCL}		10				
			15				
Min. Set-up Time ($\overline{\text{CARRY IN}}$ - CLOCK)	t _{SU}		5	-	75	140	ns
			10	-	35	60	
			15	-	25	30	
Min. Set-up Time (B/ $\overline{\text{D}}$, U/ $\overline{\text{D}}$ - CLOCK)	t _{SU}		5	-	120	320	
			10	-	55	130	
			15	-	40	90	
Min. Set-up Time (A,B,C,D - PRESET ENABLE)	t _{SU}		5	-	35	70	
			10	-	15	30	
			15	-	10	20	
Min. Hold Time ($\overline{\text{CARRY IN}}$ - CLOCK)	t _H		5	-	-	50	
			10	-	-	30	
			15	-	-	25	
Min. Hold Time (B/ $\overline{\text{D}}$, U/ $\overline{\text{D}}$ - CLOCK)	t _H		5	-	-	30	
			10	-	-	30	
			15	-	-	30	
Min. Hold Time (A,B,C,D - PRESET ENABLE)	t _H		5	-	15	70	
			10	-	10	40	
			15	-	5	40	
Min. Removal Time (PRESET ENABLE - CLOCK)	t _{rem}		5	-	40	150	
			10	-	20	80	
			15	-	15	60	
Input Capacitance	C _{IN}			-	5	7.5	pF

SWITCHING TIME TEST WAVEFORMS



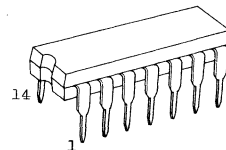
TC4030BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

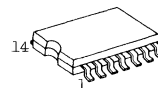
TC4030BP/TC4030BF QUAD EXCLUSIVE-OR GATE

TC4030BP/BF contains four circuits of exclusive OR gates. Since the buffers of two stage inverters are provided for all the outputs, the input/output voltage characteristic has been improved and the noise immunity has been also improved. And increase of transmission time due to load capacity increase is kept minimum.

Wide variety of applications are offered, such as digital comparators and parity circuits.



DIP14(3D14A-P)

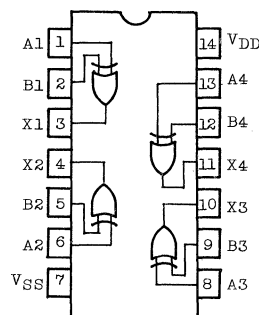


MFP14(F140B-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

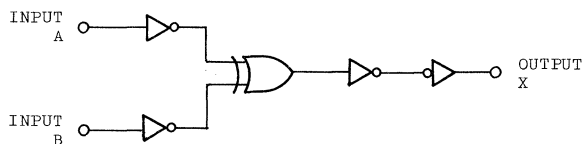
PIN ASSIGNMENT



(TOP VIEW)

CIRCUIT DIAGRAM

1/4 TC4030BP/BF



TRUTH TABLE

INPUTS		OUTPUT
A	B	X
L	L	L
L	H	H
H	L	H
H	H	L

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL		MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	4.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA
			10	1.5	-	1.3	3.2	-	1.1	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
			5	-	1.5	-	2.25	1.5	-	1.5	
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	3.0	-	4.5	3.0	-	3.0	V
			10	-	4.0	-	6.75	4.0	-	4.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
			5	-	1	-	0.001	1	-	7.5	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	10	-	2	-	0.001	2	-	15	μA
			15	-	4	-	0.002	4	-	30	
			5	-	1	-	0.001	1	-	7.5	

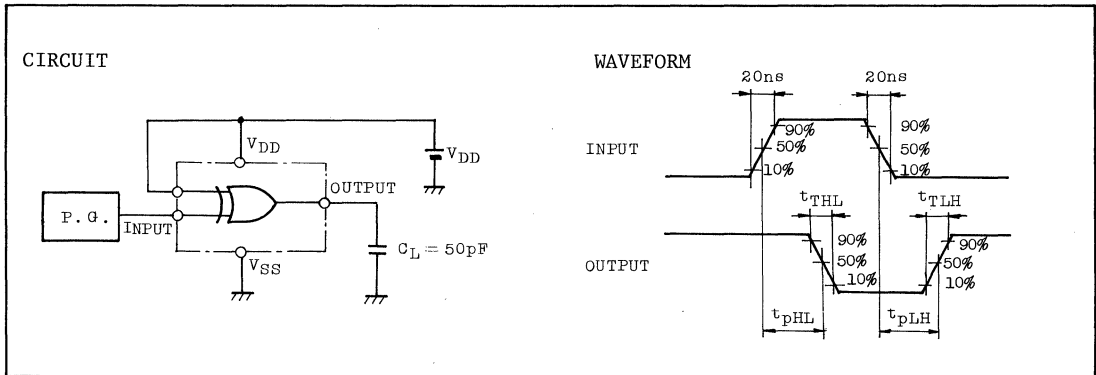
* All valid input combinations.

TC4030BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time	t _{pLH}		5	-	90	280	ns
	t _{pHL}		10	-	45	130	
	t _{pHL}		15	-	35	100	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

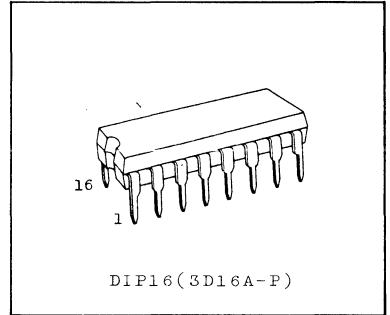


TC4032BP TRIPLE SERIAL ADDER (POSITIVE LOGIC ADDER)
TC4038BP TRIPLE SERIAL ADDER (NEGATIVE LOGIC ADDER)

TC4032BP and TC4038BP are tripple serial adders having common CLOCK input and CARRY RESET input to all the adders.

Each adder has two SERIAL DATA inputs (An and Bn; n=1 - 3), INVERT input and SUM output. When INVERT input is "L", both TC4032BP and TC4038BP perform positive addition and when it is "H", negative addition is performed.

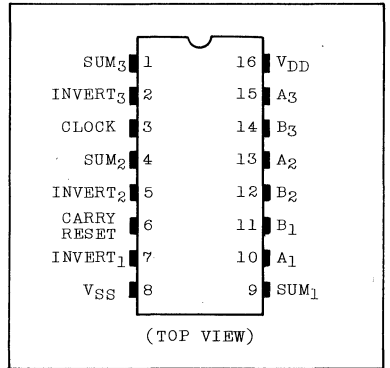
CARRY of TC4032BP is triggered by rising edge of CLOCK and CARRY of TC4038BP is triggered by falling edge of CLOCK.



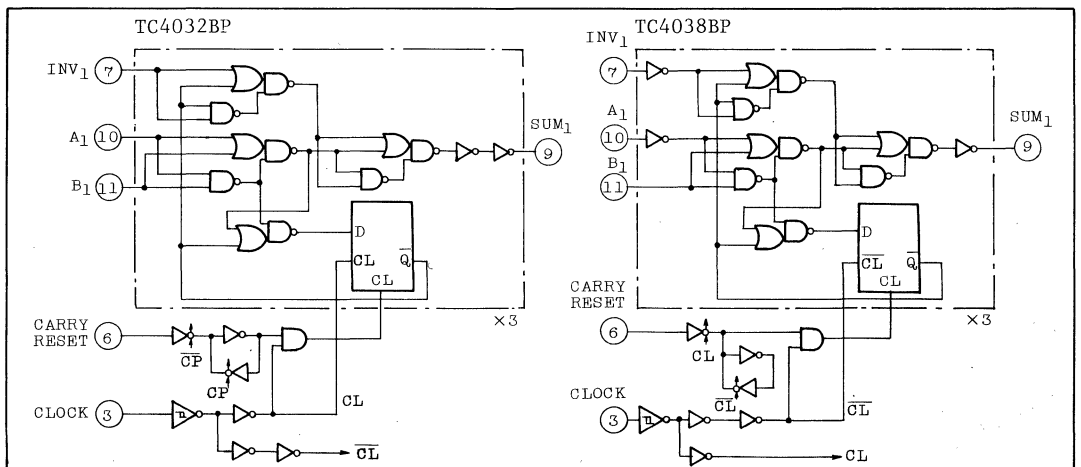
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C . 10 sec	

PIN ASSIGNMENT

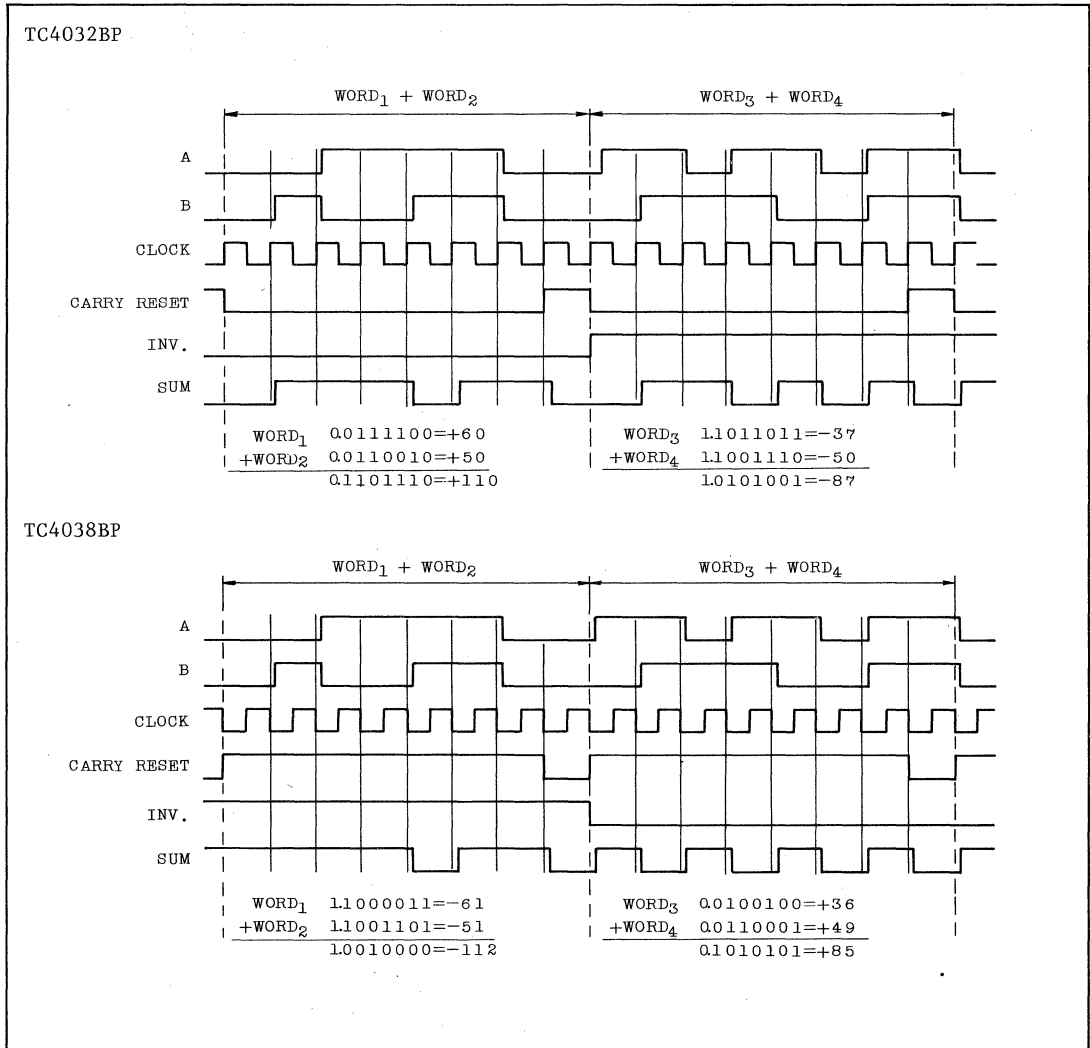


LOGIC DIAGRAM



TC4032BP, TC4038BP

TIMING DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

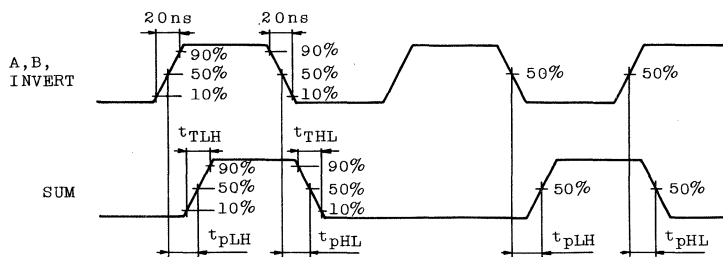
TC4032BP, TC4038BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

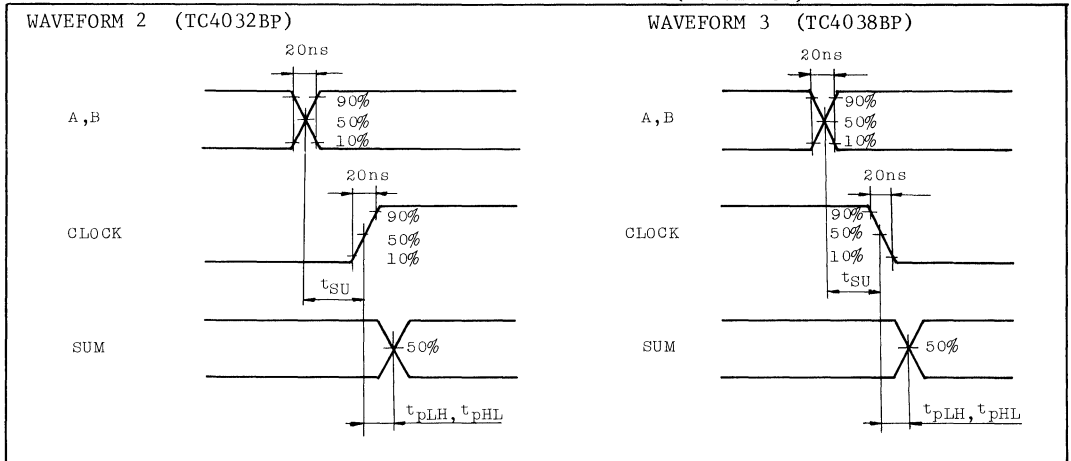
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - SUM)	t _{pLH} t _{pHL}		5	-	240	650	ns
			10	-	95	350	
			15	-	70	300	
Propagation Delay Time (A,B,INV - SUM)	t _{pLH} t _{pHL}		5	-	330	660	ns
			10	-	130	260	
			15	-	95	190	
Max. Clock Frequency	f _{CL}		5	2.5	5	-	MHz
			10	5	10	-	
			15	6	12	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Set-up Time (A,B - CLOCK)	t _{SU}		5	-	80	200	ns
			10	-	30	80	
			15	-	20	60	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

WAVEFORM 1.



WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS (Continued)



TC4034BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

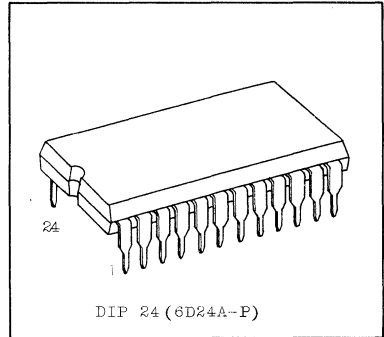
TC4034BP 8-STAGE STATIC BIDIRECTIONAL PARALLEL/SERIAL INPUT/OUTPUT BUS REGISTER

TC4034BP is bidirectional 8 bit bus register having eight data input/output lines A₁ through A₈ and another set of eight data input/output lines B₁ through B₈. Switching of input/output for A data lines and B data lines is controlled by A/ \bar{B} input terminal and selection of serial operation/parallel operation is controlled by P/ \bar{S} input terminal. (PARALLEL OPERATION)

When P/ \bar{S} input is placed at "H", synchronous or asynchronous parallel data can be input.

(SERIAL OPERATION)

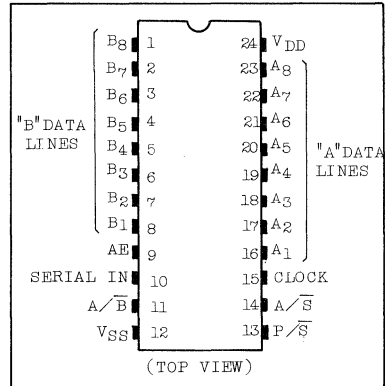
When P/ \bar{S} input is placed at "L", serial data can be read synchronously.



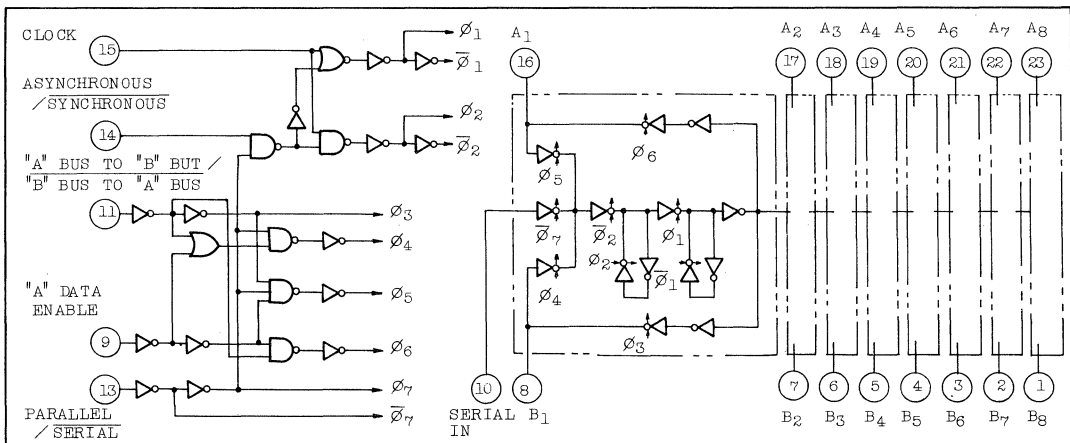
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

AE	P/S	A/B	A/S	MODE	OPERATION
L	L	L	*	Serial	Synchronous Serial data input, "A" Parallel data outputs disabled
L	L	H	*	Serial	Synchronous Serial data input, "B" Parallel data output
L	H	L	L	Parallel	"B" Synchronous Parallel data inputs, "A" Parallel data outputs disabled
L	H	L	H	Parallel	"B" Asynchronous Parallel data inputs, "A" Parallel data outputs disabled
L	H	H	L	Parallel	"A" Parallel data inputs disabled, "B" Parallel data outputs, Synchronous data recirculation
L	H	H	H	Parallel	"A" Parallel data inputs disabled, "B" Parallel data outputs, Asynchronous data recirculation
H	L	L	*	Serial	Synchronous Serial data input, "A" Parallel data outputs
H	L	H	*	Serial	Synchronous Serial data input, "B" Parallel data outputs
H	H	L	L	Parallel	"B" Synchronous Parallel data inputs, "A" Parallel data outputs
H	H	L	H	Parallel	"B" Asynchronous Parallel data inputs, "A" Parallel data outputs
H	H	H	L	Parallel	"A" Synchronous Parallel data inputs, "B" Parallel data outputs
H	H	H	H	Parallel	"A" Asynchronous Parallel data inputs, "B" Parallel data outputs

* Don't care

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

TC4034BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{CC} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁵	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.010	5	-	150	μA	
			10	-	10	-	0.020	10	-	300		
			15	-	20	-	0.030	20	-	600		

* All valid input combinations.

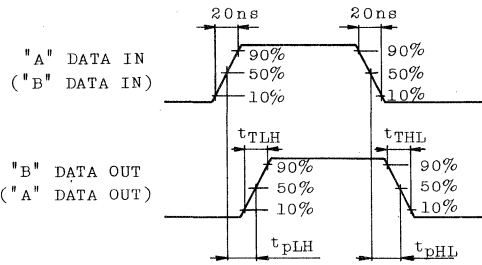
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A(B) _{IN} - B(A) _{OUT})	t _{pLH} t _{pHL}		5	-	260	700	ns
			10	-	100	240	
			15	-	65	170	
Propagation Delay Time (A _E - A _{OUT})	t _{pLZ} t _{pZL} t _{pHZ} t _{pZH}	R _L =1kΩ	5	-	130	400	ns
			10	-	55	160	
			15	-	30	120	
Max. Clock Frequency	f _{CL}		5	1.4	2.9	-	MHz
			10	3.5	7.1	-	
			15	5.1	10.2	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Clock Pulse Width	t _w		5	-	175	350	ns
			10	-	70	140	
			15	-	50	100	
Min. Pulse Width (A _E , P _S , A _S)	t _{WH}		5	-	145	290	ns
			10	-	55	110	
			15	-	40	80	
Min. Set-up Time (SERIAL IN - CLOCK)	t _{SU}		5	-	80	160	ns
			10	-	30	60	
			15	-	20	40	
Min. Set-up Time (A(B) _{IN} - CLOCK)	t _{SU}		5	-	60	150	ns
			10	-	20	50	
			15	-	10	25	
Input Capacitance	C _{IN}			-	5	7.5	pF

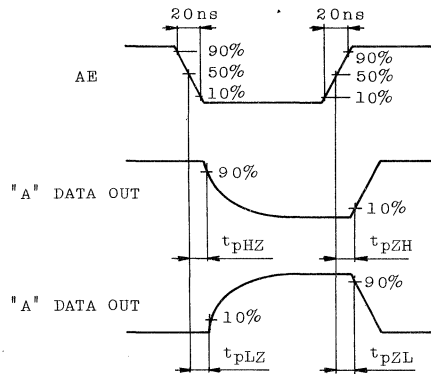
TC4034BP

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

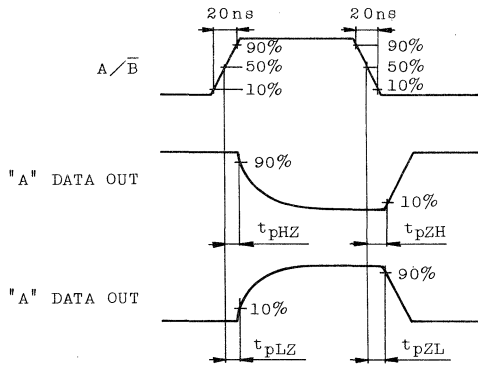
WAVEFORM 1.



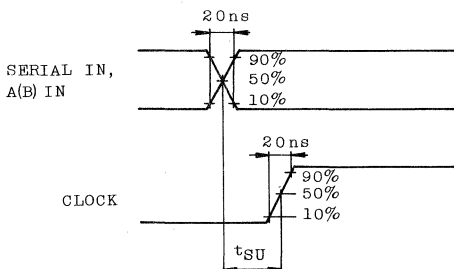
WAVEFORM 2.



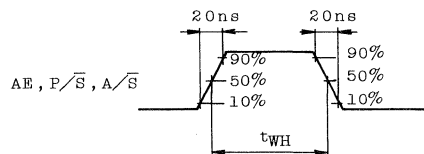
WAVEFORM 3. (AE="H")



WAVEFORM 4.

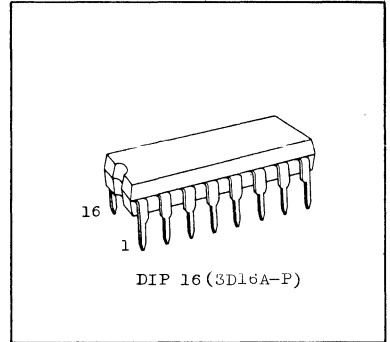


WAVEFORM 5.



TC4035BP 4-STAGE PARALLEL IN/PARALLEL OUT SHIFT REGISTER

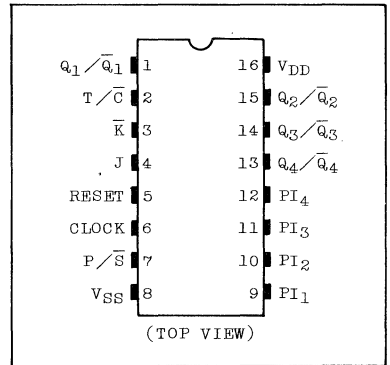
TC4035BP is 4 bit shift register having SERIAL mode and PARALLEL mode.
When PARALLEL/SERIAL CONTROL input is placed at "H", the parallel mode operation is designated and when it is placed at "L", the serial mode operation having J, \bar{K} logical inputs is designated.
The outputs are changed by rising edge of CLOCK input for both modes. When TRUE/COMPLEMENT Terminal is placed at "H", non-inverted signal is output and when it is placed at "L", inverted signal is output.
When RESET input is placed at "H", the content of register is reset regardless of other inputs.
In the case of SERIAL input, J and \bar{K} are connected for the data inputs.



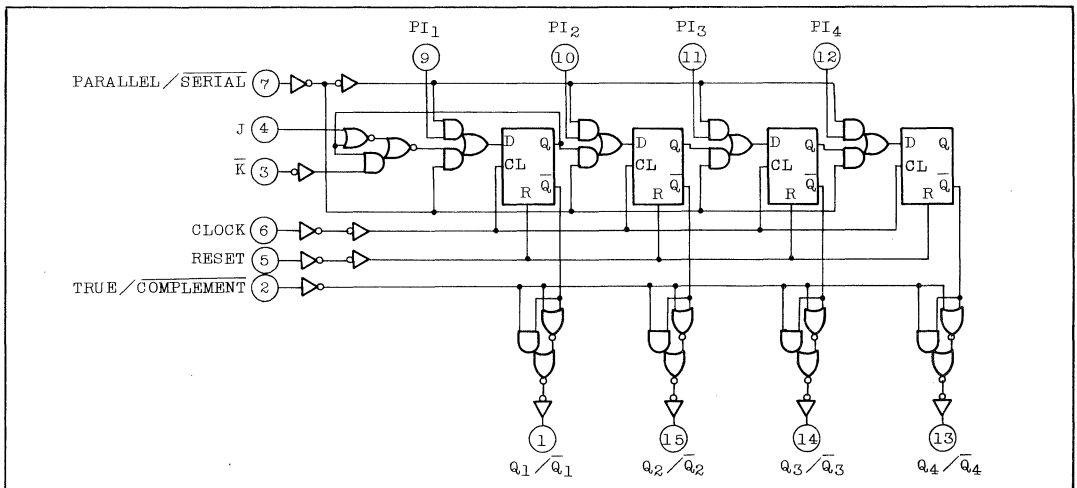
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM

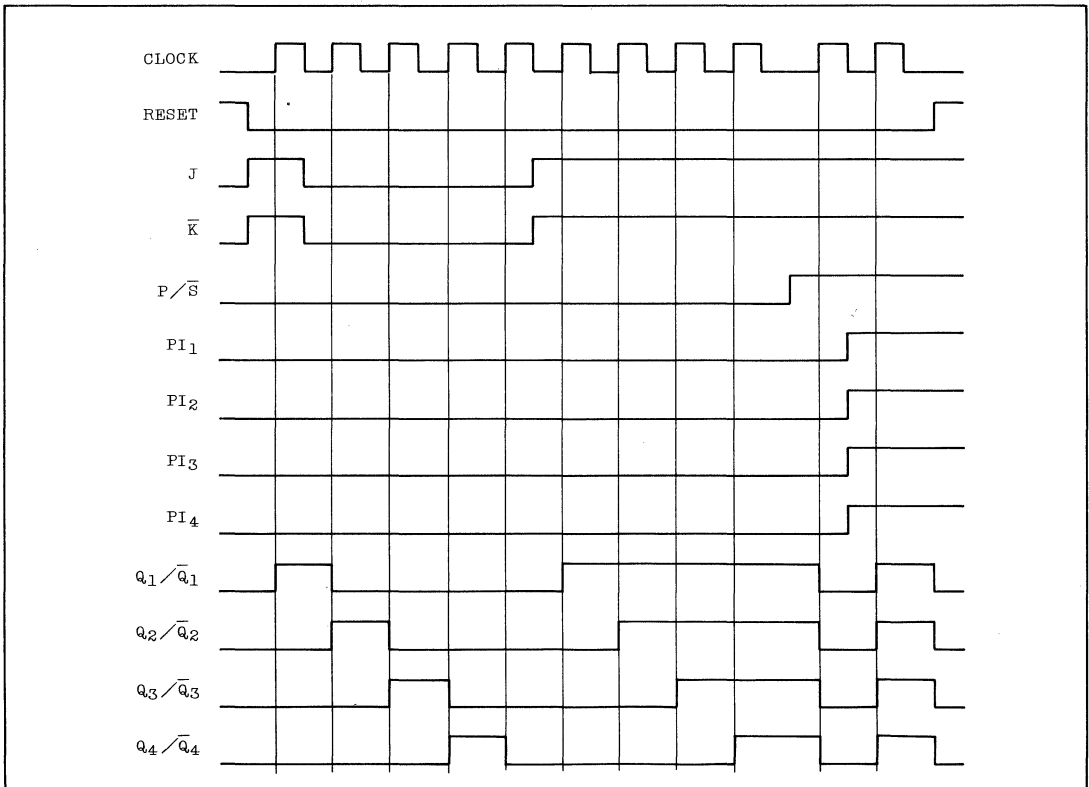


TC4035BP

TRUTH TABLE

INPUTS							OUTPUTS (T/C="H")		OUTPUTS (T/C="L")		* Don't care Δ Level change . No change .. Change n: 2~4
RESET	CLOCK ^Δ	P/ \bar{S}	J	\bar{K}	PI ₁	PI _n	Q ₁ / \bar{Q} ₁	Q _n / \bar{Q} _n	Q ₁ / \bar{Q} ₁	Q _n / \bar{Q} _n	
H	*	*	*	*	*	*	L	L	H	H	
L		H	*	*	L	L	L	L	H	H	
L		H	*	*	H	H	H	H	L	L	
L		L	L	L	*	*	L	Q _{n-1}	H	Q _{n-1}	
L		L	L	H	*	*	Q ₁ [.]		\bar{Q} ₁ [.]		
L		L	H	L	*	*	\bar{Q} ₁ ^{..}		Q ₁ ^{..}		
L		L	H	H	*	*	H		L		
L		*	*	*	*	*	Q ₁ [.]	Q _n [.]	\bar{Q} ₁ [.]	\bar{Q} _n [.]	

TIMING DIAGRAM (T/C="H")



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

TC4035BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

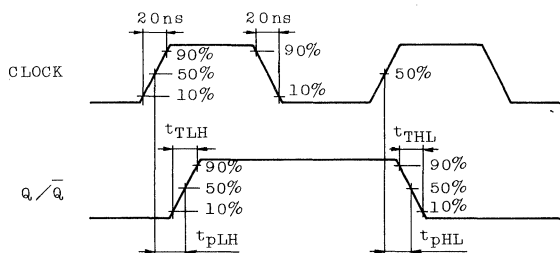
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	tTLH		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	tTHL		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q/Q̄)	t _p LH t _p HL		5	-	190	500	ns
			10	-	75	200	
			15	-	55	150	
Propagation Delay Time (RESET - Q/Q̄)	t _p LH t _p HL		5	-	160	460	ns
			10	-	65	200	
			15	-	45	160	
Max. Clock Frequency	f _{CL}		5	2	4	-	MHz
			10	6	12	-	
			15	8	16	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time	t _r CL t _f CL		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Clock Pulse Width	t _w		5	-	125	250	ns
			10	-	45	90	
			15	-	30	60	
Min. Pulse Width (RESET)	t _{WH}		5	-	110	250	ns
			10	-	45	110	
			15	-	30	80	
Min. Set-up Time (J, K̄ - CLOCK)	t _{SU}		5	-	55	220	ns
			10	-	20	80	
			15	-	15	60	
Min. Set-up Time (PI - CLCOK)	t _{SU}		5	-	40	140	ns
			10	-	15	50	
			15	-	10	40	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

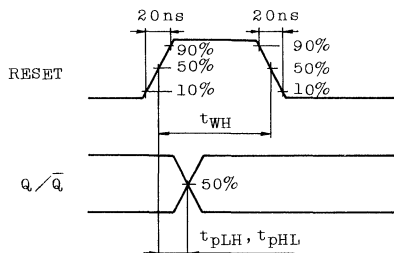
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			5				
Min. Set-up Time (P/ \bar{S} - CLOCK)	t _{SU}		5	-	40	500	ns
			10	-	15	200	
			15	-	10	150	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

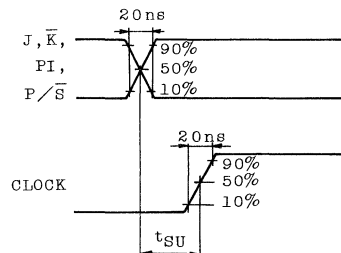
WAVEFORM 1.



WAVEFORM 2.



WAVEFORM 3.



TC4036BP, TC4039BP

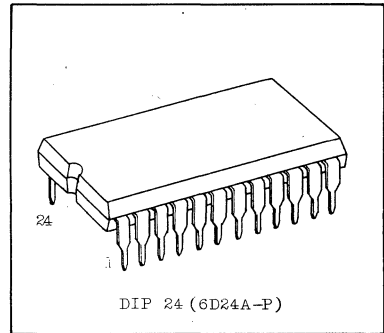
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4036BP 4 WORD × 8 BIT STATIC RAM (BINARY ADDRESSING)
TC4039BP 4 WORD × 8 BIT STATIC RAM (DIRECT WORD-LINE ADDRESSING)

TC4036BP/TC4039BP are static RAM of 4 × 8 bits and since eight data input/output lines are mutually independently provided for one word, wide variety of applications are expected for scratch pad memories, channel preset memories of digital frequency synthesizer systems, etc.

TC4036BP Each word is binarily selected by two lines of address inputs A₀ and A₁.

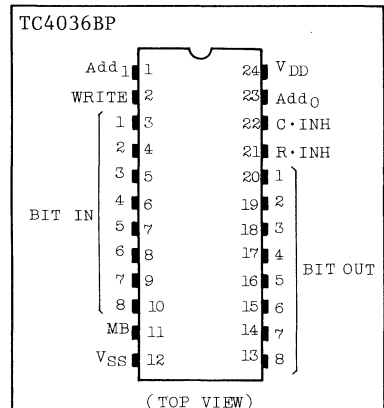
TC4039BP Each word is directly selected by mutually independent four lines of address inputs WORD 1 through WORD 4.



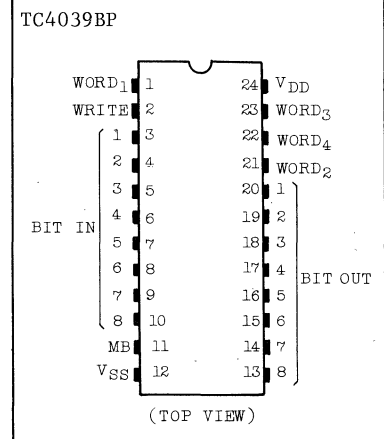
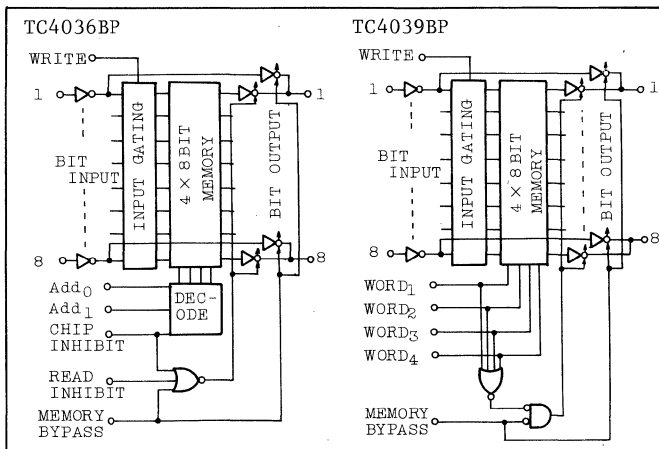
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



BLOCK DIAGRAM



FUNCTION TABLE

TC4036BP				
WRITE	READ INHIBIT	MEMORY BYPASS	CHIP INHIBIT	OPERATIONAL MODEL
*	*	L	H	Each bit output has high impedance generating floating condition. Writing into the memory is not performed.
*	*	H	H	Bit input data is directly output to the corresponding bit output. The memory retains the content of bit input data written in previous write mode.
L	*	H	L	
H	*	H	L	Bit input data is directly output to the corresponding bit output. But input data is written into the word memory designated by address inputs A0 and A1.
L	L	L	L	Memory data is read from the word designated by address inputs A0 and A1. Writing into the memory is not performed.
L	H	L	L	Each bit output has high impedance generating floating condition. Writing into the memory is not performed.
H	L	L	L	As well as each bit input data is written into the word memory designated by address inputs A0 and A1, the input data is read out.
H	H	L	L	Each bit output has high impedance generating floating condition. Each bit input data is written into the word memory designated by address inputs A0 and A1.
TC4039BP				
WRITE	MEMORY BYPASS	WORD1 ~ WORD4	OPERATIONAL MODE	
*	L	all L	Each bit output has high impedance generating floating condition. The memory retains the content of bit input data written in previous write mode.	
*	H	all L	Bit input data is directly output to the corresponding bit output. The memory retains the content of bit input data written in previous write mode.	
L	H	△△		
H	H	△△	Bit input data is directly output to the corresponding bit output. Each bit input data is written into the memory designated by the word input.	
L	L	△△	Memory data designated by the word input is read out. Writing into the memory is not performed.	
H	L	△△	As well as each bit input data is written into the memory designated by the word input, the input data is read out.	
* Don't care △△ Only one WORD input has "H" level.				

TC4036BP, TC4039BP

ADDRESS TRUTH TABLE

TC4036BP			TC4039BP				
Add ₁	Add ₀	ADDRESSED WORD	WORD 1	WORD 2	WORD 3	WORD 4	ADDRESSED WORD
L	L	WORD 1	H	L	L	L	WORD 1
L	H	WORD 2	L	H	L	L	WORD 2
H	L	WORD 3	L	L	H	L	WORD 3
H	H	WORD 4	L	L	L	H	WORD 4
OTHER STATES							*

* Inhibit mode

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

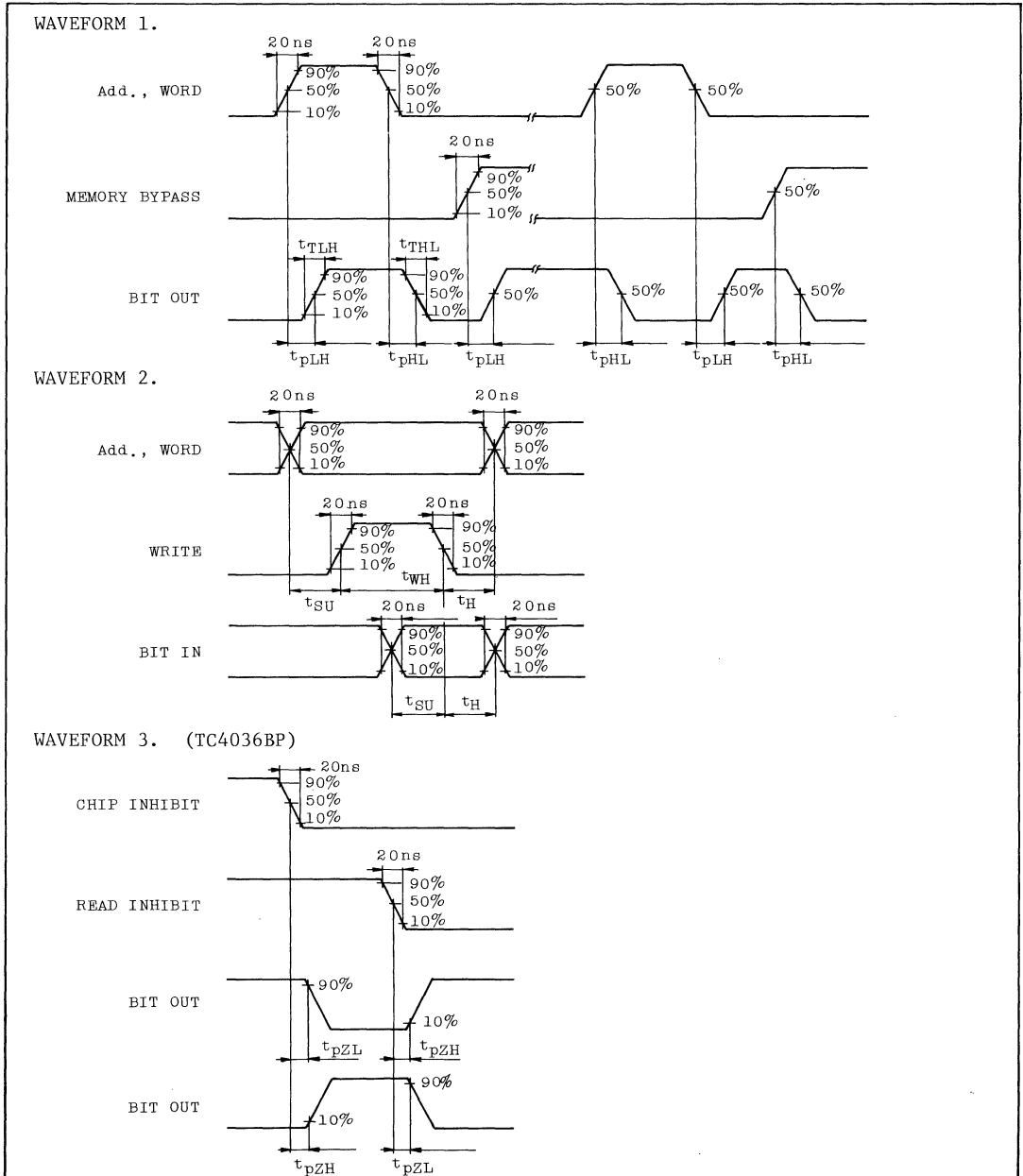
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	

TC4036BP, TC4039BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time (R·INH - BIT OUT) (TC4036BP)	t _{pZL} t _{pZH}	R _L =1kΩ	5	-	200	750	ns
			10	-	90	350	
			15	-	70	300	
Propagation Delay Time (C·INH - BIT OUT) (TC4036BP)	t _{pZL} t _{pZH}	R _L =1kΩ	5	-	250	750	ns
			10	-	120	350	
			15	-	90	300	
Propagation Delay Time (M·B - BIT OUT)	t _{pLH} t _{pHL}		5	-	210	750	ns
			10	-	100	350	
			15	-	80	300	
Propagation Delay Time (Add.WORD - BIT OUT)	t _{pLH} t _{pHL}		5	-	260	750	ns
			10	-	110	350	
			15	-	80	300	
Min. Set-up Time (Add. WORD - WRITE)	t _{SU}		5	-	45	200	ns
			10	-	25	110	
			15	-	20	60	
Min. Hold Time (Add. WORD - WRITE)	t _H		5	-	-60	100	ns
			10	-	-35	70	
			15	-	-25	40	
Min. Pulse Width (WRITE)	t _{WH}		5	-	60	150	ns
			10	-	20	60	
			15	-	15	50	
Min. Set-up Time (BIT IN - WRITE)	t _{SU}		5	-	-20	100	ns
			10	-	-15	50	
			15	-	-10	40	
Min. Hold Time (BIT IN - WRITE)	t _H		5	-	40	200	ns
			10	-	25	90	
			15	-	20	60	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4040BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4040BP/TC4040BF 12 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS

TC4040BP/BF is 12 stage ripple-carry binary counter with the asynchronous clear function. The counter advances its counting state by falling edge of $\overline{\text{CLOCK}}$ input. When RESET input is placed at "H", all the circuits are reset making all the outputs (Q1 through Q12) to be "L" regardless of $\overline{\text{CLOCK}}$ Input. This is most suitable for frequency dividers, control circuits and timing circuits.

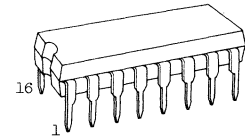
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

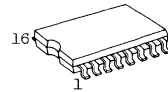
TRUTH TABLE

CLCOK Δ	RESET	OUTPUT STAGE
*	H	ALL OUTPUTS="L"
	L	NO CHANGE
	L	ADVANCE TO NEXT STAGE

Δ : LEVEL CHANGE, *: DON'T CARE

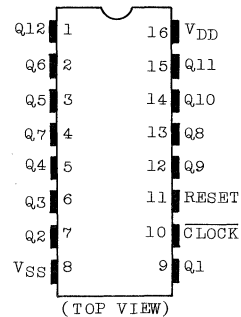


DIP16(3D16A-P)

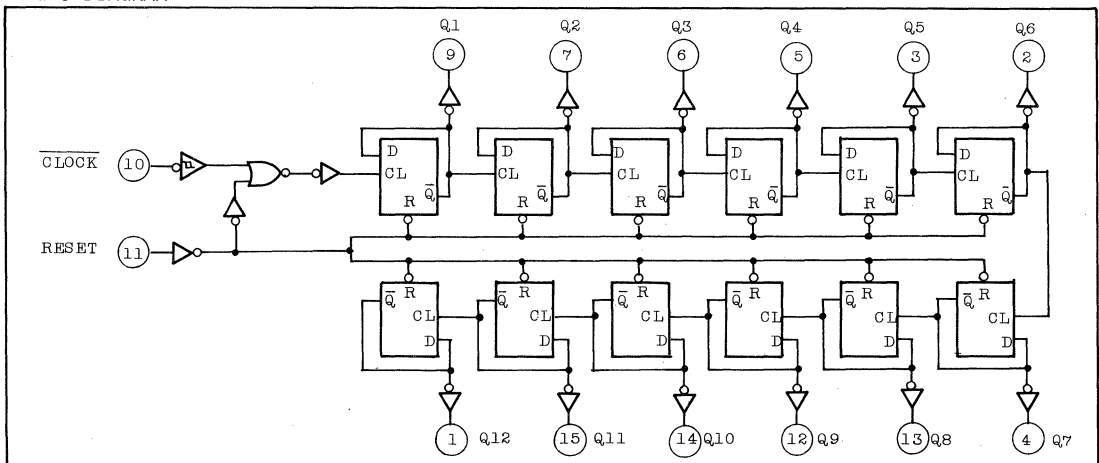


MFP16(F16GC-P)

PIN ASSIGNMENT



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.52	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

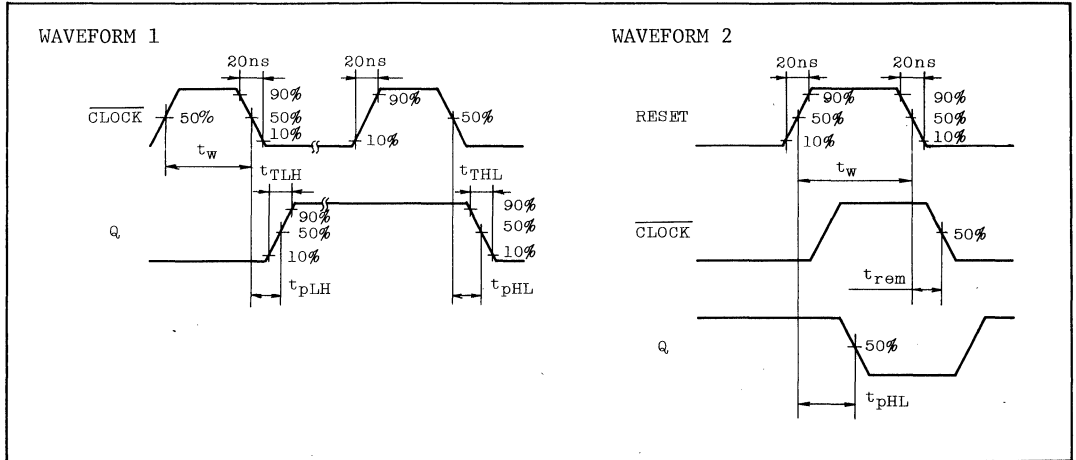
* All valid input combinations.

TC4040BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{PLH}		5	-	160	360	
			10	-	80	160	
			15	-	65	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q1)	t _{PHL}		5	-	160	360	
			10	-	80	160	
			15	-	65	130	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q12)	t _{PLH}		5	-	900	1800	
			10	-	450	900	
			15	-	360	720	
Propagation Delay Time ($\overline{\text{CLOCK}}$ - Q12)	t _{PHL}		5	-	900	1800	
			10	-	450	900	
			15	-	360	720	
Propagation Delay Time (RESET - Q)	t _{PHL}		5	-	150	280	
			10	-	70	120	
			15	-	50	100	
Max. Clock Frequency	f _{CL}		5	3.5	10	-	MHz
			10	8	20	-	
			15	12	25	-	
Min. Clock Pulse Width	t _w		5	-	50	140	ns
			10	-	20	60	
			15	-	15	40	
Min. Pulse Width (RESET)	t _w		5	-	100	200	
			10	-	40	80	
			15	-	30	60	
Min. Removal Time (RESET - $\overline{\text{CLOCK}}$)	t _{rem}		5	-	-	350	
			10	-	-	150	
			15	-	-	100	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5 10 15	No Limit				μs
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4042BP/BF

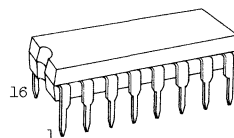
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4042BP/TC4042BF QUAD CLOCKED "D" LATCH

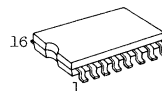
TC4042BP/BF contains four circuits of "D" type latches having common CLOCK input and POLARITY input.

When POLARITY input is placed at "H" level, D input appears as it is at Q output during CLOCK input stays high and D input at the time of falling edge of CLOCK input is retained at Q output. As long as CLOCK input stays low, Q output is not changed even when D input varies.

When POLARITY input is placed "L", D input appears as it is at Q output during CLOCK input stays at "L" level and the latch operation is seen as long as CLOCK input is "H".



DIP16 (3D16A-P)

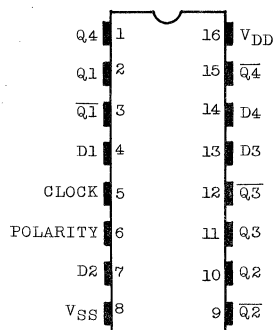


MFP16 (F16GC-P)

ABSOLUTE MAXIMUM RATINGS

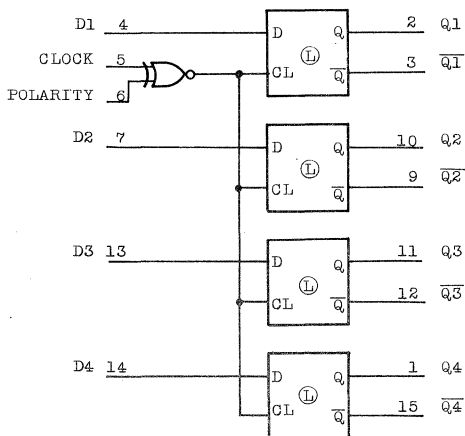
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



(TOP VIEW)

BLOCK DIAGRAM



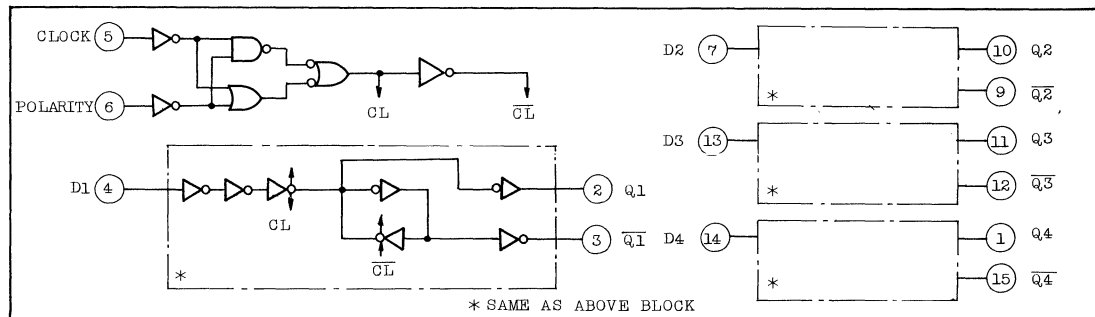
TRUTH TABLE

INPUTS		OUTPUTS
CLOCK Δ	POLARITY	Q _n *
H	H	D _n
L	L	D _n
\downarrow	L	LATCH
\uparrow	H	LATCH

Δ : Level Change

* : 1 ~ 4

LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
Output Low Current	I _{OL}	V _{OL} =-0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA
			10	1.5	-	1.3	3.2	-	1.1	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
			15	-	4.0	-	6.75	4.0	-	4.0	

TC4042BP/BF

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC		SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD}	5	-	1	-	0.002	1	-	30		
			10	-	2	-	0.004	2	-	60		
			15	-	4	-	0.008	4	-	120		

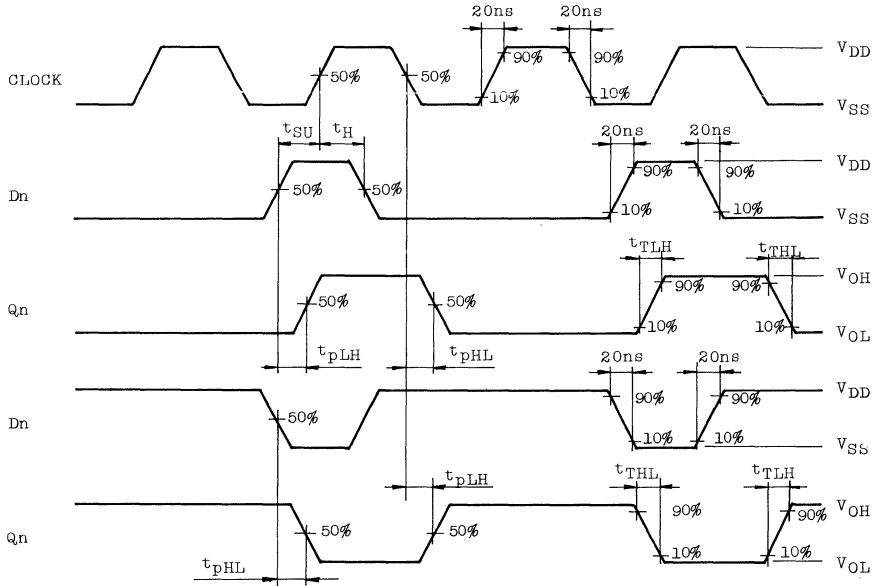
* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

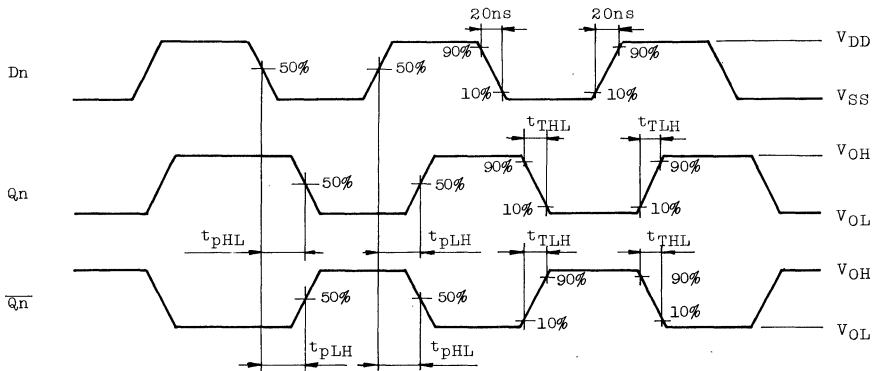
CHARACTERISTICS	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transisition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - Q, \bar{Q})	t _{pLH} t _{pHL}		5	-	150	440	
			10	-	70	180	
			15	-	50	120	
Propagation Delay Time (DATA - Q, \bar{Q})	t _{pLH} t _{pHL}		5	-	110	220	
			10	-	55	110	
			15	-	40	80	
Min. Clock Pulse Width	t _w		5	-	55	200	
			10	-	25	100	
			15	-	20	60	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	5	50	
			10	-	3	20	
			15	-	2	20	
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	20	50	
			10	-	10	30	
			15	-	5	25	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

WAVEFORM 1 (POLARITY="L")



WAVEFORM 2 (CLOCK=POLARITY="H")



TC4043BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

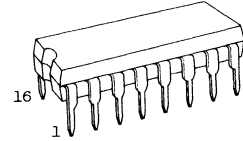
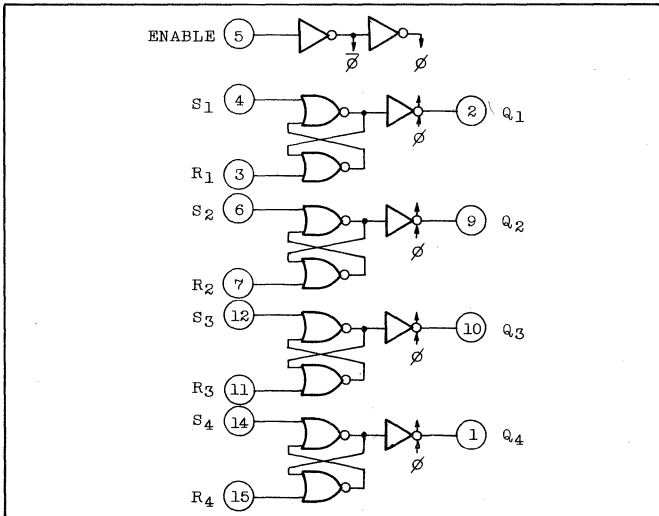
TC4043BP QUAD 3-STATE R/S LATCH (Quad NOR R/S Latch)

TC4043BP is the latches composed by four independent R/S flip-flop circuits. TC4043BP fabricated with NOR gates is suitable for data processing of four bits configuration. Four output lines can have high impedance regardless of the contents of latches by means of common ENABLE input to make connection to the bus lines easy.

ABSOLUTE MAXIMUM RATINGS

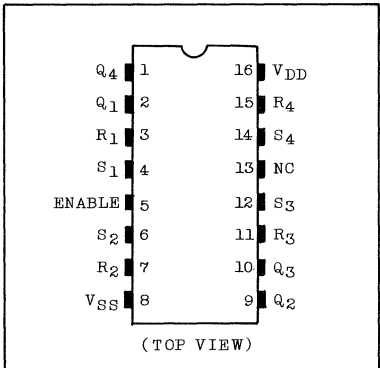
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

LOGIC DIAGRAM



DIP16 (3D16A-P)

PIN ASSIGNMENT



TRUTH TABLE

S	R	E	Q
*	*	L	HZ
L	L	H	No Change
L	H	H	L
H	L	H	H
H	H	H	H

* : Don't Care
HZ : High Impedance

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.5	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			18	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4043BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

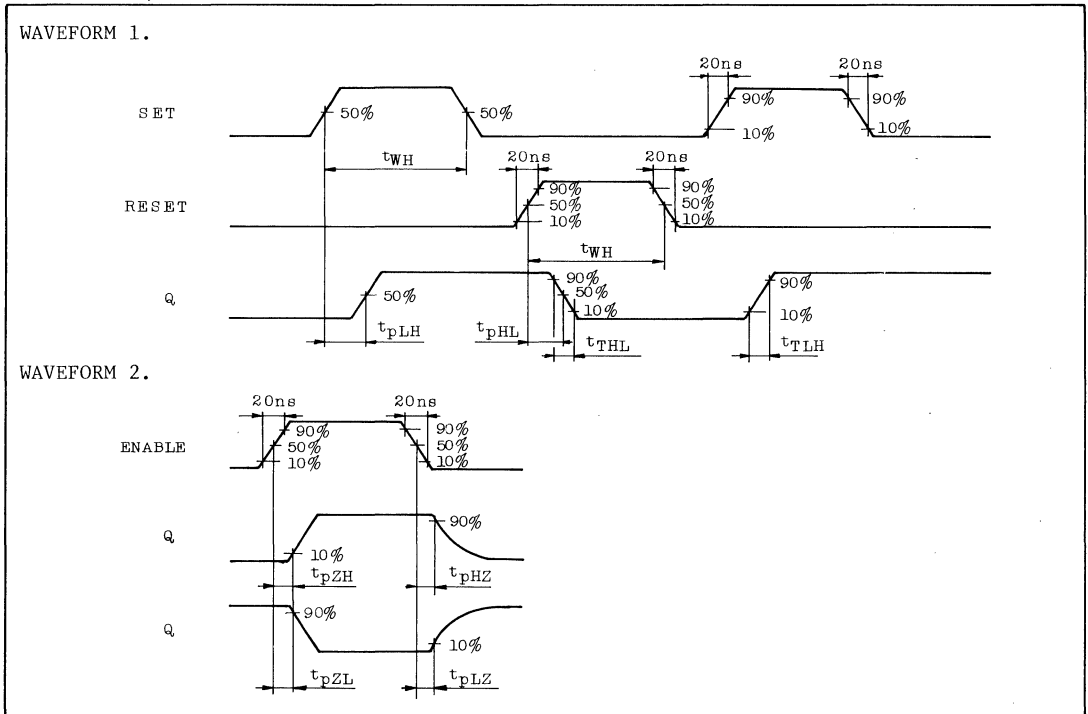
CHARACTERISTIC		SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OH} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OL} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current		I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA
				10	-	2	-	0.004	2	-	60	
				15	-	4	-	0.008	4	-	120	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (SET, RESET - Q)	t _{pLH} t _{pHL}		5	-	150	300	ns
			10	-	60	140	
			15	-	40	100	
3-State Propagation Delay Time (ENABLE - Q)	t _{pHZ} t _{pZH}	R _L =1kΩ	5	-	60	230	ns
			10	-	25	110	
			15	-	20	80	
3-State Propagation Delay Time (ENABLE - Q)	t _{pLZ} t _{pZL}	R _L =1kΩ	5	-	80	180	ns
			10	-	35	100	
			15	-	25	70	
Min. Pulse Width (SET, RESET)	t _{WH}		5	-	30	160	ns
			10	-	15	80	
			15	-	10	40	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4044BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

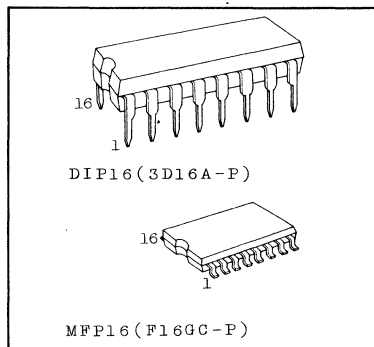
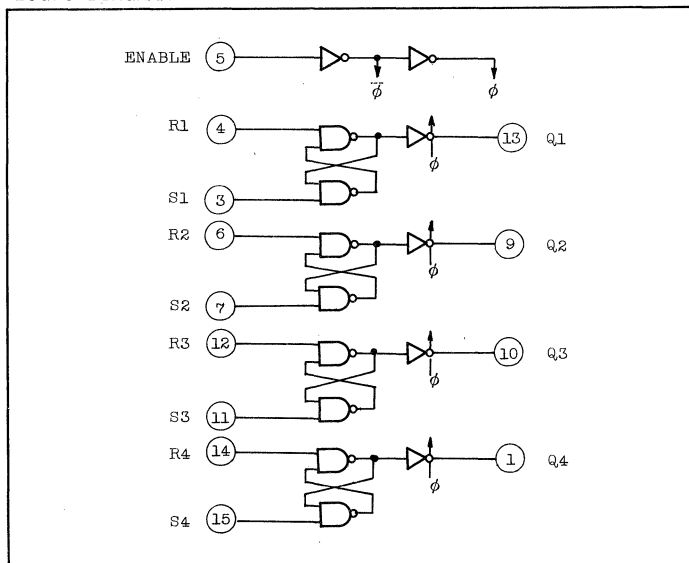
TC4044BP/TC4044BF QUAD 3-STATE R/S LATCH (Quad NAND R/S Latch)

TC4044BP/BF the latches composed by four independent R/S flip-flop circuits. TC4044BP/BF fabricated with NAND gates is suitable for data processing of four bits configuration. Four output lines can have high impedance regardless of the contents of latches by means of common ENABLE input to make connection to the bus lines easy.

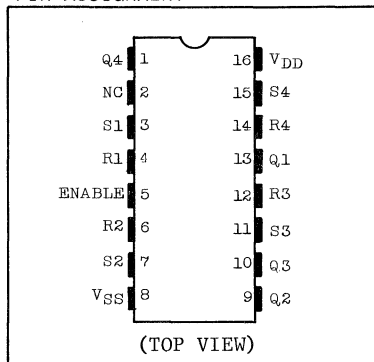
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

R	S	E	Q
*	*	L	HZ
L	L	H	L
L	H	H	L
H	L	H	H
H	H	H	No Change

* : Don't Care

HZ : High Impedance

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			10	-2.5	-	-2.1	-4.0	-	-1.7	-		
			15	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	10 ⁻⁵	-0.1	-	-1.0	

TC4044BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

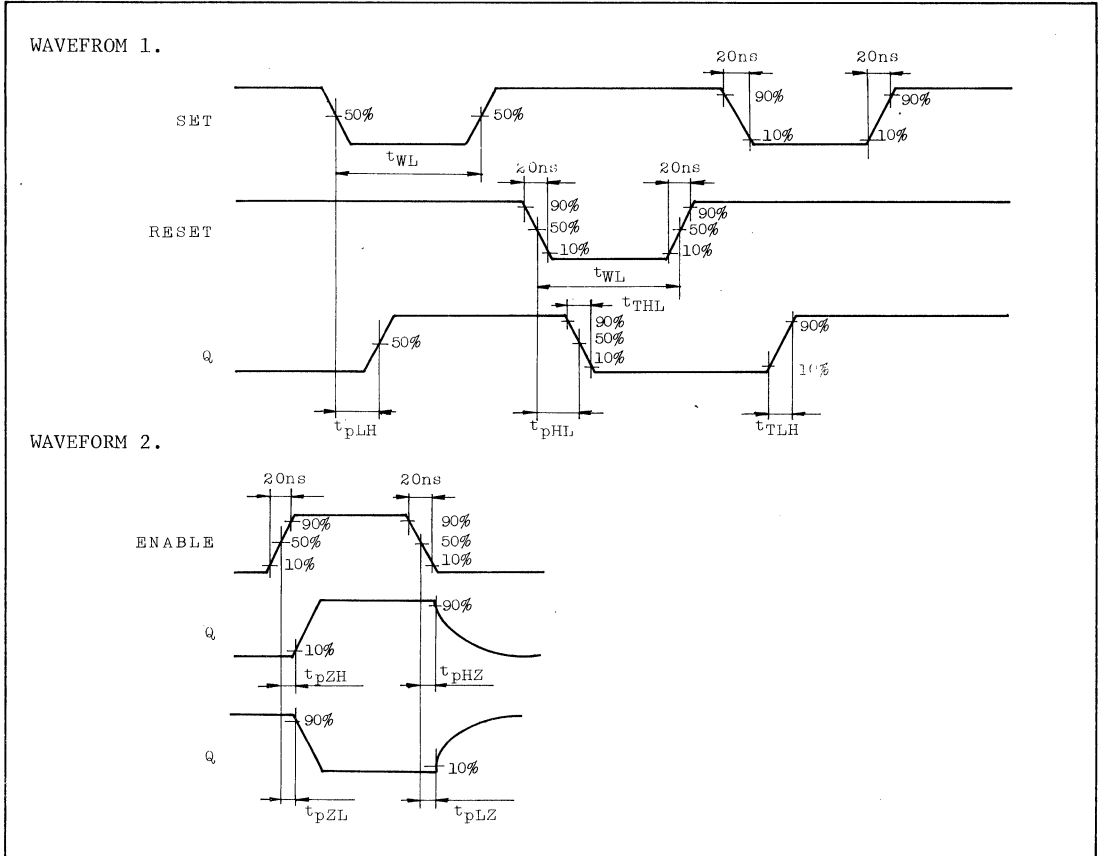
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
3-State Output Leakage Current	"H" Level	I _{DH}	VOH=18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	VOL=0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA	
			10	-	2	-	0.004	2	-	60		
			15	-	4	-	0.008	4	-	120		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Output Transition Time (High to Low)	t _{THL}		5 10 15	- - -	70 35 30	200 100 80	
Propagation Delay Time (SET, RESET - Q)	t _{pLH}		5 10 15	- - -	90 45 35	300 140 100	
	t _{pHL}						
3-State Propagation Delay Time (ENABLE - Q)	t _{pHZ}	R _L =1kΩ	5 10 15	- - -	55 35 30	180 100 70	
	t _{pLZ}						
	t _{pZH}						
3-State Propagation Delay Time (ENABLE - Q)	t _{pZH}	R _L =1kΩ	5 10 15	- - -	55 30 25	180 100 70	
	t _{pZL}						
	t _{pZL}						
Min. Pulse Width (SET, RESET)	t _{WL}		5 10 15	- - -	25 20 20	160 80 40	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4047BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

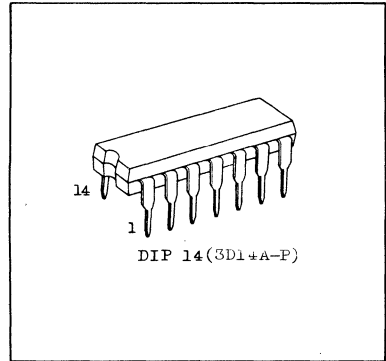
TC4047BP LOW-POWER MONOSTABLE/ASTABLE MULTIVIBRATOR

TC4047BP is the multivibrator equipped with both astable function and mono-stable function, and retrigger operation and reset operation are also achievable.

For both operational modes, the pulse width can be varied by externally connected capacitor (C) and resistor (R).

Establish RETRIG="L". +TRIG="L", -TRIG="H" for astable operation and AST="L", $\overline{\text{AST}}$ ="H" for mono-stable operation. (Refer to FUNCTION TABLE and OPERATING CONSIDERATIONS).

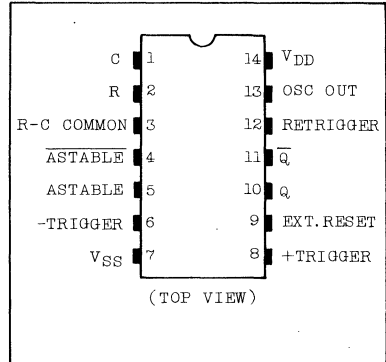
When EXTERNAL RESET input is set at "H", both operational modes of astable and mono-stable operations are reset to Q="L" and $\overline{\text{Q}}$ ="H".



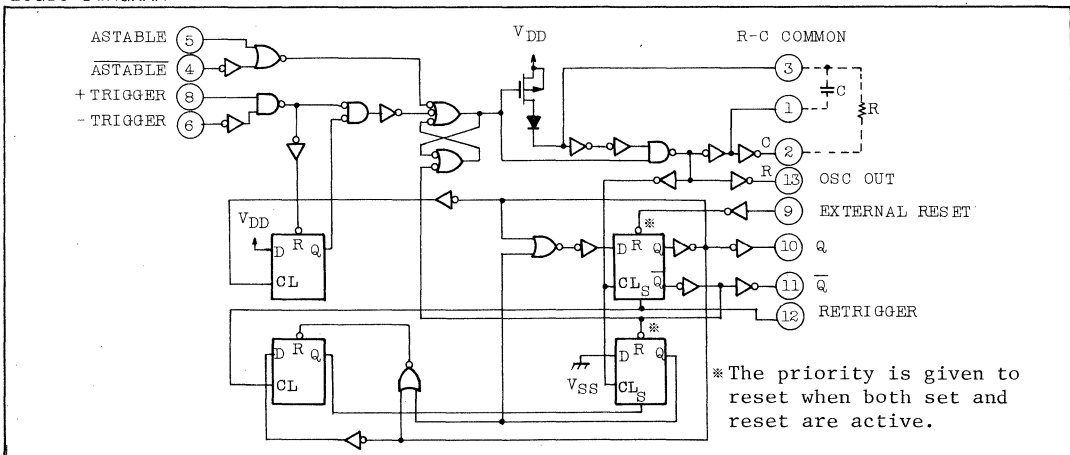
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	




PIN ASSIGNMENT



LOGIC DIAGRAM



FUNCTION TABLE

FUNCTION							OUTPUT PERIOD OR PULSE WIDTH
	AST.	AST.	-TRIG.	+TRIG.	RETRIG.	EXT. RESET	
ASTABLE MULTIVIBRATOR							Q, \bar{Q}
Free Running	*	H	H	L	L	L	T=4.40RC
	L	*	H	L	L	L	OSC OUT
Inhibit	H	L	H	L	L	L	T=2.20RC
MONOSTABLE MULTIVIBRATOR							Q, \bar{Q}
Positive-Edge Trigger	H	L	L		L	L	t _w =2.48RC
Negative-Edge Trigger	H	L		H	L	L	
Retrigger	H	L	L			L	
Note : External resistor and capacitance as LOGIC DIAGRAM * Don't care							

OPERATING CONSIDERATION

1. Astable Operation

By connecting inputs of -TRIGGER, +TRIGGER, RETRIGGER AND EXTERNAL RESET as shown in FUNCTION TABLE, stable operation of astable multivibrator can be obtained.

- When ASTABLE input is placed at "H", oscillation is continued regardless of ASTABLE input. When ASTABLE input is placed at "L", oscillation is continued regardless of ASTABLE input. (Free Running).
- Having ASTABLE input at "H", if ASTABLE input is set at "L", oscillation stops as long as it is at "L". (True Gating)
- Having ASTABLE input at "L", if ASTABLE input is set at "H", oscillation stops as long as it is at "H". (Complement Gating)

The oscillating period is determined by the external resistor and capacitor to be approximately T=2.2RC. This oscillation waveform is obtained as it is at OSC OUT and the oscillation waveform with double period and 50% duty cycle is obtained at outputs Q and \bar{Q} .

2. Mono-Stable Operation

By connecting ASTABLE and ASTABLE inputs to "L" level and "H" level respectively, mono-stable multivibrator with the capabilities of retrigger operation and external asynchronous reset operation is obtained. This is normally used with RETRIGGER input and EXTERNAL RESET input connected to "L" level.

- When -TRIGGER input is set to "L", mono-stable pulse is obtained at the rising edge of +TRIGGER input at Q and \bar{Q} outputs. (Positive-edge Trigger)
- When +TRIGGER input is set to "H", mono-stable pulse is obtained at the falling edge of -TRIGGER input at Q and \bar{Q} outputs. (Negative-edge Trigger)
- Keeping -TRIGGER input at "L", if the same pulse input (T<2.48RC) is applied to both +TRIGGER input and RETRIGGER input, retrigger operation is achieved.

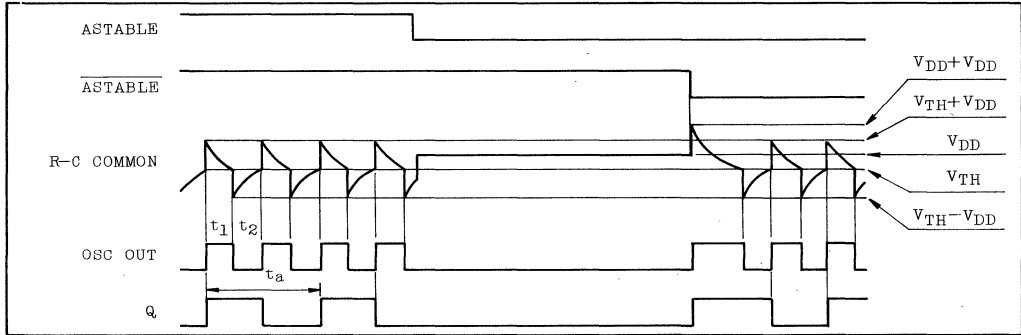
However, the last transition of this pulse input must be negative going. (Retrigger)
The width of mono-stable pulse is determined by the external resistor and capacitor to be approximately t_w=2.48RC.

Note : The external resistor and capacitor should be connected as shown by broken lines in the logical diagram for both mono-stable and astable operations.
The capacitor used should be non-directional.

TC4047BP

TIMING DIAGRAM

(ASTABLE MODE)

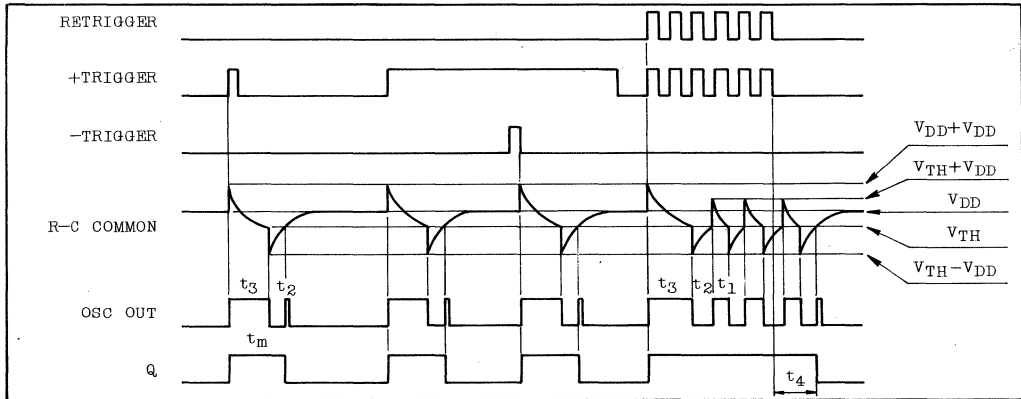


$$t_1 = -RC \ln \frac{V_{TH}}{V_{DD} + V_{TH}} \quad , \quad t_2 = -RC \ln \frac{V_{DD} - V_{TH}}{2V_{DD} - V_{TH}}$$

$$t_a = 2(t_1 + t_2) = -2RC \ln \frac{V_{TH}(V_{DD} - V_{TH})}{(V_{DD} + V_{TH})(2V_{DD} - V_{TH})}$$

TYPICAL : $V_{TH} = 1/2V_{DD}$ $t_a = 4.40RC$

(MONO STABLE MODE)



$$t_1 = -RC \ln \frac{V_{TH}}{V_{DD} + V_{TH}} \quad , \quad t_2 = -RC \ln \frac{V_{DD} - V_{TH}}{2V_{DD} - V_{TH}}$$

$$t_3 = -RC \ln \frac{V_{TH}}{2V_{DD}} \quad , \quad t_1 + t_2 < t_4 < 2(t_1 + t_2)$$

$$t_m = t_3 + t_2 = -RC \ln \frac{V_{TH}(V_{DD} - V_{TH})}{2V_{DD}(2V_{DD} - V_{TH})}$$

TYPICAL : $V_{TH} = 1/2V_{DD}$ $t_m = 2.48RC$

Note : V_{TH} : Threshold Level

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
External Resistance	R _X	5	-	1000	kΩ
External Condenser	C _X	No Limit			μF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-	
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-	
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-	
		V _{IN} =V _{SS} , V _{DD}									
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-	
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-	
		V _{IN} =V _{SS} , V _{DD}									
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-	
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-	
		|I _{OUT}| < 1μA									
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0	
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0	
		|I _{OUT}| < 1μA									

TC4047BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC		SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current		I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.005	1	-	30	μA
				10	-	2	-	0.010	2	-	60	
				15	-	4	-	0.015	4	-	120	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

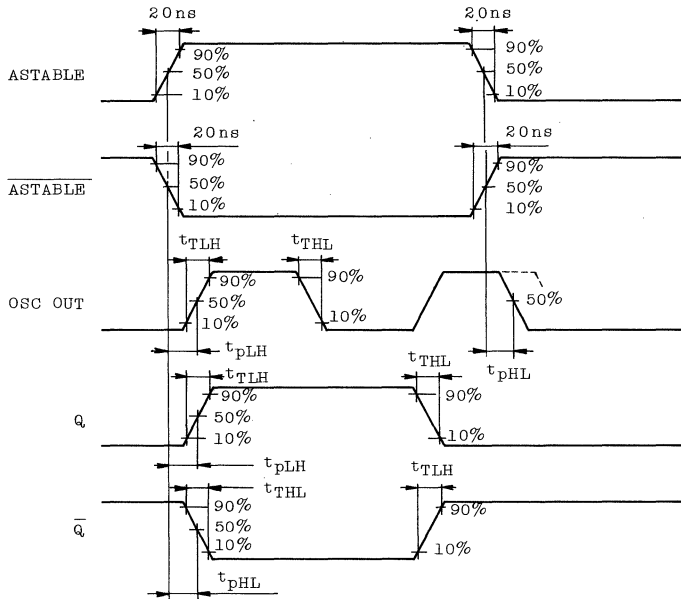
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (ASTABLE, $\overline{\text{ASTABLE}}$ - OSC OUT)	t _{pLH} t _{pHL}		5	-	290	580	ns
			10	-	110	220	
			15	-	70	160	
Propagation Delay Time (ASTABLE, $\overline{\text{ASTABLE}}$ - Q, \overline{Q})	t _{pLH} t _{pHL}		5	-	480	960	ns
			10	-	170	350	
			15	-	110	250	
Propagation Delay Time (+TRIGGER, -TRIGGER - Q, \overline{Q})	t _{pLH} t _{pHL}		5	-	550	1100	ns
			10	-	200	450	
			15	-	130	300	
Propagation Delay Time (RETRIGGER - Q, \overline{Q})	t _{pLH} t _{pHL}		5	-	250	600	ns
			10	-	100	300	
			15	-	65	200	
Propagation Delay Time (EXTERNAL RESET - Q, \overline{Q})	t _{pLH} t _{pHL}		5	-	270	540	ns
			10	-	100	200	
			15	-	65	140	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

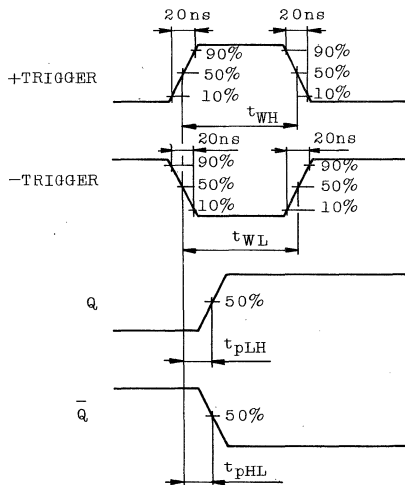
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width (+TRIGGER, -TRIGGER)	t _{WH} t _{WL}		5	-	370	740	ns
			10	-	130	260	
			15	-	70	140	
Min. Pulse Width (EXT. RESET)	t _{WH}		5	-	100	200	ns
			10	-	35	100	
			15	-	25	60	
Min. Pulse Width (RETRIGGER)	t _{WH}		5	-	95	600	ns
			10	-	40	230	
			15	-	25	150	
Max. Clock Input Rise Time	t _r		5	20	-	-	μs
Max. Clock Input Fall Time	t _f		10	2.5	-	-	
			15	1.0	-	-	
Deviation from 50% Duty Factor (Q, \bar{Q})		$\frac{t_w(H) - t_w(L)}{t_w(L)} \times 100$ (%)	5	-	±0.2	-	%
			10	-	±0.2	-	
			15	-	±0.1	-	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

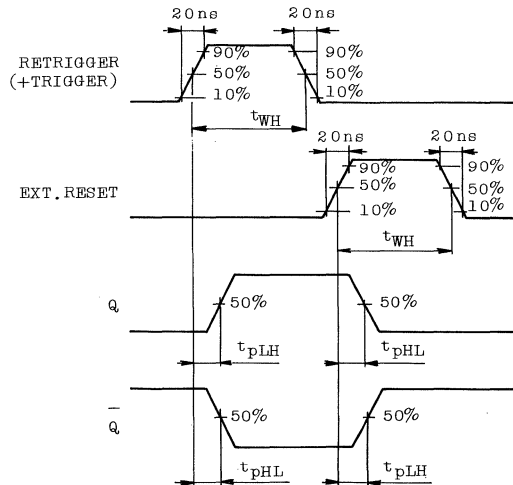
WAVEFORM 1.



WAVEFORM 2.



WAVEFORM 3.

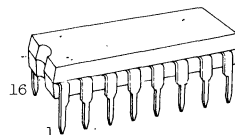


TC4049BP/TC4049BF HEX BUFFER/CONVERTER (Inverting Type)
TC4050BP/TC4050BF HEX BUFFER/CONVERTER (Non-Inverting Type)

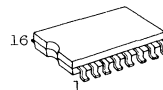
TC4049BP/BF, TC4050BP/BF contain six circuits of buffers. TC4049BP/BF is inverter type and TC4050BP/BF is non-inverter type.

Since one TTL or DTL can be directly driven having large output current, these are useful for interfacing from CMOS to TTL or DTL. As voltage up to $V_{SS} + 18$ volts can be applied to the input regardless of V_{DD} , these can be also used as the level converter IC's which converts CMOS logical circuits of 15 volts or 10 volts system to CMOS/TTL logical circuits of 5 volts system.

Ideal switching characteristic has been obtained by the circuit diagram of three stage inverters for TC4049BP/BF and two stage inverters for TC4050BP/BF.



DIP16 (3D16A-P)

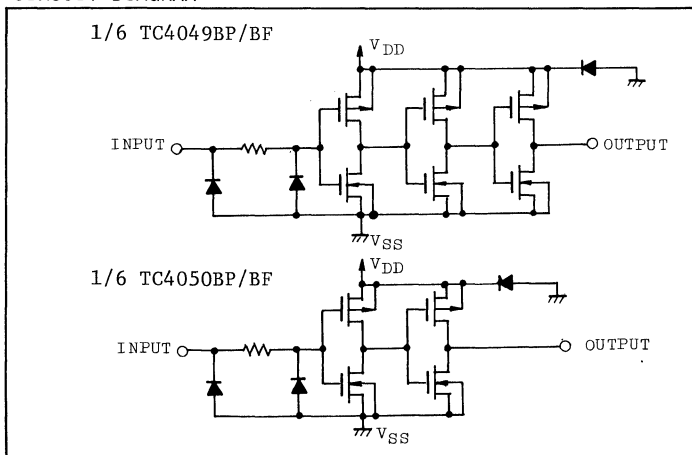


MFP16 (F16GC-P)

ABSOLUTE MAXIMUM RATINGS

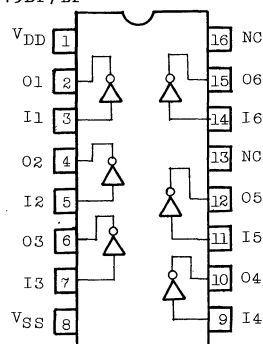
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{SS}+20$	v
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Voltage	I_{IN}	-10	mA
Power Dissipation	P_D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10 \text{ sec}$	

CIRCUIT DIAGRAM

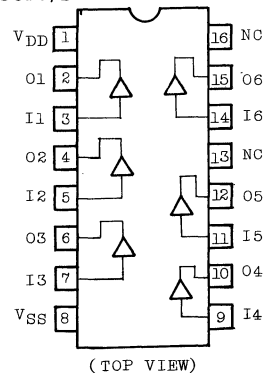


PIN ASSIGNMENT

TC4049BP/BF



TC4050BP/BF



(TOP VIEW)

TC4049BP/BF, TC4050BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	18	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.73	-	-0.65	-1.2	-	-0.58	-	mA	
			5	-2.4	-	-2.1	-3.9	-	-1.9	-		
			10	-1.8	-	-1.65	-2.5	-	-1.35	-		
			15	-4.8	-	-4.3	-8.0	-	-3.5	-		
			15	-	-	-	-	-	-	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	3.8	-	3.2	6.4	-	2.9	-	mA	
			10	9.6	-	8.0	16	-	6.6	-		
			15	25.0	-	24.0	48	-	20.0	-		
			15	-	-	-	-	-	-	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	-	-	-	-	-	-	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	-	-	-	-	-	-		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA	
			10	-	2	-	0.004	2	-	60		
			15	-	4	-	0.008	4	-	120		

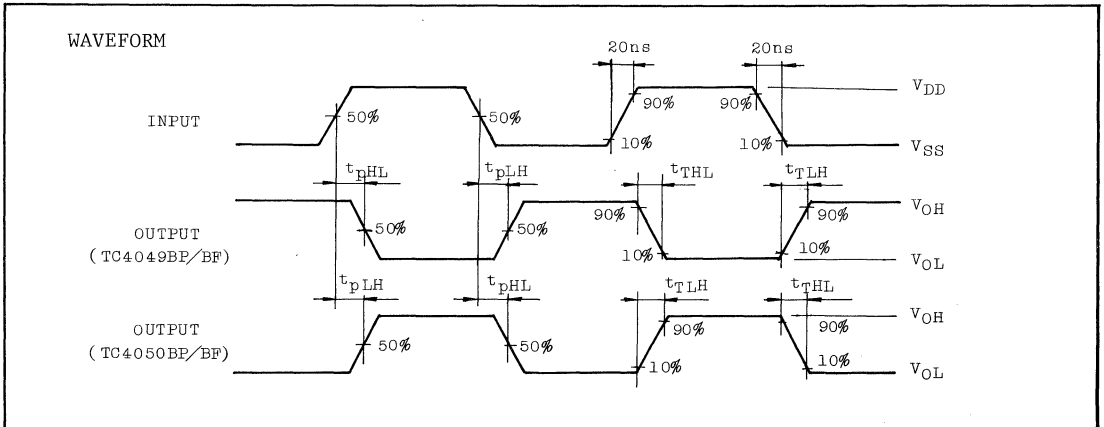
* All valid input combinations.

TC4049BP/BF, TC4050BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC		SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX	UNITS
Output Transition Time (Low to High)		t_{TLH}		5	-	60	160	ns
				10	-	30	80	
				15	-	25	60	
Output Transition Time (High to Low)		t_{THL}		5	-	20	60	
				10	-	10	40	
				15	-	8	30	
TC4049BP/BF	Propagation Delay Time (Low to High)	t_{pLH}		5	-	60	120	
				10	-	35	65	
				15	-	30	50	
	Propagation Delay Time (High to Low)	t_{pHL}		5	-	40	60	
				10	-	20	30	
				15	-	15	20	
TC4050BP/BF	Propagation Delay Time (Low to High)	t_{pLH}		5	-	50	130	
				10	-	30	70	
				15	-	25	55	
	Propagation Delay Time (High to Low)	t_{pHL}		5	-	30	70	
				10	-	17	35	
				15	-	14	25	
Input Capacitance		C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4051BP/BF, TC4052BP/BF, TC4053BP/BF

TC4051BP/TC4051BF SINGLE 8-CHANNEL MULTIPLEXER/DEMULTIPLEXER
 TC4052BP/TC4052BF DIFFERENTIAL 4-CHANNEL MULTIPLEXER/DEMULTIPLEXER
 TC4053BP/TC4053BF TRIPLE 2-CHANNEL MULTIPLEXER/DEMULTIPLEXER

TC4051BP/BF, TC4052BP/BF and TC4053BP/BF are multiplexers with capabilities of selection and mixture of analog signal and digital signal. TC4051BP/BF has 8 channels configuration. TC4052BP/BF has 4 channel $\times 2$ configuration and TC4053BP/BF has 2 channel $\times 3$ configuration.

The digital signal to the control terminal turns "ON" the corresponding switch of each channel, with large amplitude ($V_{DD}-V_{EE}$) can be switched by the control signal with small logical amplitude ($V_{DD}-V_{SS}$). For example, in the case of $V_{DD}=5V$, $V_{SS}=0V$ and $V_{EE}=-5V$, signals between $-5V$ and $+5V$ can be switched from the logical circuit with single power supply of 5 volts. As the ON-resistance of each switch is low, these can be connected to the circuits with low input impedance.

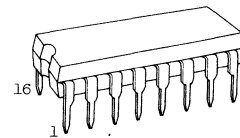
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	$V_{DD}-V_{SS}$	$-0.5 \sim 20$	V
DC Supply Voltage	$V_{DD}-V_{EE}$	$-0.5 \sim 20$	V
Control Input Voltage	V_{CIN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Switch I/O Voltage	$V_{I/O}$	$V_{EE}-0.5 \sim V_{DD}+0.5$	V
Control Input Current	I_{CIN}	± 10	mA
Potential difference across I/O during ON	V_{I-0}	$-0.5 \sim 0.5$	V
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10 \text{ sec}$	

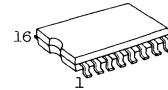
TRUTH TABLE

CONTROL INPUTS				"ON" CHANNEL		
INHIBIT	C^A	B	A	TC4051BP	TC4052BP	TC4053BP
				TC4051BF	TC4052BF	TC4053BF
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	-	0X, 0Y, 1Z
L	H	L	H	5	-	1X, 0Y, 1Z
L	H	H	L	6	-	0X, 1Y, 1Z
L	H	H	H	7	-	1X, 1Y, 1Z
H	*	*	*	NOTE	NOTE	NOTE

* DON'T CARE Δ EXCEPT TC4052

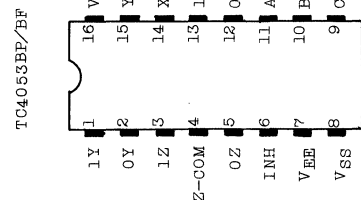
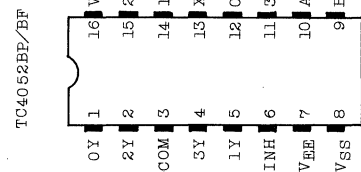
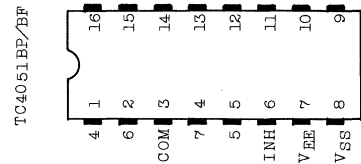


DIP16(3D16A-P)

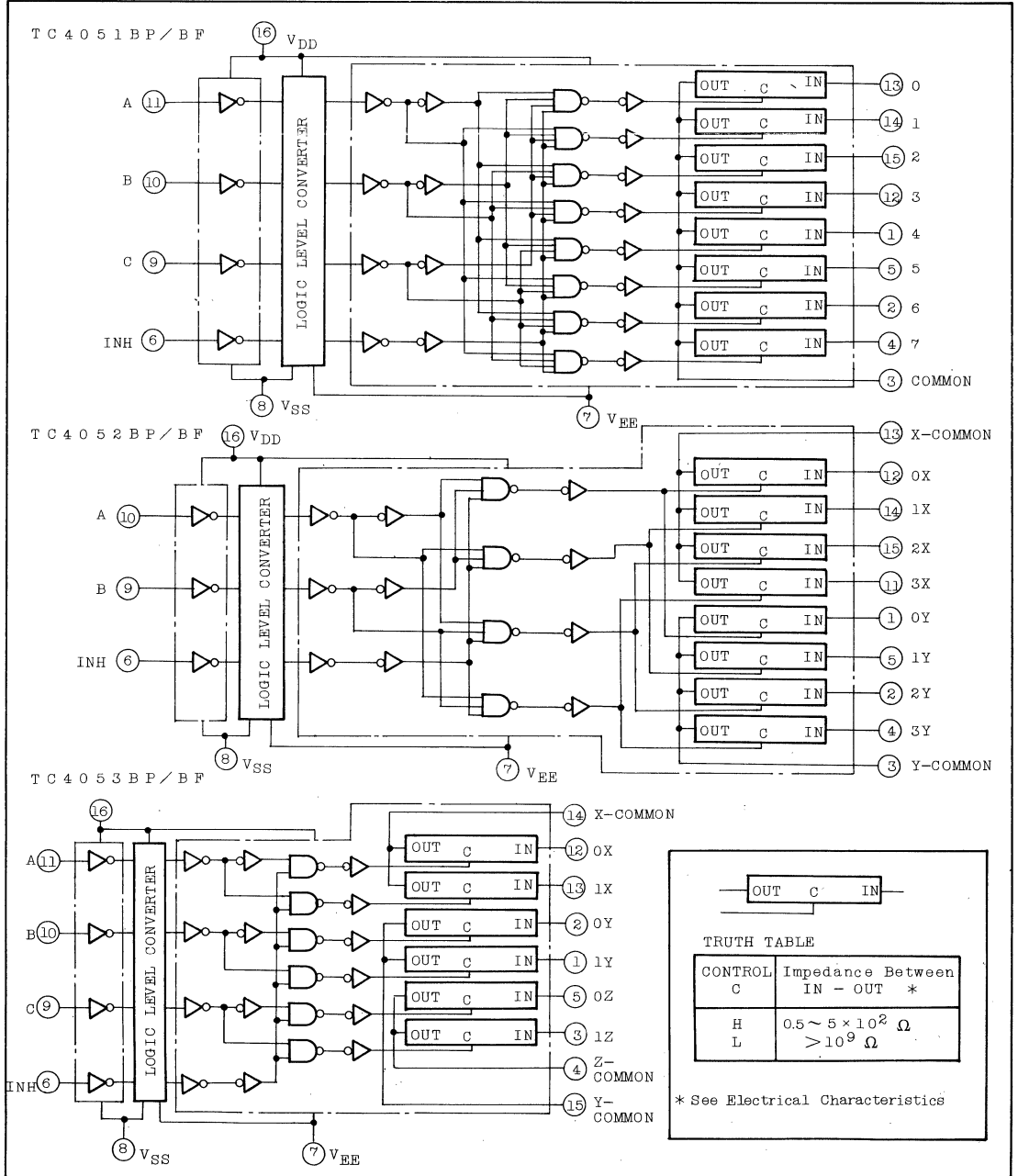


MFP16(F16G0-P)

PIN ASSIGNMENT (TOP VIEW)



LOGIC DIAGRAM



TC4051BP/BF, TC4052BP/BF, TC4053BP/BF

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	$V_{DD}-V_{SS}$	3	-	18	V
	$V_{DD}-V_{EE}$	3	-	18	
Control Input Voltage	V_{IN}	V_{SS}	-	V_{DD}	V
Input/Output Voltage	V_{IN}/V_{OUT}	V_{EE}	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			-40°C		25°C			85°C		UNITS	
		V_{SS} (V)	V_{EE} (V)	V_{DD} (V)	MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Control Input High Voltage	V_{IH}	$V_{IS}=V_{DD}$ thru $1k\Omega$	$V_{EE}=V_{SS}$ $R_L=1k\Omega$ to V_{SS}	5	3.5	-	3.5	2.75	-	3.5	-	V	
				10	7.0	-	7.0	5.50	-	7.0	-		
				15	11.0	-	11.0	8.25	-	11.0	-		
Control Input Low Voltage	V_{IL}		$I_{IS}<2\mu s$ on all OFF channels	5	-	1.5	-	2.25	1.5	-	1.5	V	
				10	-	3.0	-	4.5	3.0	-	3.0		
				15	-	4.0	-	5.75	4.0	-	4.0		
On-State Resistance	R_{ON}	$0 \leq V_{IS} \leq V_{DD}$ $R_L=10k\Omega$	0	0	5	-	850	-	240	950	-	1200	Ω
			0	0	10	-	210	-	110	250	-	300	
			0	0	15	-	140	-	80	160	-	200	
Δ On-State Resistance Between Any 2 Switches	$R_{ON\Delta}$		0	0	5	-	-	-	10	-	-	-	Ω
			0	0	10	-	-	-	6	-	-	-	
			0	0	15	-	-	-	4	-	-	-	
Input/Output Leakage Current	I_{OFF}	$V_{IN}=18V, V_{OUT}=0V$ $V_{IN}=0V, V_{OUT}=18V$			18	-	± 100	-	± 0.01	± 100	-	± 1000	nA
					18	-	± 100	-	± 0.01	± 100	-	± 1000	
Quiescent Device Current	I_{DD}	$V_{IN}=V_{SS}, V_{DD}$ *			5	-	5.0	-	0.005	5.0	-	150	μA
					10	-	10	-	0.010	10	-	300	
					15	-	20	-	0.015	20	-	600	
Input Current	I_{IN}	$V_{IH}=18V$ $V_{IL}=0V$			18	-	0.1	-	10^{-5}	0.1	-	1.0	μA
					18	-	-0.1	-	-10^{-5}	-0.1	-	-1.0	
Input Capacitance	C_{IN}				-	-	-	5	7.5	-	-	pF	
Switch Input Capacitance	C_{IN}				-	-	-	10	-	-	-		
Output Capacitance	C_{OUT}			10	-	-	-	58	-	-	-		
					-	-	-	30	-	-	-		
					-	-	-	17	-	-	-		
Feedthrough Capacitance	C_{IN-OUT}			10	-	-	-	0.2	-	-	-		
					-	-	-	0.2	-	-	-		
					-	-	-	0.2	-	-	-		

* All valid input combinations.

TC4051BP/BF, TC4052BP/BF, TC4053BP/BF

TYPICAL ELECTRICAL CHARACTERISTICS (Ta=25°C, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VSS	VEE	VDD	MIN.	TYP.	MAX.	UNITS
			(V)	(V)	(V)				
Propagation Delay Time (Switch IN-OUT)	t _{pLH}		0	0	5	-	15	45	ns
	t _{pHL}		0	0	10	-	8	20	
			0	0	15	-	6	15	
Propagation Delay Time (A, B, C - OUT)	t _{pZL}	R _L =1kΩ	0	0	5	-	170	550	
	t _{pZH}		0	0	10	-	90	240	
	t _{pLZ}		0	0	15	-	70	160	
			0	-5	5	-	100	240	
			0	-7.5	7.5	-	80	160	
Propagation Delay Time (INH - OUT)	t _{pZL}	R _L =1kΩ	0	0	5	-	120	380	
	t _{pZH}		0	0	10	-	60	200	
			0	0	15	-	50	160	
			0	-5	5	-	80	200	
			0	-7.5	7.5	-	60	160	
Propagation Delay Time (INH - OUT)	t _{pLZ}	R _L =1kΩ	0	0	5	-	170	450	
			0	0	10	-	90	210	
	t _{pHZ}		0	0	15	-	70	160	
			0	-5	5	-	100	210	
			0	-7.5	7.5	-	80	160	
-3dB Cutoff Frequency TC4051B TC4052B TC4053B	f _{MAX}	R _L =1kΩ (*1)	-5	-5	5	-	20	-	MHz
	(I - O)		-5	-5	5	-	30	-	
			-5	-5	5	-	40	-	
			-5	-5	5	-	-	-	
Total Harmonic Distortion	-	R _L =10kΩ f=1kHz (*2)	-2.5	-2.5	2.5	-	0.15	-	%
			-5	-5	5	-	0.03	-	
			-7.5	-7.5	7.5	-	0.02	-	
-50dB Feedthrough (Switch OFF)	-	R _L =1kΩ (*3)	-5	-5	5	-	500	-	kHz
Crosstalk	-	R _L =1kΩ (*4)	-5	-5	5	-	1.5	-	MHz
Crosstalk (CONTROL - OUT)	-	R _{IN} =1kΩ R _{OUT} =10kΩ C _L =15pF	0	0	10	-	200	-	mV
			-	-	-	-	400	-	
			-	-	-	-	600	-	

*1 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log 10 \frac{V_{OS}}{V_{IS}} = -3\text{dB}$ shall be f_{MAX}.

*2 V_{IS} shall be sine wave of $\pm \left(\frac{V_{DD} - V_{EE}}{4} \right) \text{p-p}$.

*3 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log 10 \frac{V_{OS}}{V_{IS}} = -50\text{dB}$ shall be feed-through.

*4 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log 10 \frac{V_{OS}}{V_{IS}} = -50\text{dB}$ shall be Crosstalk.

TC4054BP/BF

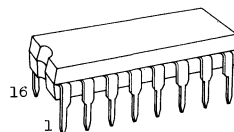
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4054BP/TC4054BF LIQUID-CRYSTAL DISPLAY DRIVER (4-SEGMENT DISPLAY DRIVER)

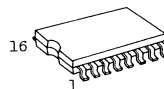
TC4054BP/BF contains four circuits of liquid crystal (field effect type) drivers.

When pulse is applied to DF input, the output with 180° out of phase from DF pulse is obtained at OUT if input IN is "H". If input IN is "L", OUT and DF pulse become in-phase.

By applying DF input pulse to the common terminal (back plane) of liquid crystal, the liquid crystal element can be directly driven by the input signal with "H" level. This is suitable for illuminating the segments of decimal point and positive or negative sign. If $V_{EE} < V_{SS}$, the level conversion operation which lowers only "L" side of logical signal can be achieved.



DIP16(3D16A-P)

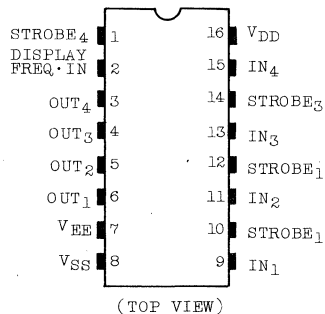


MFP16(F16GC-P)

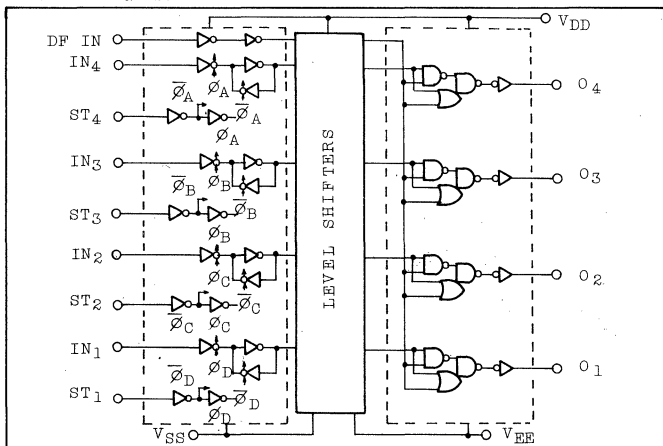
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	$V_{DD}-V_{SS}$	-0.5 ~ 20	V
	$V_{DD}-V_{EE}$	-0.5 ~ 20	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{EE}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	±10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	-40 ~ 85	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C
Lead Temp./Time	T_{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

DF IN	IN _n	STROBE _n	OUT _n
L	L	H	L
H	L	H	H
L	H	H	H
H	H	H	L
*	*	L	△△

*: Don't care

△△: Depends upon the INPUT mode previously applied when STROBE "H".

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD} -V _{SS}	3	-	18	V
	V _{DD} -V _{EE}	3	-	18	V
Input Voltage	V _{IN}	V _{SS}	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4054BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

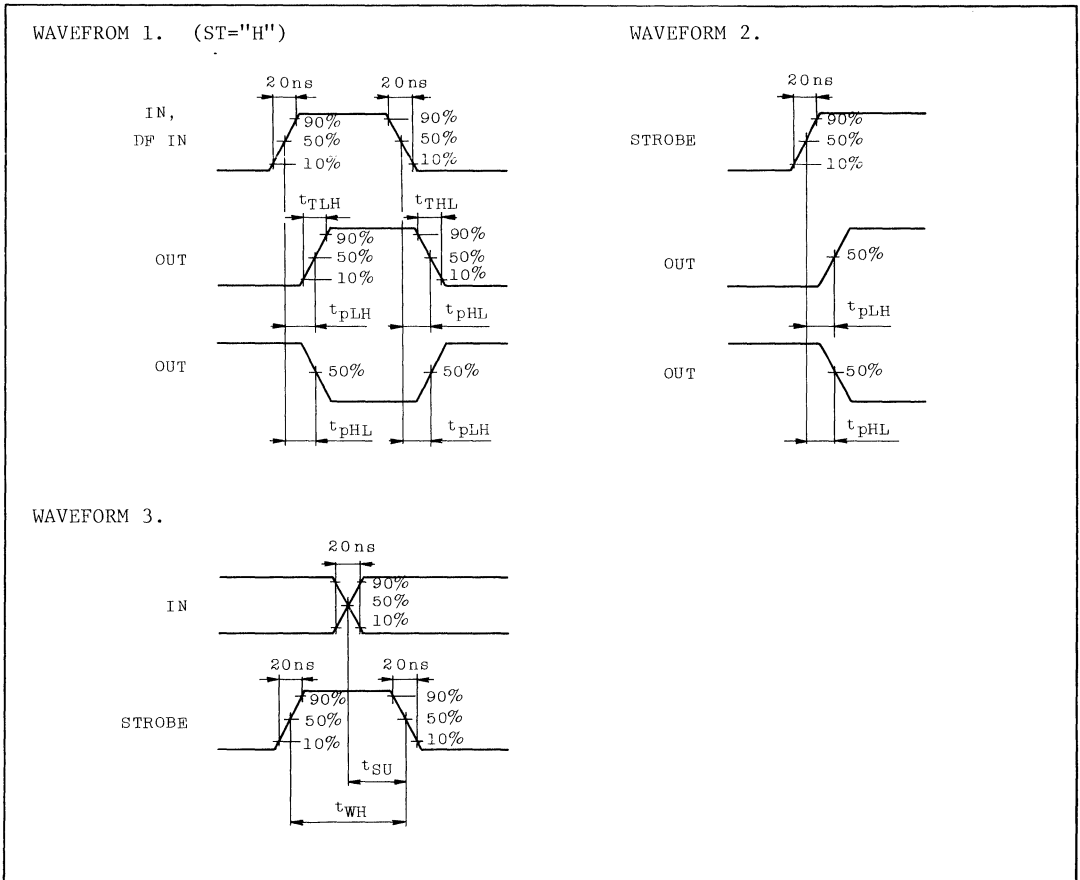
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT	
		V _{DD} (V)	V _{EE} (V)					
Output Transition Time	t _{TLH} t _{THL}		5	0	-	80	200	ns
			5	-5	-	50	100	
			10	0	-	50	100	
			15	0	-	40	80	
Propagation Delay Time (NI - OUT)	t _{pLH} t _{pHL}		5	0	-	660	1800	ns
			5	-5	-	250	800	
			10	0	-	210	680	
			15	0	-	140	500	
Propagation Delay Time (DF IN - OUT)	t _{pLH} t _{pHL}		5	0	-	720	1800	ns
			5	-5	-	260	800	
			10	0	-	240	680	
			15	0	-	150	500	
Propagation Delay Time (STROBE - OUT)	t _{pLH} t _{pHL}		5	0	-	660	1800	ns
			5	-5	-	250	800	
			10	0	-	210	680	
			15	0	-	140	500	
Min. Clock Pulse Width (STROBE)	t _{WH}		5	0	-	60	220	ns
			5	-5	-	70	220	
			10	0	-	20	100	
			15	0	-	15	70	
Min. Set-up Time (IN - STROBE)	t _{SU}		5	0	-	50	220	ns
			5	-5	-	60	220	
			10	0	-	15	100	
			15	0	-	10	70	
Input Capacitance	C _{IN}				-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4055BP, TC4056BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4055BP LIQUID-CRYSTAL DISPLAY DRIVER

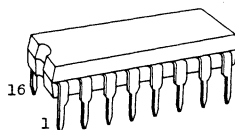
(BCD TO 7-Segment Decoder/Driver with "Display-Frequency" Output)

TC4056BP/TC4056BF LIQUID-CRYSTAL DISPLAY DRIVER

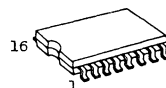
(BCD TO 7-Segment Decoder/Driver with Strobed-Latch Function)

TC4055BP, TC4056BP/BF are LC drivers which drive the field effect type liquid crystal with seven segments by BCD input.

If DF input="L", a selected output among segment outputs of a through g becomes "H" level and if DF input="H", a selected output becomes "L" level. Seven segment liquid crystal element can be directly driven by applying the pulse in-phase with DF input to the common terminal (back plane) of liquid crystal. TC4055BP is equipped with DF output for the common terminal and TC4056BP/BF is equipped with the latch. If $V_{EE} < V_{SS}$, the level conversion operation which lowers only "L" side of logical signal can be achieved.



DIP 16 (3D16A-P)



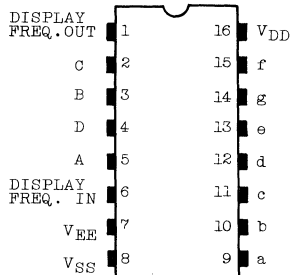
MFP 16 (P16GC-P)

MAXIMUM RATINGS

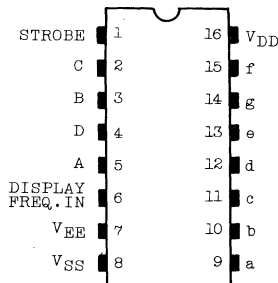
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	$V_{DD}-V_{SS}$	-0.5 ~ 20	V
	$V_{DD}-V_{EE}$	-0.5 ~ 20	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{EE}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T_A	-40 ~ 85	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C
Lead Temp./Time	T_{sol}	260°C · 10sec	

PIN ASSIGNMENT

TC4055BP

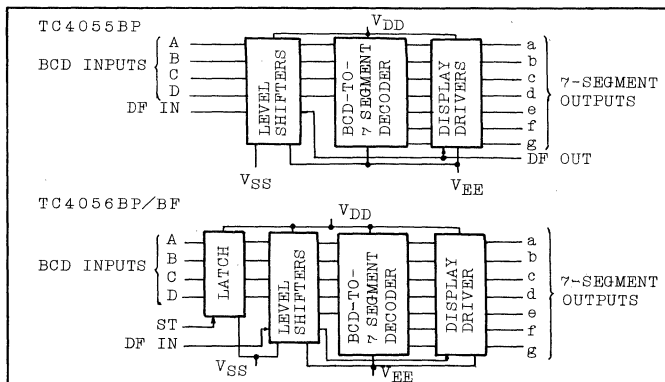


TC4056BP/BF



(TOP VIEW)

BLOCK DIAGRAM



TRUTH TABLE

BCD INPUTS				7-SEGMENT OUTPUTS (DF IN="L")							7-SEGMENT OUTPUTS (DF IN="H")							DISPLAY CHARACTER
D	C	B	A	a	b	c	d	e	f	g	a	b	c	d	e	f	g	
L	L	L	L	H	H	H	H	H	H	L	L	L	L	L	L	L	H	0
L	L	L	H	L	H	H	L	L	L	L	H	L	L	H	H	H	H	1
L	L	H	L	H	H	L	H	H	L	H	L	L	H	L	L	H	L	2
L	L	H	H	H	H	H	H	L	L	H	L	L	L	L	H	H	L	3
L	H	L	L	L	H	H	L	L	H	H	H	L	L	H	H	L	L	4
L	H	L	H	H	L	H	H	L	H	H	L	H	L	L	H	L	L	5
L	H	H	L	H	L	H	H	H	H	H	L	H	L	L	L	L	L	6
L	H	H	H	H	H	H	L	L	L	L	L	L	L	H	H	H	H	7
H	L	L	L	H	H	H	H	H	H	H	L	L	L	L	L	L	L	8
H	L	L	H	H	H	H	H	L	H	H	L	L	L	L	H	L	L	9
H	L	H	L	L	L	L	H	H	H	L	H	H	H	L	L	L	H	A
H	L	H	H	L	H	H	L	H	H	H	H	L	L	H	L	L	L	B
H	H	L	L	H	H	L	L	H	H	H	L	L	H	H	L	L	L	C
H	H	L	H	H	H	H	L	H	H	H	L	L	L	H	L	L	L	D
H	H	H	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L	E
H	H	H	H	L	L	L	L	L	L	L	H	H	H	H	H	H	H	BLANK

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD} -V _{SS}	3	-	18	V
	V _{DD} -V _{EE}	3	-	18	
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=V_{EE}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

TC4055BP, TC4056BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=V_{EE}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
		V _{DD} (V)	V _{EE} (V)				
Output Transition Time	t _{TLH} t _{THL}	5	0	-	80	200	ns
		5	-5	-	50	100	
		10	0	-	50	100	
		15	0	-	40	80	

TC4055BP, TC4056BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

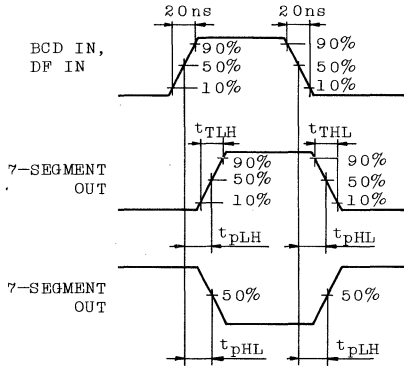
CHARACTERISTIC	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
		V _{DD} (V)	V _{EE} (V)				
Propagation Delay Time (BCD IN - 7-SEGMENT OUT)	t _{pLH}	5	0	-	980	2000	ns
		5	-5	-	380	900	
	t _{pHL}	10	0	-	320	750	
		15	0	-	210	500	
Propagation Delay Time (DF IN - 7-SEGMENT OUT)	t _{pLH}	5	0	-	620	1800	ns
		5	-5	-	240	900	
	t _{pHL}	10	0	-	200	750	
		15	0	-	130	500	
* Propagation Delay Time (DF IN - DF OUT)	t _{pLH}	5	0	-	570	1500	ns
		5	-5	-	220	800	
	t _{pHL}	10	0	-	180	700	
		15	0	-	110	550	
** Propagation Delay Time (STROBE - 7-SEGMENT OUT)	t _{pLH}	5	0	-	1000	3100	ns
		5	-5	-	400	1300	
	t _{pHL}	10	0	-	340	1150	
		15	0	-	210	750	
*** Min. Pulse Width (STROBE)	t _{WH}	5	0	-	55	220	ns
		5	-5	-	60	220	
		10	0	-	25	100	
		15	0	-	20	70	
** Min. Set-up Time (BCD IN - STROBE)	t _{SU}	5	0	-	50	220	ns
		5	-5	-	50	220	
		10	0	-	25	100	
		15	0	-	20	70	
Input Capacitance	C _{IN}			-	5	7.5	pF

* TC4055BP, ** TC4056BP/BF

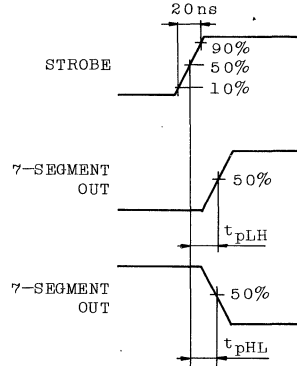
TC4055BP, TC4056BP/BF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

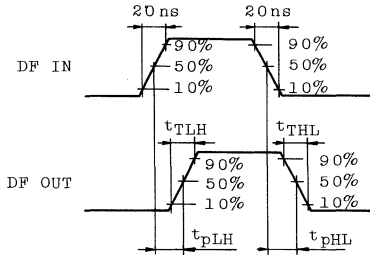
WAVEFORM 1



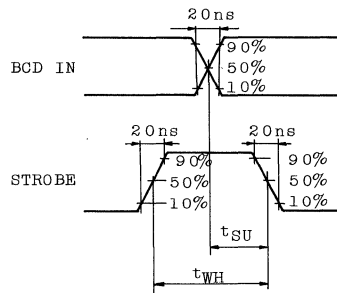
WAVEFORM 2 (TC4056BP/BF)



WAVEFORM 3 (TC4055BP)

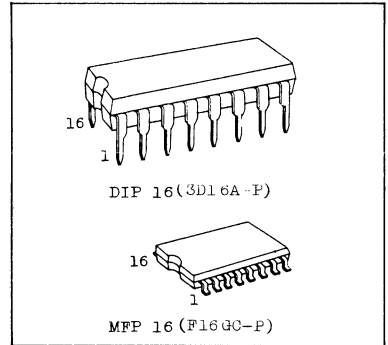


WAVEFORM 4 (TC4056BP/BF)



TC4063BP/TC4063BF 4-BIT MAGNITUDE COMPARATOR

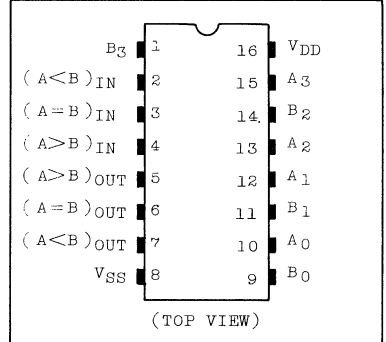
TC4063BP/BF is weighted comparator which compares magnitude of 4 bits input data B₀ through B₃. When TC4063BP/BF is used, the signals of larger, smaller and equal can be obtained at three output lines by the cascade input mode of three lines of (A>B)_{IN}, (A=B)_{IN} and (A<B)_{IN}. Cascade connection of n number of TC4063BP/BF's easily realizes magnitude comparator of 4 × n bits.



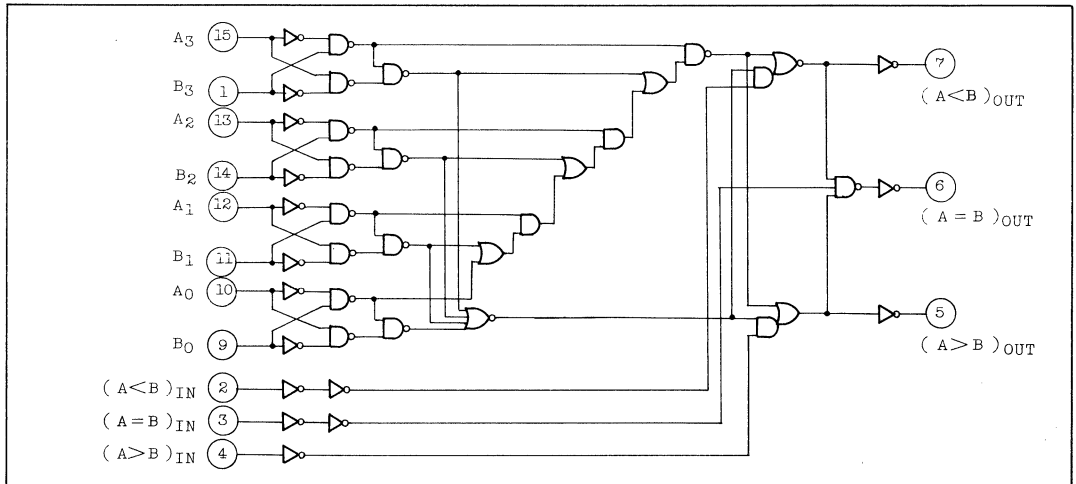
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC4063BP/BF

TRUTH TABLE

INPUTS							OUTPUTS			
COMPARING				CASCADING			A < B	A = B	A > B	
A ₃ , B ₃	A ₂ , B ₂	A ₁ , B ₁	A ₀ , B ₀	A < B	A = B	A > B	A < B	A = B	A > B	
A ₃ > B ₃	*	*	*	*	*	*	L	L	H	* Don't care
A ₃ = B ₃	A ₂ > B ₂	*	*	*	*	*	L	L	H	
A ₃ = B ₃	A ₂ = B ₂	A ₁ > B ₁	*	*	*	*	L	L	H	
A ₃ = B ₃	A ₂ = B ₂	A ₁ = B ₁	A ₀ > B ₀	*	*	*	L	L	H	
A ₃ = B ₃	A ₂ = B ₂	A ₁ = B ₁	A ₀ = B ₀	L	L	H	L	L	H	
A ₃ = B ₃	A ₂ = B ₂	A ₁ = B ₁	A ₀ = B ₀	L	H	L	L	H	L	
A ₃ = B ₃	A ₂ = B ₂	A ₁ = B ₁	A ₀ = B ₀	H	L	L	H	L	L	
A ₃ = B ₃	A ₂ = B ₂	A ₁ = B ₁	A ₀ < B ₀	*	*	*	H	L	L	
A ₃ = B ₃	A ₂ = B ₂	A ₁ < B ₁	*	*	*	*	H	L	L	
A ₃ = B ₃	A ₂ < B ₂	*	*	*	*	*	H	L	L	
A ₃ < B ₃	*	*	*	*	*	*	H	L	L	

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

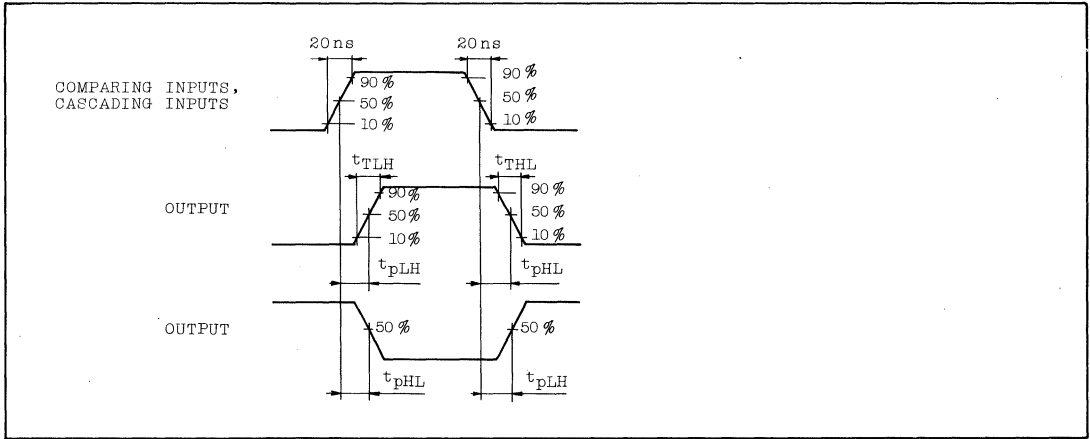
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (COMPARING INPUTS - OUTPUTS)	t _{pLH} t _{pHL}		5	-	340	1250	ns
			10	-	140	500	
			15	-	100	350	

TC4063BP/BF

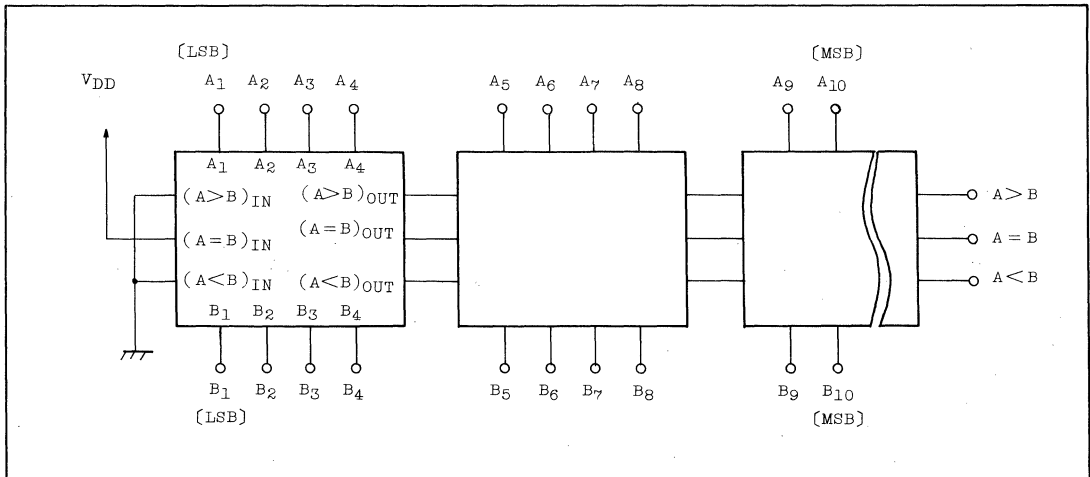
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
			5				
Propagation Delay Time (CASCADING INPUTS - OUTPUTS)	t _{pLH}		5	-	280	1000	ns
	t _{pHL}		10	-	110	400	
			15	-	90	280	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



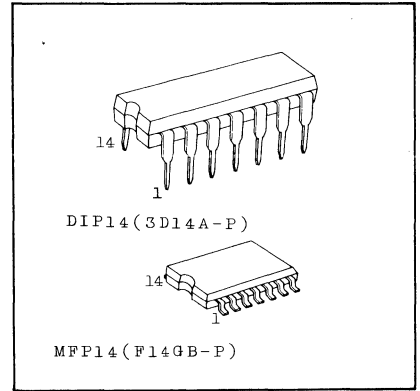
APPLICATION CIRCUIT



TC4066BP/TC4066BF QUAD BILATERAL SWITCH

TC4066BP/BF contains four independent circuits of bidirectional switches. When control input CONT is set to "H" level, the impedance between input and output of the switch becomes low and when it is set to "L" level, the impedance becomes high. This can be applied for switching of analog signals and digital signals.

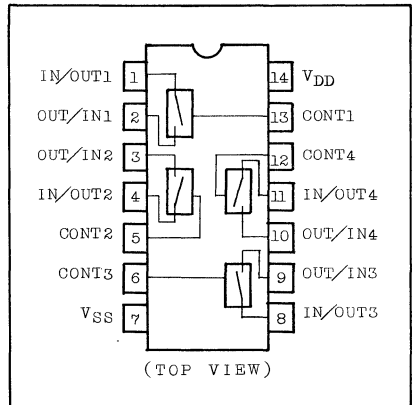
- ON-resistance, R_{ON}
 - 250 Ω (TYP.) $V_{DD}-V_{SS}=5V$
 - 110 Ω (TYP.) $V_{DD}-V_{SS}=10V$
 - 70 Ω (TYP.) $V_{DD}-V_{SS}=15V$
- OFF-resistance, R_{OFF}
 - R_{OFF} (TYP.) > 10⁹ Ω



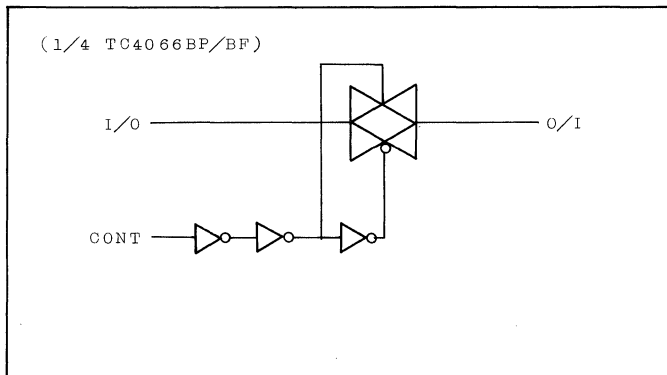
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Control Input Voltage	V_C IN	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Switch I/O Voltage	$V_{I/O}$	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Potential difference across I/O during ON	V_I-V_O	± 0.5	V
Control Input Current	I_C IN	± 10	mA
Operating Temperature Range	T_A	-40 ~ 85	$^{\circ}C$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^{\circ}C$
Lead Temp./Time	T_{sol}	260 $^{\circ}C \cdot 10$ sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

CONTROL	Impedance Between IN/OUT-OUT/IN *
H	0.5 ~ 5 × 10 ² Ω
L	> 10 ⁹ Ω

* See Static Electrical Characteristics

TC4066BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input/Output Voltage	V _{DD} /V _{OUT}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (In case not specifically appointed, V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{SS} (V)	V _{DD} (V)	-40°C		25°C			85°C		UNITS
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Control Input High Voltage	V _{IH}	|I _{is}|=10 μ A		5	3.5	-	3.5	2.75	-	3.5	-	V
				10	7.0	-	7.0	5.50	-	7.0	-	
				15	11.0	-	11.0	8.25	-	11.0	-	
Control Input Low Voltage	V _{IL}	|I _{is}|=10 μ A		5	-	1.5	-	2.25	1.5	-	1.5	V
				10	-	3.0	-	4.5	3.0	-	3.0	
				15	-	4.0	-	6.75	4.0	-	4.0	
On-State Resistance	R _{ON}	0 \leq V _{is} \leq V _{DD} R _L =10k Ω		5	-	800	-	290	950	-	1200	Ω
				10	-	210	-	120	250	-	300	
				15	-	140	-	85	160	-	200	
Δ On-State Resistance (Between Any 2 Switches)	R _{ONΔ}			5	-	-	-	10	-	-	-	Ω
				10	-	-	-	6	-	-	-	
				15	-	-	-	4	-	-	-	
Input/Output Leakage Current	I _{OFF}	V _{IN} =18V, V _{OUT} =0V V _{IN} =0V, V _{OUT} =18V		18	-	\pm 100	-	\pm 0.1	\pm 100	-	\pm 1000	nA
				18	-	\pm 100	-	\pm 0.1	\pm 100	-	\pm 1000	
Quiescent Device Current	I _{DD}	V _{IN} =V _{DD} , V _{SS} *		5	-	0.25	-	0.001	0.25	-	7.5	μ A
				10	-	0.5	-	0.001	0.5	-	15	
				15	-	1.0	-	0.002	1.0	-	30	
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μ A
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{SS} (V)	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS	
Propagation Delay Time (IN - CUT)	t _{pLH}	C _L =50pF	0	5	-	15	40	ns	
	t _{pHL}		0	10	-	8	20		
			0	15	-	5	15		
Propagation Delay Time (CONTROL - OUT)	t _{pZL}	R _L =1kΩ	0	5	-	55	120		
	t _{pZH}	C _L =50pF	0	10	-	25	40		
			0	15	-	20	30		
Propagation Delay Time (CONTROL - OUT)	t _{pLZ}	R _L =1kΩ	0	5	-	45	80		
	t _{pHZ}	C _L =50pF	0	10	-	30	70		
			0	15	-	25	60		
Max. Control Input Repetition Rate	f _{MAX}	R _L =1kΩ	0	5	-	10	-	MHz	
	(C)	C _L =50pF	0	10	-	12	-		
			0	15	-	12	-		
-3dB Cutoff Frequency	f _{MAX} (I-O)	R _L =1kΩ C _L =15pF	(*1)	-5	5	-	30	-	
Total Harmonic Distortion	-	R _L =10kΩ f=1kHz	(*2)	-5	5	-	0.03	-	%
-50dB Feed through Frequency	-	R _L =1kΩ	(*3)	-5	5	-	600	-	kHz
-50dB Crosstalk Frequency	-	R _L =1kΩ	(*4)	-5	5	-	1	-	MHz
Crosstalk (CONTROL - OUT)	-	R _{IN} =1kΩ		0	5	-	200	-	mV
		R _{OUT} =10kΩ		0	10	-	400	-	
		C _L =15pF		0	15	-	600	-	
Input Capacitance	C _{IN}	Control Input			-	5	7.5	pF	
		Switch I/O			-	10	-		
Feed through Capacitance	C _{IN-OUT}				-	0.5	-		

*1 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log_{10} \frac{V_{OS}}{V_{IS}} = -3\text{dB}$ shall be f_{MAX}.

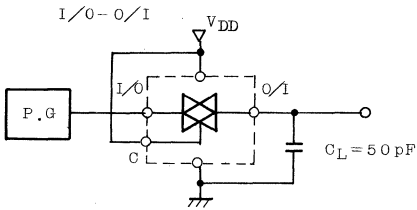
*2 V_{IS} shall be sine wave of ±2.5Vp-p.

*3 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log_{10} \frac{V_{OUT}}{V_{IS}} = -50\text{dB}$ shall be feed-through.

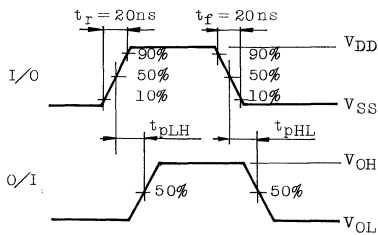
*4 Sine wave of ±2.5Vp-p shall be used for V_{IS} and the frequency of $20 \log_{10} \frac{V_{OUT}}{V_{IS}} = -50\text{dB}$ shall be crosstalk.

CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

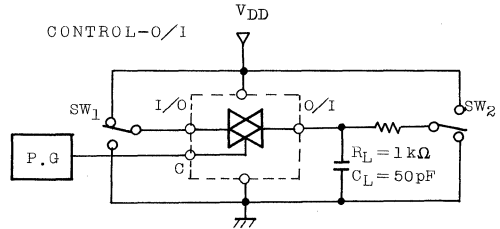
1. t_{pLH} , t_{pHL}



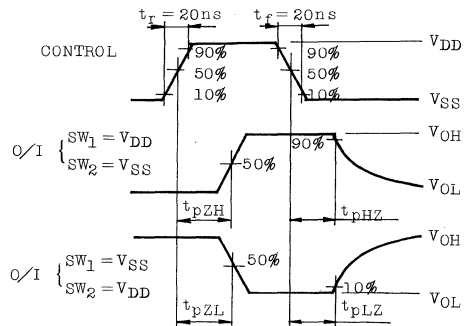
WAVEFORM



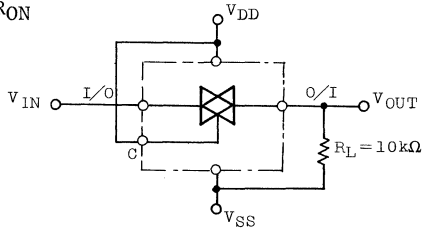
2. t_{pZL} , t_{pZH} , t_{pLZ} , t_{pHZ}



WAVEFORM

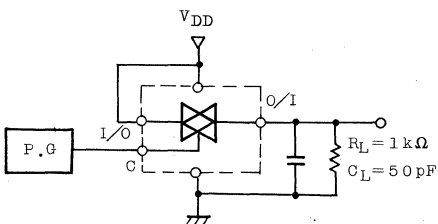


3. R_{ON}

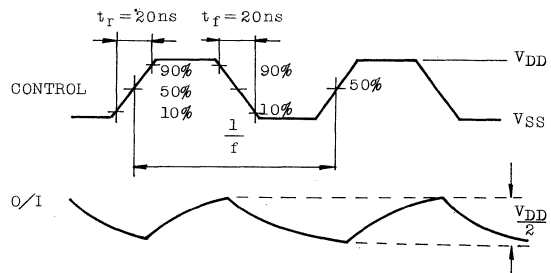


$$R_{ON} = 10 \times \frac{(V_{IN} - V_{OUT})}{V_{OUT}} \quad (\text{k}\Omega)$$

4. $f_{MAX}(C)$

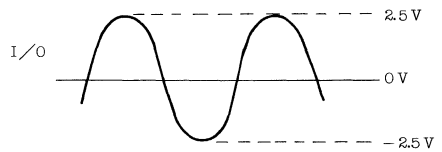
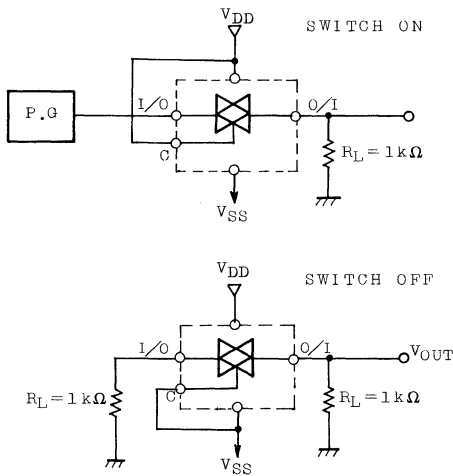


WAVEFORM

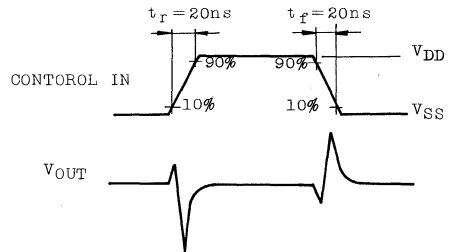
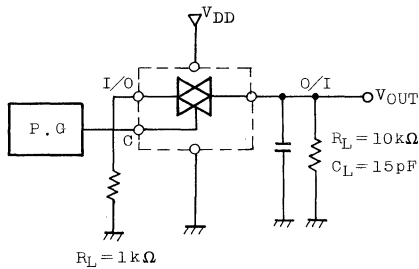


CIRCUIT FOR MEASUREMENT OF ELECTRICAL CHARACTERISTICS

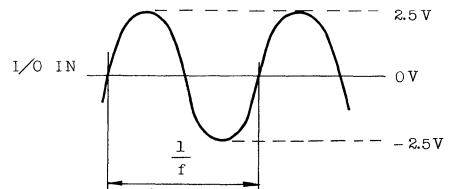
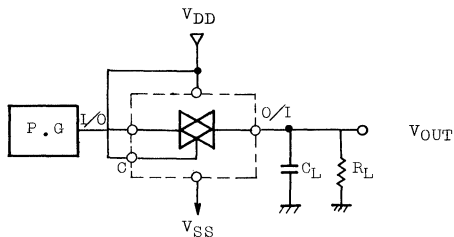
5. CROSTALK BETWEEN ANY TWO SWITCHES



6. CROSTALK, CONTROL TO INPUT



7. TOTAL HARMONIC DISTORTION, $f_{MAX}(I-O)$, FEEDTHROUGH



TC4068BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4068BP/TC4068BF 8-INPUT NAND/AND GATE

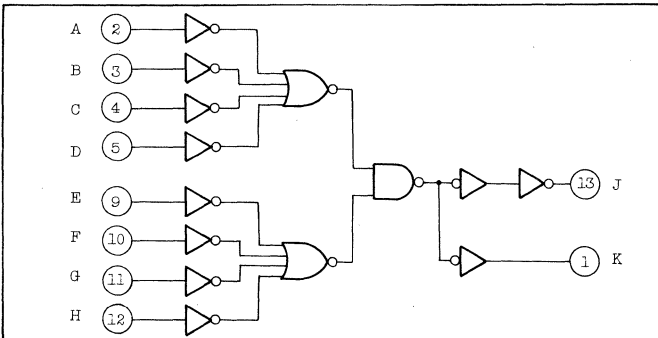
The TC4068BP/BF is 8-input positive logic NAND/AND gate.

Since each output of this gate is provided with a buffer, the input/output voltage characteristics have been improved, allowing noise immunity to be elevated; thus, the variation of propagation delay time due to the increase in load capacity is kept down to the minimum.

MAXIMUM RATINGS

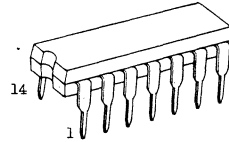
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM

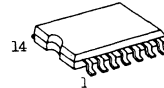


RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

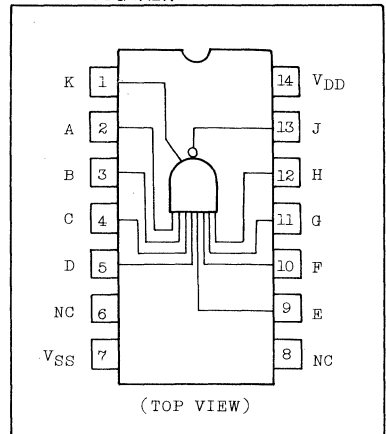


DIP14 (3D14A-P)



MFP14 (F14GB-P)

PIN ASSIGNMENT



STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

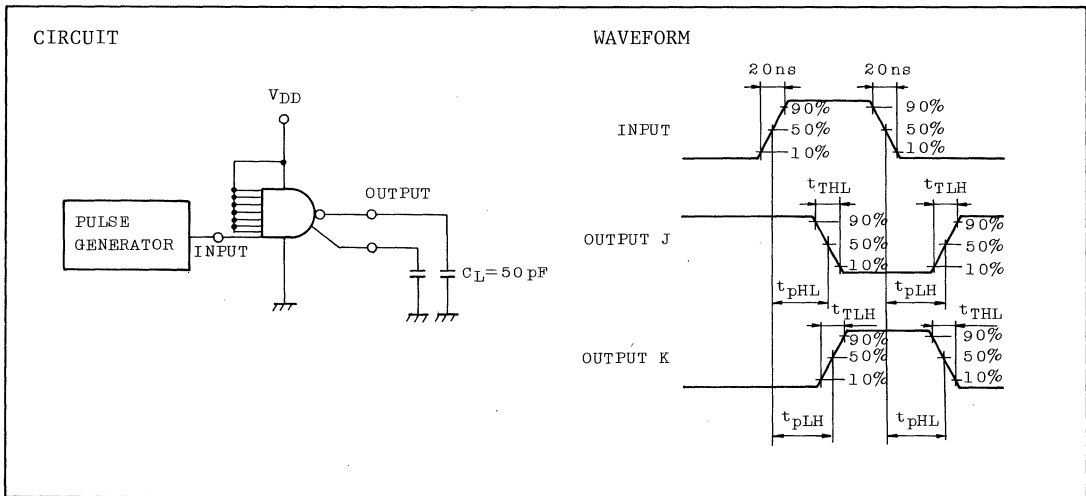
* All valid input combinations.

TC4068BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH}		5	-	160	300	ns
	t _{pHL}		10	-	70	150	
			15	-	45	110	
Input Capacitance	C _{IN}			-	5	7.5	pF

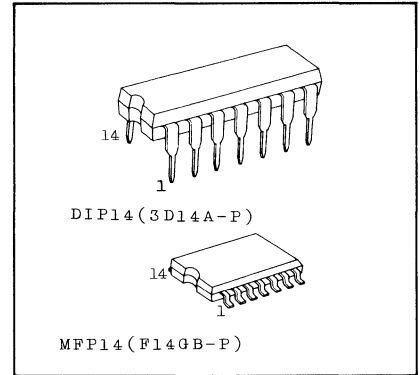
CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4069UBP/TC4069UBF HEX INVERTER

TC4069UBP/UBF contains six circuits of inverters. The pin allocation is same as TC7404UB and since the operating current consumption is smaller, this is suitable for the applications of CR oscillator circuits, crystal oscillator circuits and linear amplifiers in addition to its application as inverters.

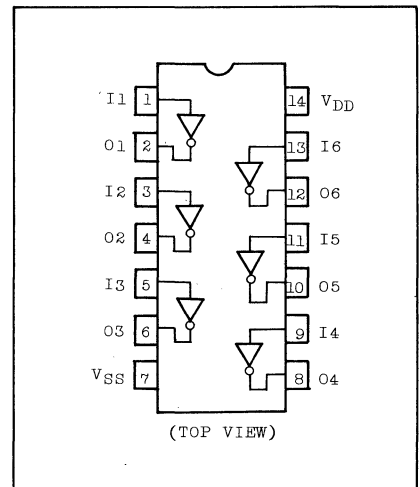
Because of one stage gate configuration, the propagation time has been reduced.



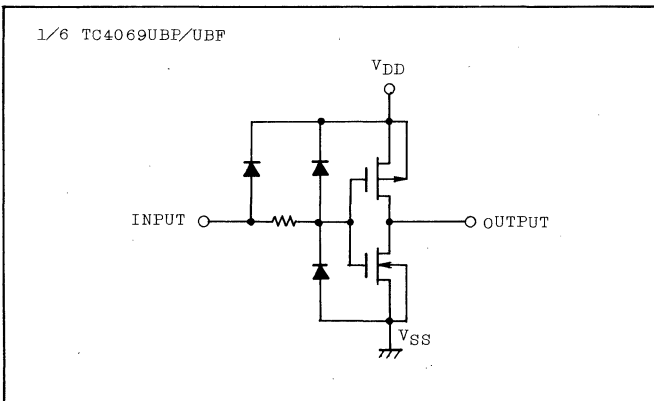
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



CIRCUIT DIAGRAM



TC4069UBP/UBF

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

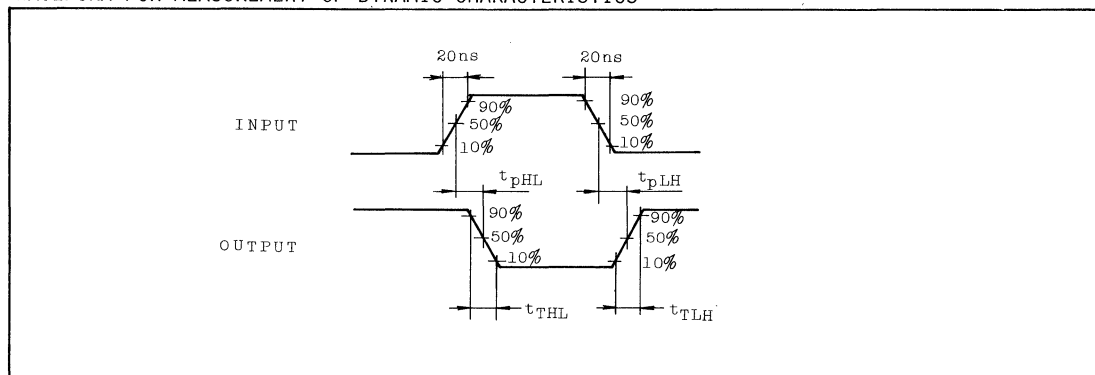
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}$	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I_{OH}	$V_{OH}=4.6V$ $V_{OH}=2.5V$ $V_{OH}=9.5V$ $V_{OH}=13.5V$ $V_{IN}=V_{SS}$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I_{OL}	$V_{OL}=0.4V$ $V_{OL}=0.5V$ $V_{OL}=1.5V$ $V_{IN}=V_{DD}$	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V_{IH}	$V_{OUT}=0.5V$ $V_{OUT}=1.0V$ $V_{OUT}=1.5V$ $|I_{OUT}| < 1\mu A$	5	4.0	-	4.0	-	-	4.0	-	V	
			10	8.0	-	8.0	-	-	8.0	-		
			15	12.0	-	12.0	-	-	12.0	-		
			15	12.0	-	12.0	-	-	12.0	-		
Input Low Voltage	V_{IL}	$V_{OUT}=4.5V$ $V_{OUT}=9.0V$ $V_{OUT}=13.5V$ $|I_{OUT}| < 1\mu A$	5	-	1.0	-	-	1.0	-	1.0	V	
			10	-	2.0	-	-	2.0	-	2.0		
			15	-	3.0	-	-	3.0	-	3.0		
			15	-	3.0	-	-	3.0	-	3.0		
Input Current	"H" Level	I_{IH}	$V_{IH}=18V$	18	-	0.1	-	10^{-5}	0.1	-	1.0	μA
	"L" Level	I_{IL}	$V_{IL}=0V$	18	-	-0.1	-	-10^{-5}	-0.1	-	-1.0	
Quiescent Device Current	I_{DD}	$V_{IN}=V_{SS}, V_{DD}$ *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (Low to High)	t _{pLH}		5	-	55	110	
			10	-	30	60	
			15	-	25	50	
Propagation Delay Time (High to Low)	t _{pHL}		5	-	55	110	
			10	-	30	60	
			15	-	25	50	
Input Capacitance	C _{IN}			-	7.5	15	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4071BP/BF, TC4072BP/BF, TC4075BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

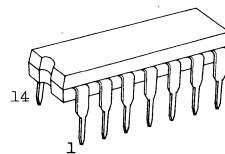
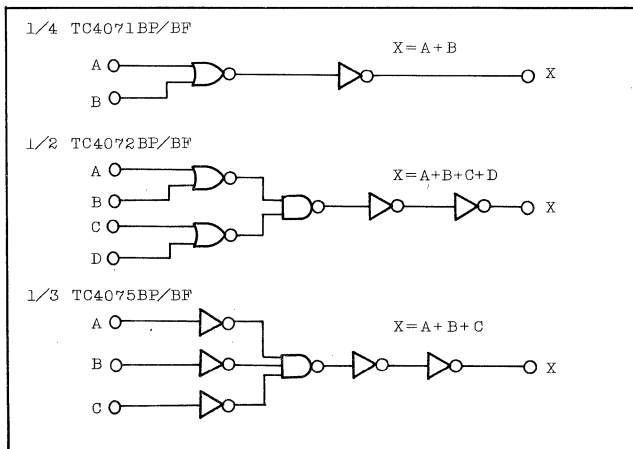
TC4071BP/TC4071BF QUAD 2 INPUT OR GATE
TC4072BP/TC4072BF DUAL 4 INPUT OR GATE
TC4075BP/TC4075BF TRIPLE 3 INPUT OR GATE

TC4071BP/BF, TC4075BP/BF and TC4072BP/BF are positive logic OR gates with two inputs, three inputs and four inputs respectively. As all the outputs of gates are equipped with the buffer circuits of inverters, the input/output propagation characteristic has been improved and the variation of propagation time caused by increase of load capacity is kept minimum.

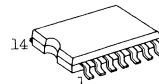
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

LOGIC DIAGRAM



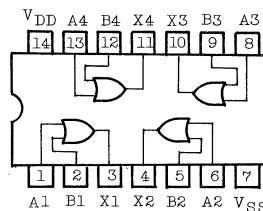
DIP14 (3D14A-P)



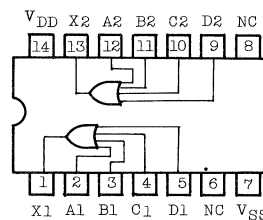
MFP14 (F14GB-P)

PIN ASSIGNMENT (TOP VIEW)

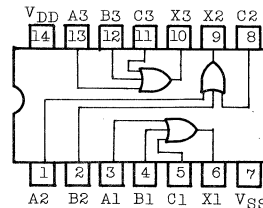
TC4071BP/BF



TC4072BP/BF



TC4075BP/BF



TC4071BP/BF, TC4072BP/BF, TC4075BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	0.61	-	0.51	1.5	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	3.5	-	3.5	2.75	-	3.5	-		
			15	7.0	-	7.0	5.5	-	7.0	-		
Input High Voltage	V _{IH}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

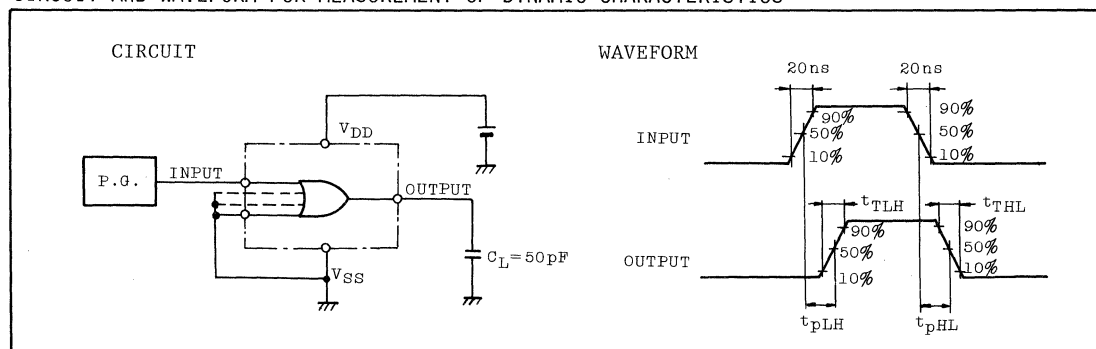
* All valid input combinations.

TC4071BP/BF, TC4072BP/BF, TC4075BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (TC4072BP/BF) (TC4075BP/BF)	t_{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4072BP/BF) (TC4075BP/BF)	t_{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4071BP/BF)	t_{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4071BP/BF)	t_{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (TC4071BP/BF)	t_{pLH}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4071BP/BF)	t_{pHL}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4072BP/BF)	t_{pLH}		5	-	115	250	
			10	-	45	120	
			15	-	30	90	
Propagation Delay Time (TC4072BP/BF)	t_{pHL}		5	-	115	250	
			10	-	45	120	
			15	-	30	90	
Propagation Delay Time (TC4075BP/BF)	t_{pLH}		5	-	95	250	
			10	-	40	120	
			15	-	30	90	
Propagation Delay Time (TC4075BP/BF)	t_{pHL}		5	-	95	250	
			10	-	40	120	
			15	-	30	90	
Input Capacitance	C_{IN}			-	5	7.5	pF

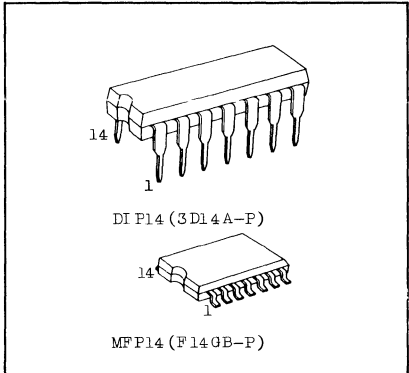
CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4073BP/TC4073BF TRIPLE 3 INPUT AND GATE
TC4081BP/TC4081BF QUAD 2 INPUT AND GATE
TC4082P DUAL 4 INPUT AND GATE

TC4081BP/BF, TC4073BP/BF and TC4082BP are positive logic AND gates with two inputs, three inputs and four inputs respectively.

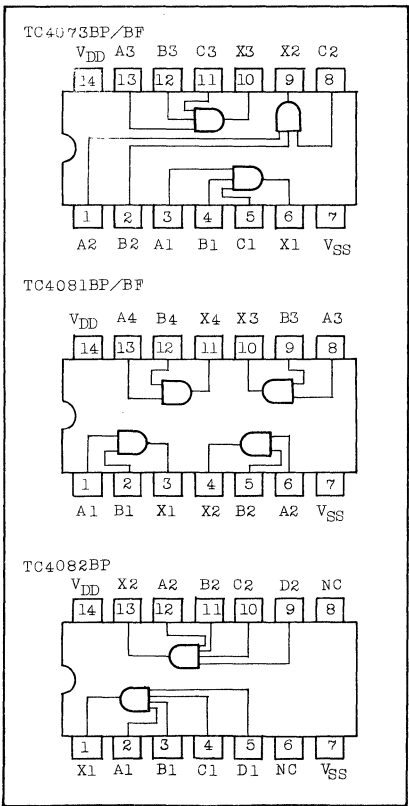
Since all the outputs of these gates are equipped with the buffer circuits of inverters, the input/output propagation characteristic has been improved and variation of propagation time caused by increase of load capacity is kept minimum.



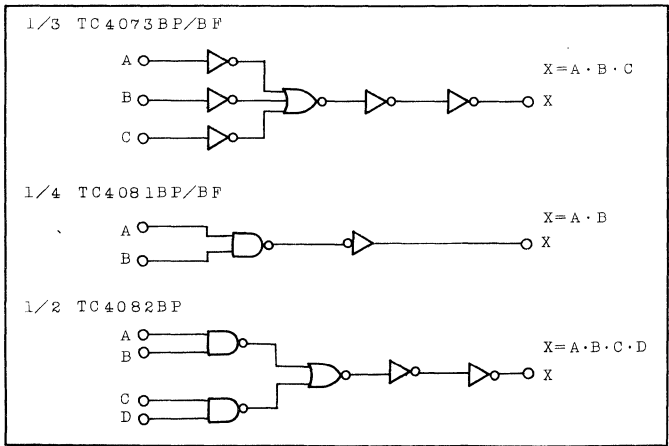
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Laed Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT (TOP VIEW)



LOGIC DIAGRAM



TC4073BP/BF, TC4081BP/BF, TC4082BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2*8	-		
			15	4.0	-	3.4	12.0	-	2*8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Current	V _{IL}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

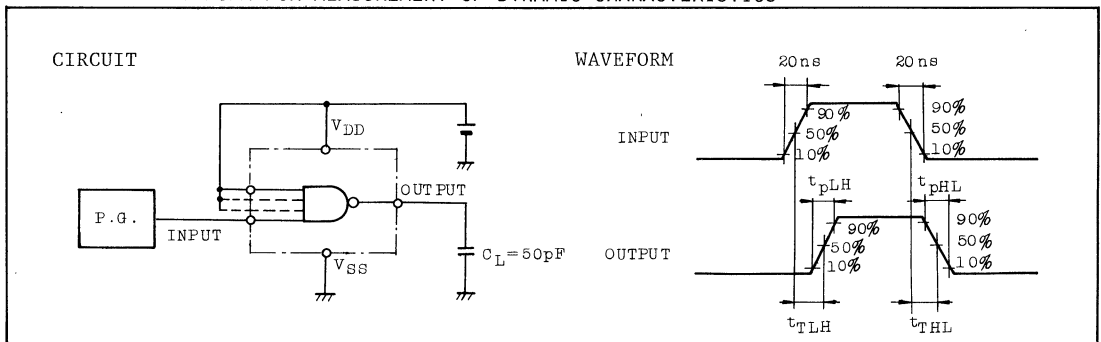
* All valid input combinations.

TC4073BP/BF, TC4081BP/BF, TC4082BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (TC4073BP/BF) (TC4082BP/BF)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4073BP/BF) (TC4082BP/BF)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Output Transition Time (TC4081BP/BF)	t _{TLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Output Transition Time (TC4081BP/BF)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (TC4073BP/BF)	t _{pLH}		5	-	115	250	
			10	-	50	120	
			15	-	35	90	
Propagation Delay Time (TC4073BP/BF)	t _{pHL}		5	-	115	250	
			10	-	50	120	
			15	-	35	90	
Propagation Delay Time (TC4081BP/BF)	t _{pLH}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4081BP/BF)	t _{pHL}		5	-	65	200	
			10	-	30	100	
			15	-	25	80	
Propagation Delay Time (TC4082BP)	t _{pLH}		5	-	110	250	
			10	-	50	120	
			15	-	35	90	
Propagation Delay Time (TC4082BP)	t _{pHL}		5	-	110	250	
			10	-	50	120	
			15	-	35	90	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



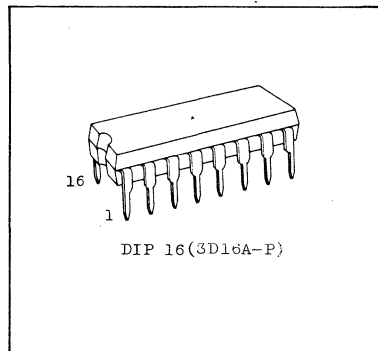
TC4076BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4076BP 4-BIT D-TYPE REGISTER

TC4076BP is the register which consists of four D type flip-flops having 3-stage outputs, and these four flip-flops are controlled by common CLOCK input and RESET input.

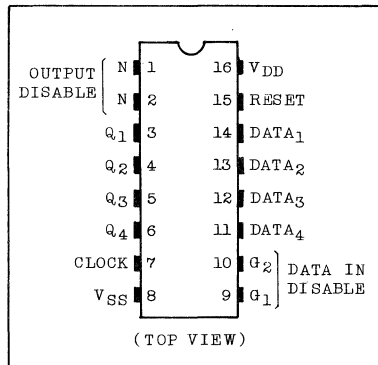
When both of INPUT DISABLE inputs G1 and G2 are at "L", data inputs D1 through D4 are stored in F/F's at the rising edge of CLOCK input, and with other combination of G1 and G2, the previous conditions of F/F's are retained even if the rising edge of CLOCK occurs. When both of OUTPUT DISABLE inputs M and N are at "L", the outputs of flip-flops appear at Q1 through Q4 outputs, and with any other combinations of M and N, the outputs have high impedance. RESET is active with "H" level.



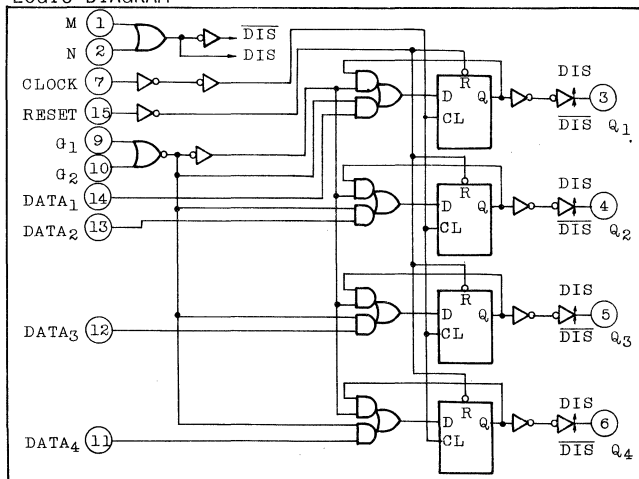
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +2.0	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

RESET	CLOCK	DATA IN DISABLE		DATA	OUTPUT DISABLE		Q _{n+1}
		G ₁	G ₂		M	N	
*	*	*	*	*	H	*	HZ
*	*	*	*	*	*	H	HZ
H	*	*	*	*	L	L	L
L	L	*	*	*	L	L	Q _n
L	\uparrow	H	*	*	L	L	Q _n
L	\uparrow	*	H	*	L	L	Q _n
L	\uparrow	L	L	H	L	L	H
L	\uparrow	L	L	L	L	L	L
L	H	*	*	*	L	L	Q _n
L	\downarrow	*	*	*	L	L	Q _n

Q_{n+1} : NEXT STATE of Q_n
 HZ : HIGH IMPEDANCE
 * : Don't care

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{CC} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4076BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC		SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current		I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
				10	-	10	-	0.010	10	-	300	
				15	-	20	-	0.015	20	-	600	

* All valid input combinations.

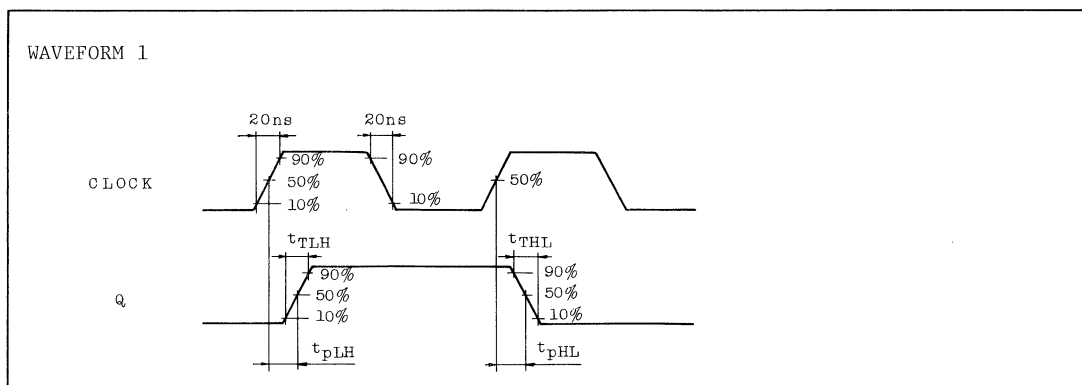
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	250	600	ns
			10	-	95	250	
			15	-	65	180	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	230	460	ns
			10	-	90	200	
			15	-	60	150	
Three State Disable Time (OUTPUT DISABLE - Q)	t _{pHZ} t _{pLZ}	R _L =1kΩ	5	-	100	300	ns
			10	-	45	120	
			15	-	35	90	
Three State Disable Time (OUTPUT DISABLE - Q)	t _{pZH} t _{pZL}	R _L =1kΩ	5	-	110	300	ns
			10	-	40	150	
			15	-	30	120	
Max. Clock Frequency	f _{CL}		5	3	7	-	MHz
			10	6	21	-	
			15	8	24	-	

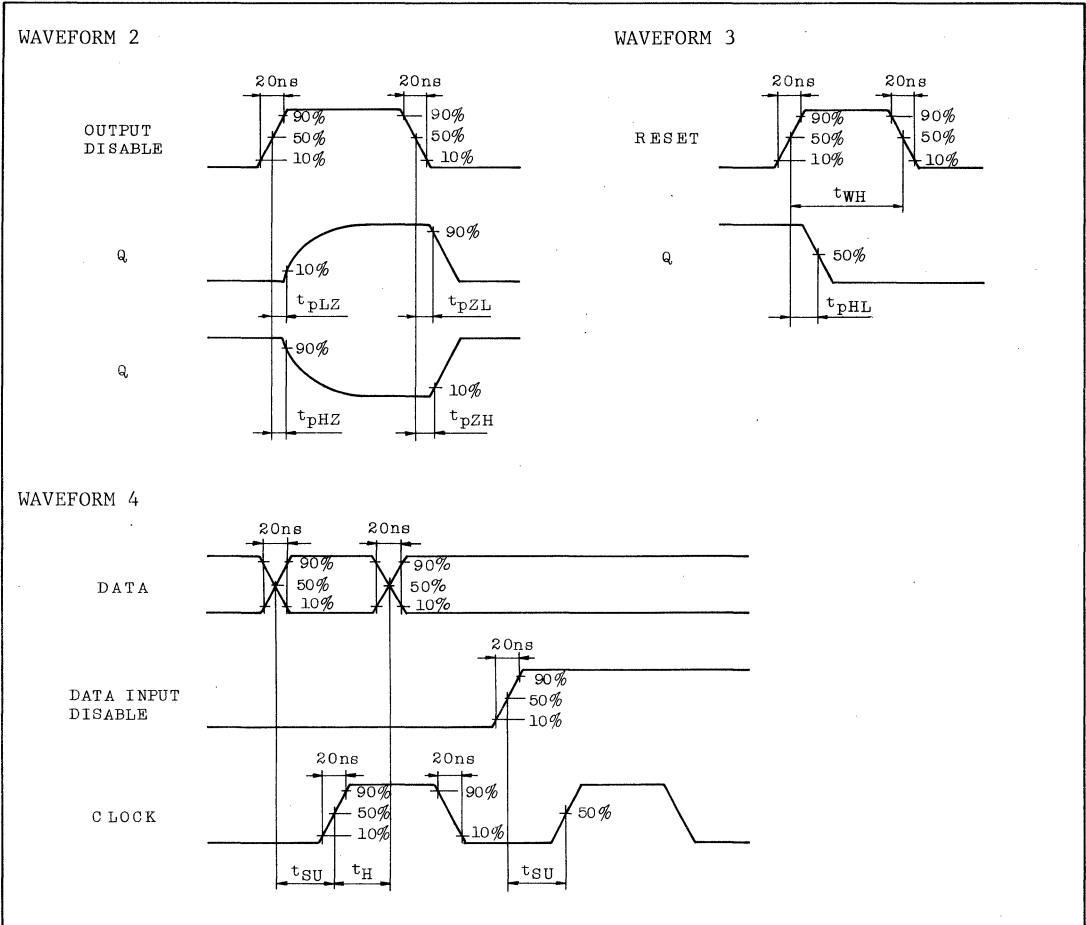
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Min. Clock Pulse Width	t_w		5	-	70	200	ns
			10	-	25	100	
			15	-	20	80	
Min. Pulse Width (RESET)	t_{WH}		5	-	100	200	ns
			10	-	40	80	
			15	-	30	60	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t_{rCL} t_{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Set-up Time (DATA - CLOCK)	t_{SU}		5	-	75	150	ns
			10	-	30	60	
			15	-	20	40	
Min. Set-up Time (DATA INPUT DISABLE - CLOCK)	t_{SU}		5	-	100	200	ns
			10	-	40	80	
			15	-	25	50	
Min. Hold Time (DATA - CLOCK)	t_H		5	-	-	135	ns
			10	-	-	60	
			15	-	-	50	
Input Capacitance	C_{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



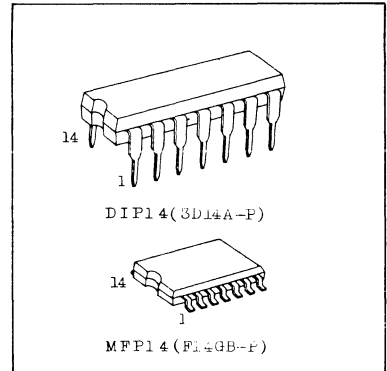
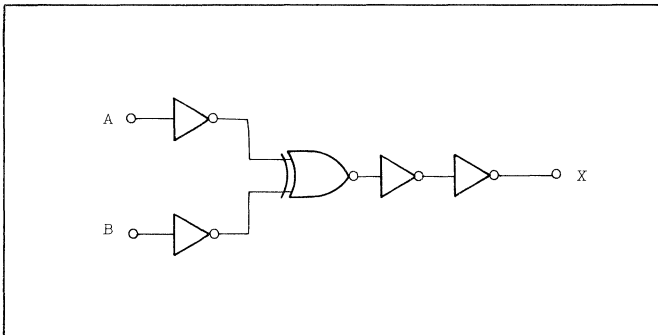
TC4077BP/TC4077BF QUAD EXCLUSIVE-NOR GATE

The TC4077BP/BF is quad exclusive-NOR gate. Since all the outputs are provided with the buffers of two stage inverters, the input/output voltage characteristics have been improved. Thus an increase in propagation delay time caused by an increase in load capacity is kept to a minimum. Therefore, this gate can be widely applied to digital comparators, parity circuits, etc.

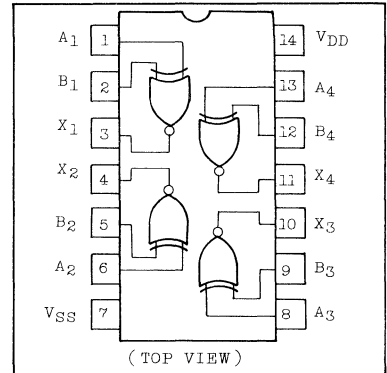
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

INPUTS		OUTPUT
A	B	X
L	L	H
L	H	L
H	L	L
H	H	H

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

TC4077BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

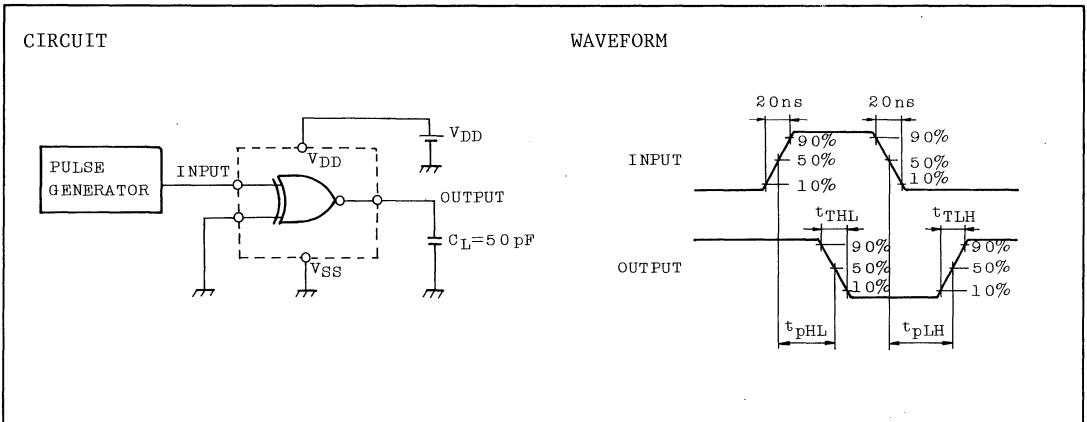
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _D D (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _D D	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _D D	5	-	0.05	-	0.00	0.05	-	0.05		
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _D D										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _D D										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _D D *	5	-	1	-	0.001	1	-	7.5	μA	
			10	-	2	-	0.001	2	-	15		
			15	-	4	-	0.002	4	-	30		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH} t _{pHL}		5	-	130	280	ns
			10	-	60	130	
			15	-	50	100	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4078BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

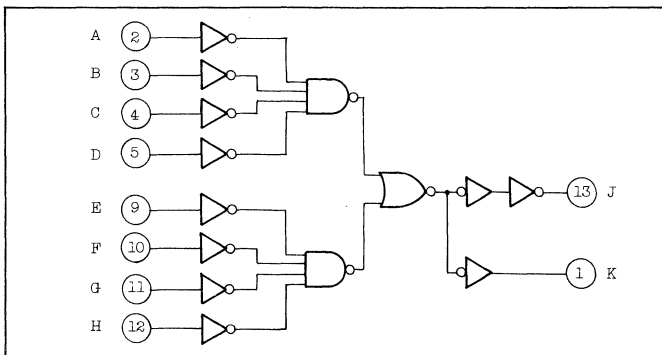
TC4078BP/TC4078BF 8-INPUT NOR/OR GATE

The TC4078BP/BF is 8-bit positive logic NOR/OR gate. Since each output of this gate is provided with a buffer, the input/output voltage characteristics have been improved, allowing noise immunity to be elevated; thus, the variation of propagation delay time due to the increase in load capacity is kept to the minimum.

MAXIMUM RATINGS

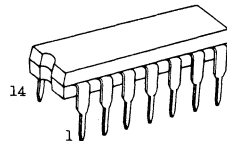
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10scc	

LOGIC DIAGRAM

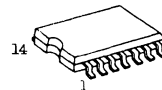


RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

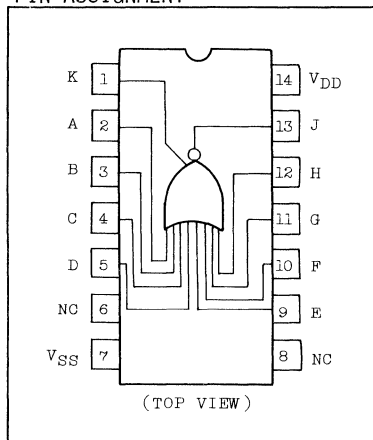


DIP14 (3D14A-P)



MFP14 (F14GB-P)

PIN ASSIGNMENT



STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _O UT| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _O UT| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _O UT=0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _O UT=1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _O UT=1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _O UT| < 1μA										
Input Low Voltage	V _{IL}	V _O UT=0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _O UT=1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _O UT=1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _O UT| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

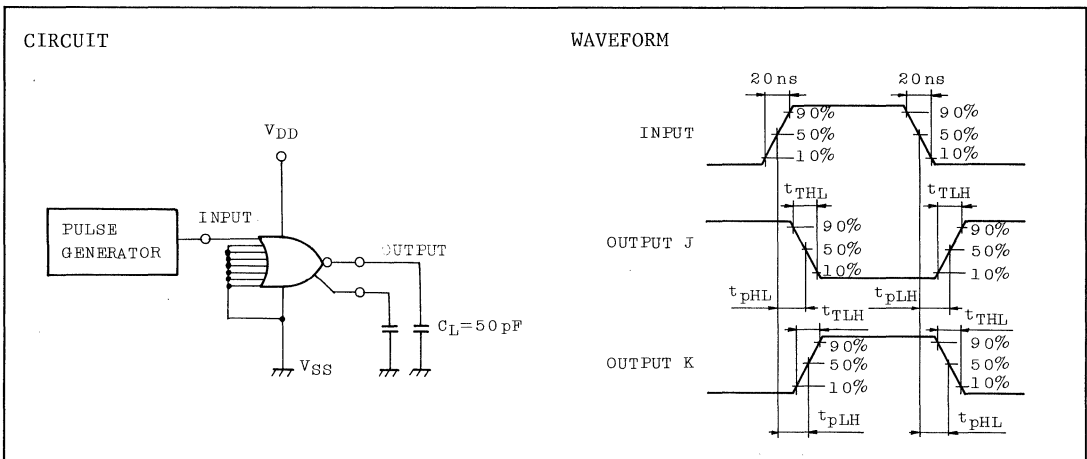
* All valid input combinations.

TC4078BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH}		5	-	170	300	ns
	t _{pHL}		10	-	70	140	
			15	-	50	110	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

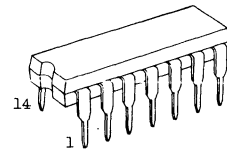


TC4085BP DUAL 2-WIDE 2-INPUT AND-OR-INVERT GATE

TC4085BP contains two circuits of AND-OR select gates and the outputs are inverted. The circuit consists of two 2 input AND gates and one NOR gate, and the logical equation of the output is as follows.

$$OUT = A \cdot B + C \cdot D + INH$$

If INH input is set at "H", the select operation is inhibited having OUT="L", so that this input can be used as an expander terminal for connecting TC4081B, etc.

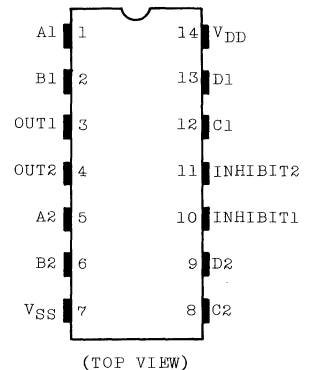


DIP14 (3D14A-P)

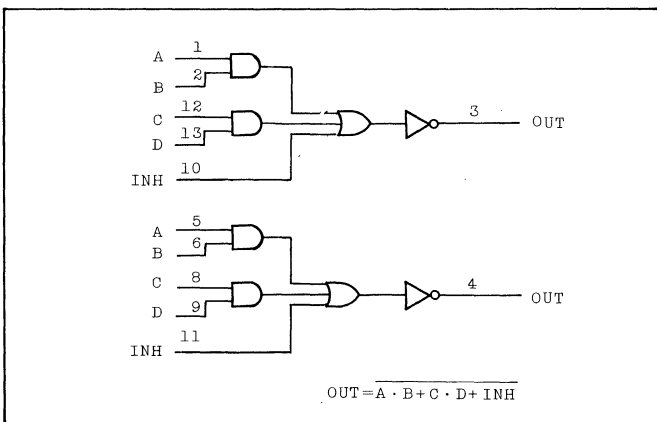
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC4085BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

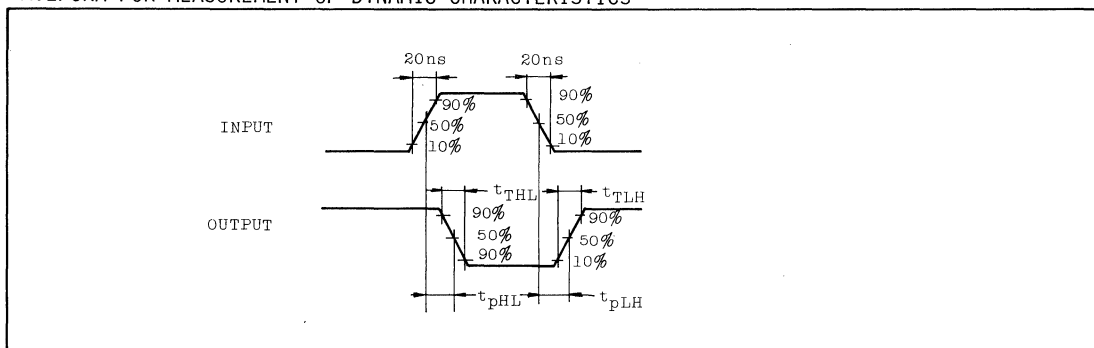
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	15.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	0	0.05		
			15	-	0.05	-	0.00	0.05	0	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.5	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (A, B, C, D - OUT)	t _{pLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (A, B, C, D - OUT)	t _{pHL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (INH - OUT)	t _{pLH}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (INH - OUT)	t _{pHL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4086BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4086BP EXPANDABLE 4-WIDE 2-INPUT AND-OR-INVERT GATE

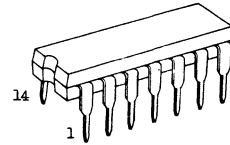
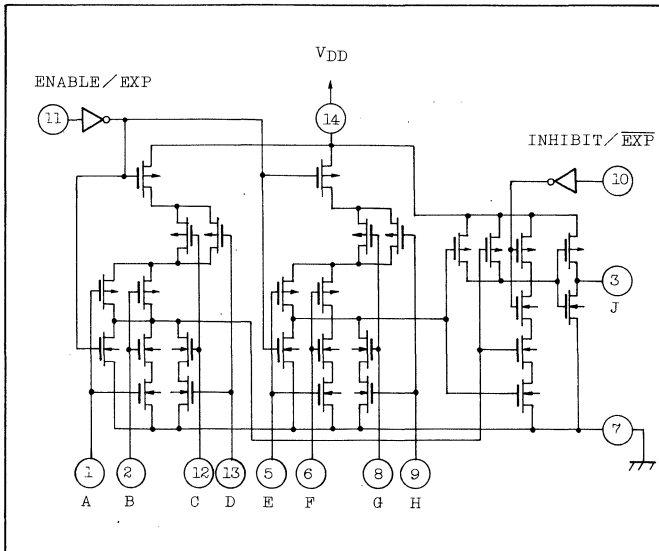
TC4086BP contains four 2 input AND gates and one OR gate which logically adds (OR) all the AND gates having an expander input to form AND-OR-select gate, and the output is inverted.

INH/EXP input and ENABLE/EXP input are the expander inputs to connect other AND gates and select gate and these can be used as INHIBIT input to inhibit the select operation besides of the expander function.

MAXIMUM RATINGS

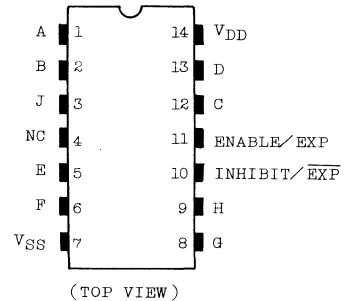
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

CIRCUIT DIAGRAM

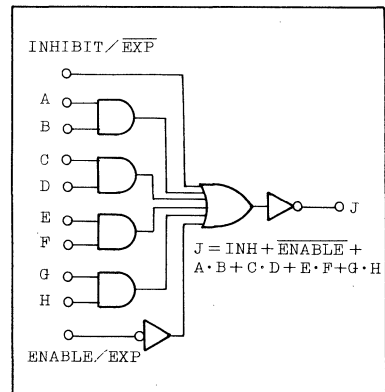


DIP 14 (3D14A-P)

PIN ASSIGNMENT



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4086BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

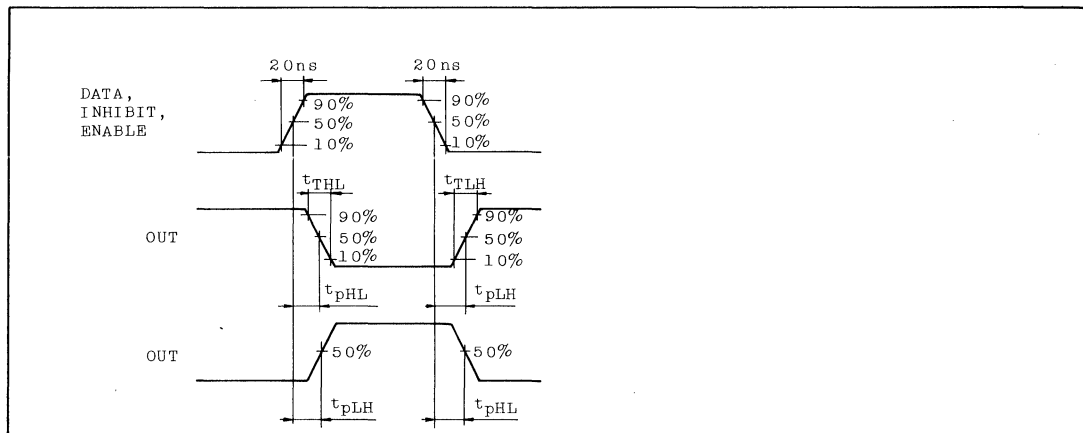
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.001	1	-	7.5	μA
			10	-	2	-	0.002	2	-	15	
			15	-	4	-	0.004	4	-	30	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (DATA - OUT)	t _{pLH}		5	-	110	450	ns
			10	-	45	180	
			15	-	30	120	
Propagation Delay Time (DATA - OUT)	t _{pHL}		5	-	110	450	ns
			10	-	45	180	
			15	-	35	120	
Propagation Delay Time (INHIBIT - OUT)	t _{pLH}		5	-	75	300	ns
			10	-	35	120	
			15	-	25	80	
Propagation Delay Time (INHIBIT - OUT)	t _{pHL}		5	-	70	300	ns
			10	-	30	120	
			15	-	25	80	
Propagation Delay Time (ENABLE - OUT)	t _{pLH}		5	-	95	300	ns
			10	-	40	120	
			15	-	30	80	
Propagation Delay Time (ENABLE - OUT)	t _{pHL}		5	-	90	300	ns
			10	-	40	120	
			15	-	30	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4093BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

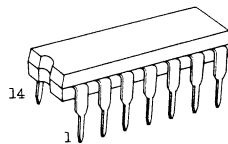
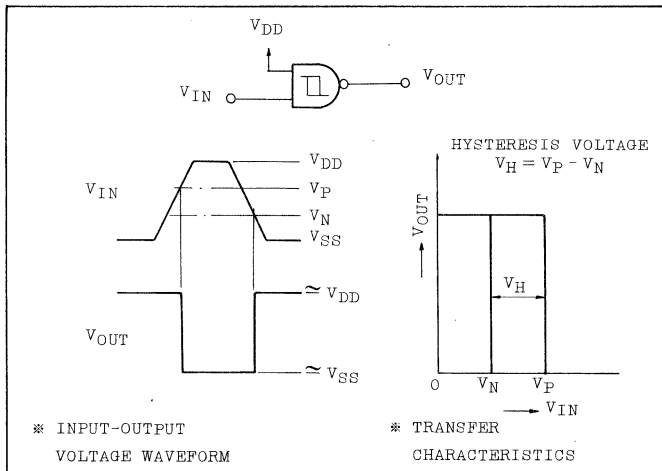
TC4093BP/TC4093BF QUAD 2-INPUT NAND SCHMITT TRIGGERS

The TC4093BP/BF is a quad 2-input NAND gate having Schmitt trigger function for all the input terminals. Since the circuit threshold voltage varies with rising time and falling time of the input waveform (V_P and V_N), this gate can be used for a wide variety of applications to line receivers, waveform shaping, astable multivibrators, monostable multivibrators, etc. in addition to regular NAND gates. As the TC4093BP/BF and the TC4011B are identical in pin assignment, they are compatible each other.

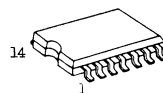
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10\text{sec}$	

INPUT-OUTPUT CHARACTERISTIC

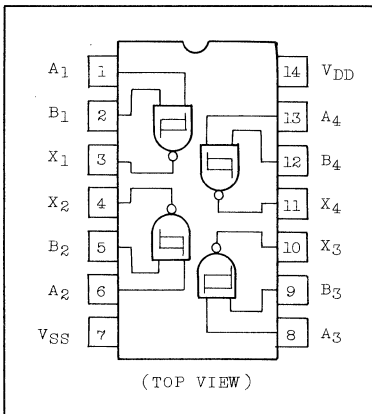


DIP14 (3D14A-P)

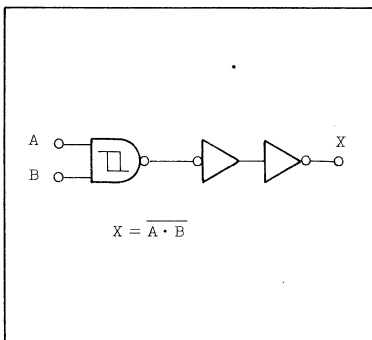


MFP14 (F14GB-P)

PIN ASSIGNMENT



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	
			15	4.0	-	3.4	15.0	-	2.8	-	
High Threshold Voltage	V _P	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V	5	-	-	2.05	2.8	3.55	-	-	V
			10	-	-	4.1	5.3	7.0	-	-	
			15	-	-	6.2	7.8	10.4	-	-	
Low Threshold Voltage	V _N	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V	5	-	-	1.5	2.3	3.15	-	-	V
			10	-	-	3.2	4.5	6.3	-	-	
			15	-	-	4.8	6.6	9.3	-	-	
Hysteresis Voltage	V _H		5	-	-	0.2	0.5	0.85	-	-	V
			10	-	-	0.3	0.8	1.4	-	-	
			15	-	-	0.45	1.2	1.9	-	-	
Input Current	"H" Level	I _{IH} V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL} V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4093BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

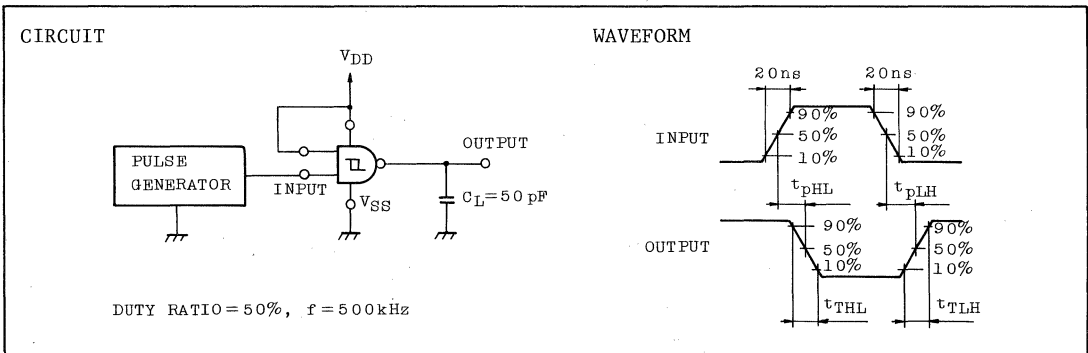
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.001	1	-	7.5	μA
			10	-	2	-	0.002	2	-	15	
			15	-	4	-	0.004	4	-	30	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH} t _{pHL}		5	-	130	260	ns
			10	-	60	120	
			15	-	40	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

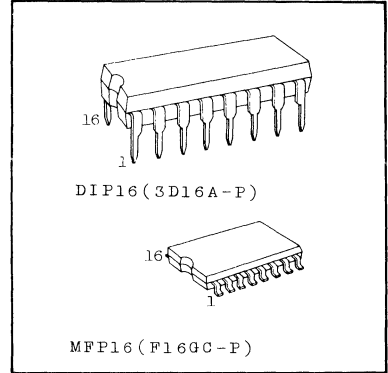
CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4094BP/TC4094BF 8-STAGE SHIFT-AND-STORE BUSREGISTER

TC4094BP/BF is a SHIFT and STORE REGISTER that consists of an 8-bit shift register and an 8-bit latch. The read data in the shift register can be taken in the latch through the asynchronous STROBE input; therefore, the data transfer mode can hold output. And, since the parallel output is of 3-state construction, it can be directly connected to the 8-bit busline.

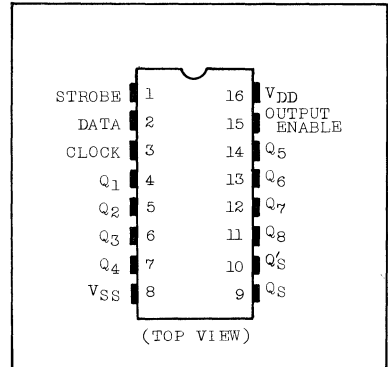
This register can be applied to Serial-to-parallel conversion, data receivers, etc.



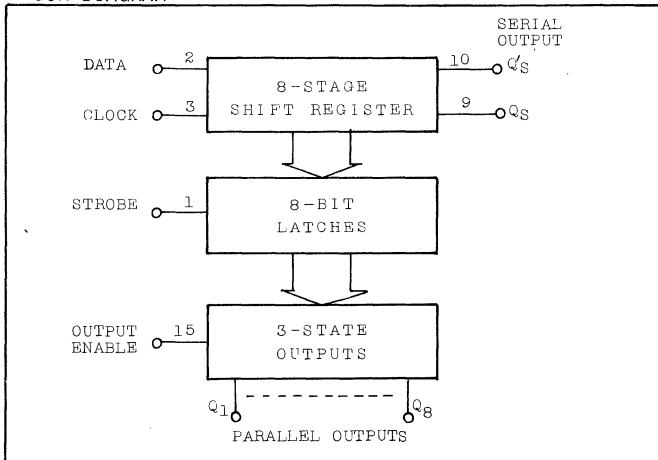
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



BLOCK DIAGRAM



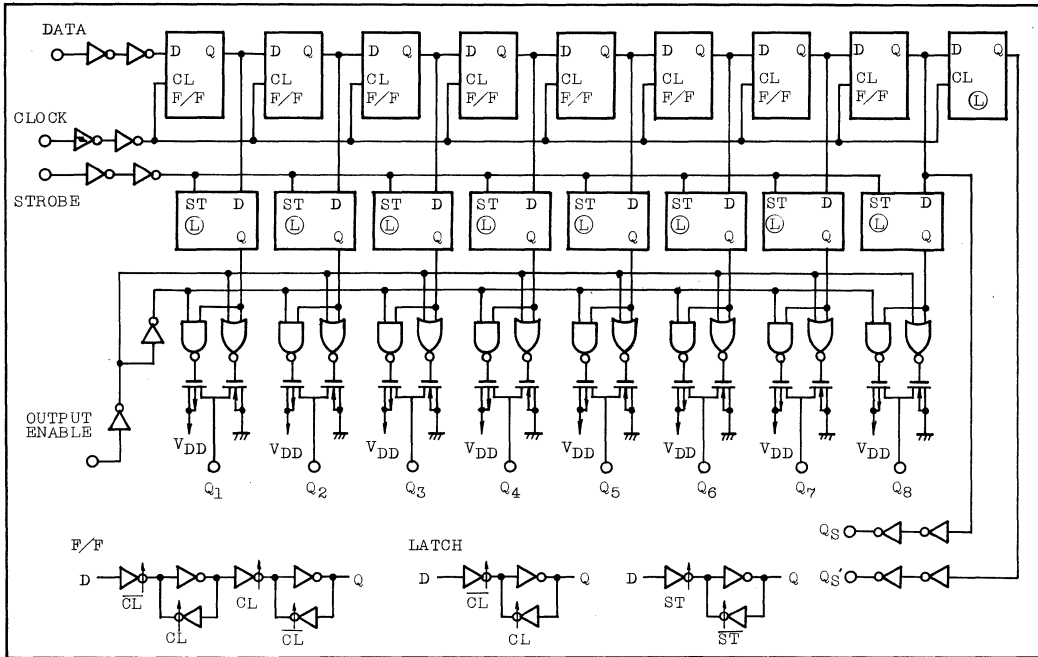
TRUTH TABLE

CL	OE	ST	D	PO		SO	
				Q_1	Q_n	Q_8	Q'_8
$\bar{1}$	H	H	L	L	Q_{n-1}	Q_7	NC
$\bar{1}$	H	H	H	H	Q_{n-1}	Q_7	NC
$\bar{1}$	H	L	X	NC	NC	Q_7	NC
$\bar{1}$	L	X	X	HZ	HZ	Q_7	NC
$\bar{1}$	H	X	X	NC	NC	NC	Q_8
$\bar{1}$	L	X	X	HZ	HZ	NC	Q_8

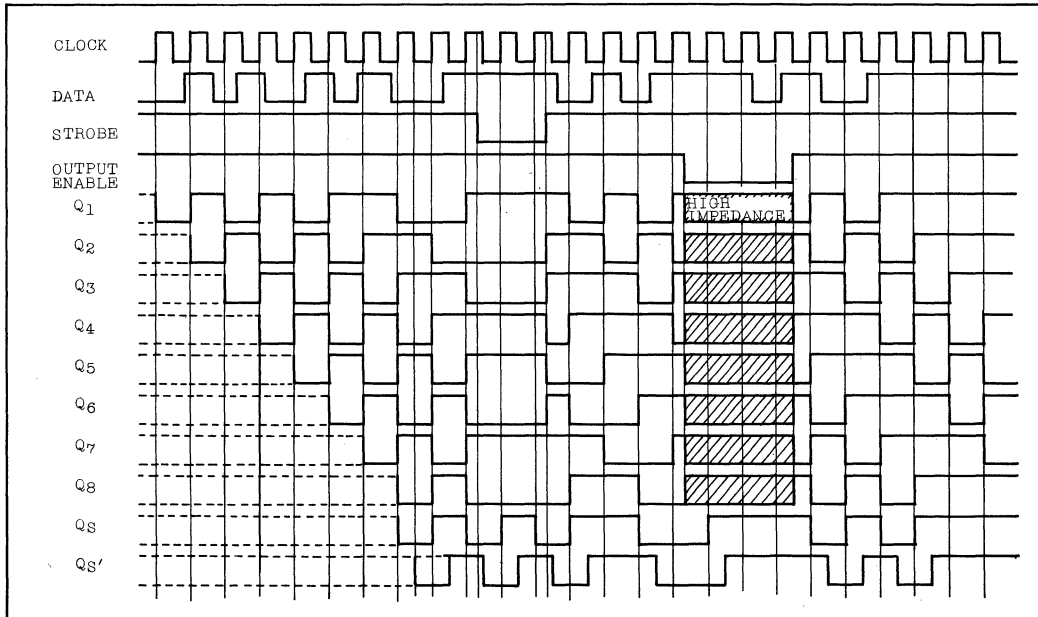
CL = Clock X = Don't care
 OE = Output Enable NC = No Change
 ST = Strobe HZ = High Impedance
 D = Data
 PO = Parallel Outputs
 SO = Serial Output

TC4094BP/BF

LOGIC DIAGRAM



TIMING CHART



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	3.0	-	4.5	3.0	-	3.0	V	
			10	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			5	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4094BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC		SYMBOL	TEST CONDITION	V _{CC} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150		
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (D)	MIN.	TYP.	MAX.	UNIT
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK - Qs)	t _{pLH} t _{pHL}		5	-	150	600	
			10	-	75	250	
			15	-	55	190	
Propagation Delay Time (CLOCK - Qs')	t _{pLH} t _{pHL}		5	-	155	460	
			10	-	75	220	
			15	-	55'	150	
Propagation Delay Time (CLOCK - Qn)	t _{pLH} t _{pHL}		5	-	190	840	
			10	-	90	390	
			15	-	65	270	
Propagation Delay Time (STROBE - Qn)	t _{pLH} t _{pHL}		5	-	150	580	
			10	-	70	290	
			15	-	50	200	
Three State Disable Time (OUTPUT ENABLE - Qn)	t _{pHZ} t _{pZH}	R _L =1kΩ	5	-	60	200	
			10	-	35	100	
			15	-	30	80	

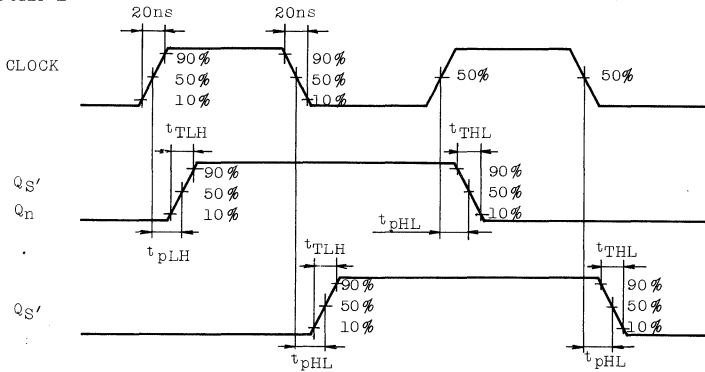
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (D)	MIN.	TYP.	MAX.	UNIT
Three State Disable Time (OUTPUT ENABLE -Q _n)	t _{pLZ} t _{pZL}		5	-	70	200	ns
			10	-	40	100	
			15	-	35	80	
Min. Clock Pulse Width	t _w		5	-	45	200	
			10	-	20	100	
			15	-	15	80	
Min. Pulse Width (STROBE)	t _{WH}		5	-	40	200	
			10	-	20	80	
			15	-	15	70	
Max. Clock Frequency	f _{CL}		5	1.25	6	-	MHz
			10	2.5	12	-	
			15	3	16	-	
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	0	125	ns
			10	-	0	55	
			15	-	0	35	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	10	40	
			10	-	10	20	
			15	-	5	15	
Min. Set-up Time (CLOCK - STROBE)	t _{SU}		5	-	90	200	
			10	-	40	100	
			15	-	30	80	
Min. Hold Time (CLOCK - STROBE)	t _H		5	-	-	0	
			10	-	-	0	
			15	-	-	0	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Input Capacitance	C _{IN}			-	5	7.5	pF

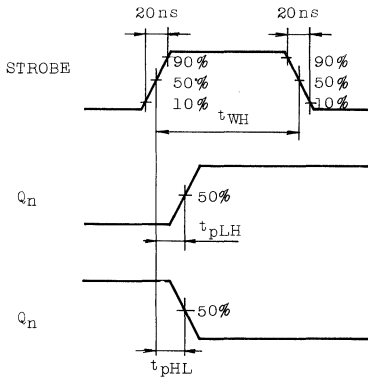
TC4094BP/BF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

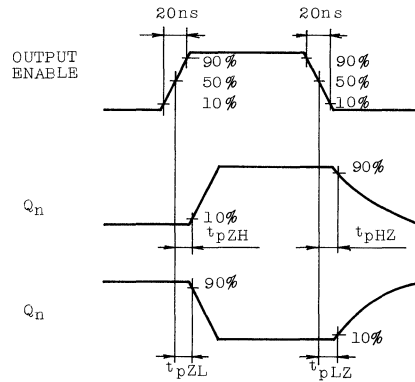
WAVEFORM 1



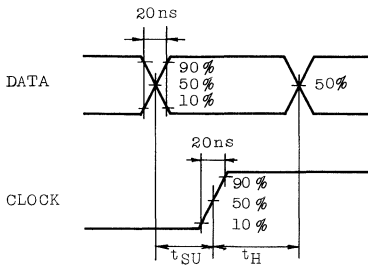
WAVEFORM 2



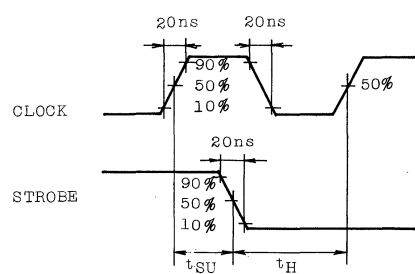
WAVEFORM 3



WAVEFORM 4



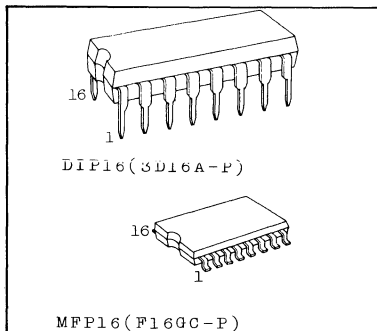
WAVEFORM 5



TC4099BP/TC4099BF 8-BIT ADDRESSABLE LATCH

TC4099BP/BF is eight bit latch having one common data input line and eight independent output lines and the latches are controlled by three bit binary address inputs (A0, A1 and A2).

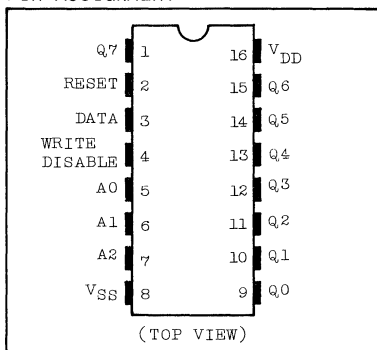
When WRITE DISABLE input and RESET input is "L", the data is written into the bit selected by the binary address input and other bits retain their previous conditions. When W. DISABLE input becomes "H", write into any bits is inhibited. When W. DISABLE input and RESET input are "H", all the bits are reset to "L".



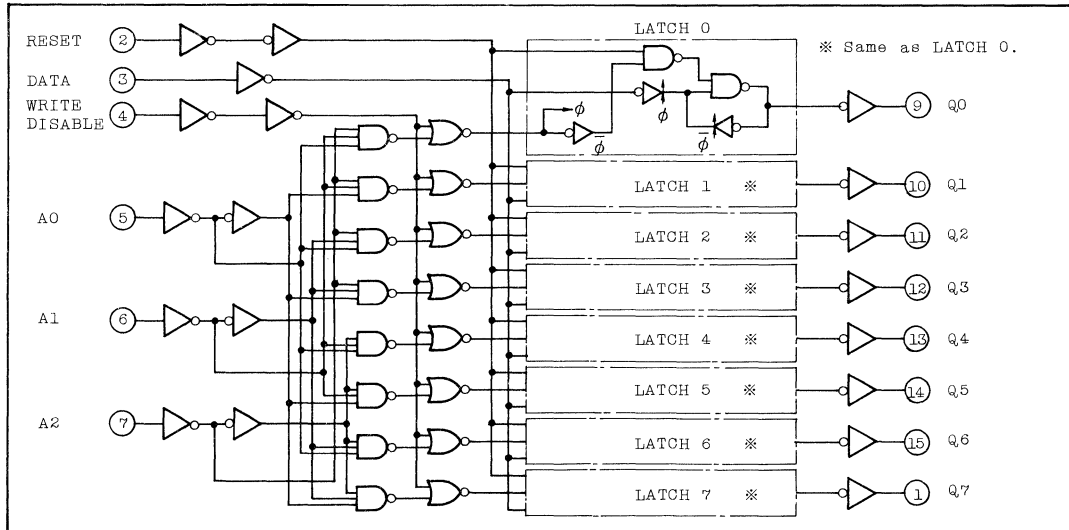
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Voltage	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC4099BP/BF

TRUTH TABLE

CONTROL INPUTS		ADDRESS INPUTS			OUTPUTS							
RESET	WRITE DISABLE	A ₂	A ₁	A ₀	Q ₀	Q ₁	Q ₂	Q ₃	Q ₄	Q ₅	Q ₆	Q ₇
H	H	*	*	*	L	L	L	L	L	L	L	L
L	H	*	*	*	-	-	-	-	-	-	-	-
H	L	L	L	L	D	L	L	L	L	L	L	L
H	L	L	L	H	L	D	L	L	L	L	L	L
H	L	L	H	L	L	L	D	L	L	L	L	L
H	L	L	H	H	L	L	L	D	L	L	L	L
H	L	H	L	L	L	L	L	L	D	L	L	L
H	L	H	L	H	L	L	L	L	L	D	L	L
H	L	H	H	L	L	L	L	L	L	L	D	L
H	L	H	H	H	L	L	L	L	L	L	L	D
L	L	L	L	L	D	-	-	-	-	-	-	-
L	L	L	L	H	-	D	-	-	-	-	-	-
L	L	L	H	L	-	-	D	-	-	-	-	-
L	L	L	H	H	-	-	-	D	-	-	-	-
L	L	H	L	L	-	-	-	-	D	-	-	-
L	L	H	L	H	-	-	-	-	-	D	-	-
L	L	H	H	L	-	-	-	-	-	-	D	-
L	L	H	H	H	-	-	-	-	-	-	-	D

* : Don't care D : Data input - : Holds previous data

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	±	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	V	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			5	-	5	-	0.005	5	-	150		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

*All valid input combinations.

 DYNAMIC ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$, $V_{SS}=0V$, $C_L=50pF$)

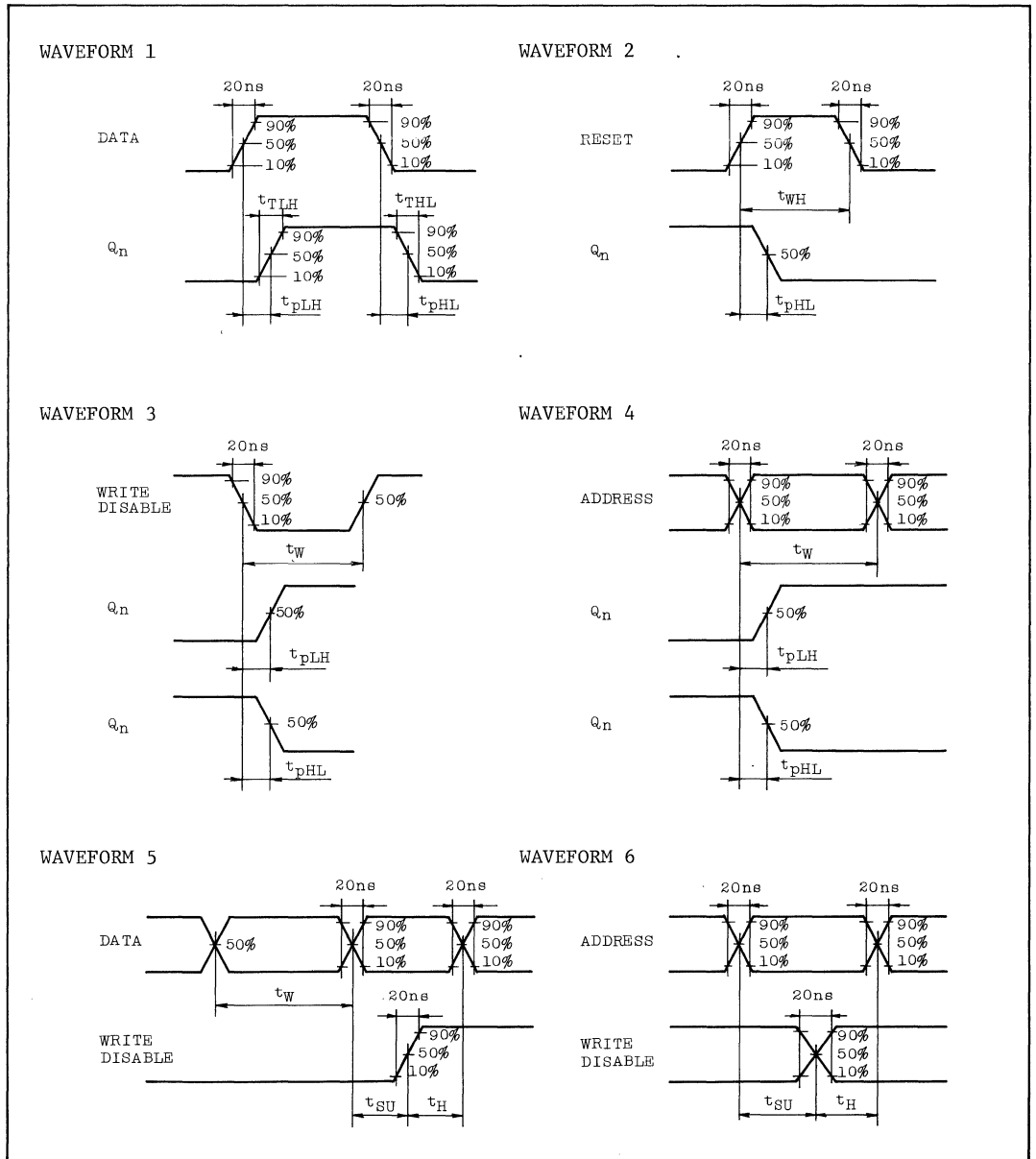
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	

TC4099BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (DATA - Q)	t _{pLH} t _{pHL}		5	-	110	400	ns
			10	-	50	150	
			15	-	40	100	
Propagation Delay Time (WRITE DISABLE - Q)	t _{pLH} t _{pHL}		5	-	130	400	
			10	-	60	160	
			15	-	45	120	
Propagation Delay Time (ADDRESS - Q)	t _{pLH} t _{pHL}		5	-	150	450	
			10	-	70	200	
			15	-	50	150	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	100	350	
			10	-	50	160	
			15	-	35	130	
Min. Pulse Width (DATA)	t _w		5	-	90	200	
			10	-	45	100	
			15	-	35	80	
Min. Pulse Width (WRITE DISABLE ADDRESS)	t _w		5	-	35	320	
			10	-	20	160	
			15	-	15	120	
Min. Pulse Width (RESET)	t _{WH}		5	-	50	150	
			10	-	25	75	
			15	-	20	50	
Min. Set-up Time (DATA - WRITE DISABLE)	t _{SU}		5	-	15	100	
			10	-	10	50	
			15	-	8	35	
Min. Hold Time (DATA - WRITE DISABLE)	t _H		5	-	-	150	
			10	-	-	75	
			15	-	-	50	
Min. Set-up Time (ADDRESS-WRITE DISABLE)	t _{SU}		5	-	20	100	
			10	-	10	50	
			15	-	5	35	
Min. Hold Time (ADDRESS-WRITE DISABLE)	t _H		5	-	-	0	
			10	-	-	0	
			15	-	-	0	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC40102BP, TC40103BP

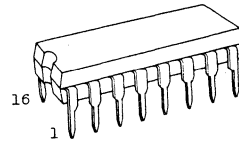
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC40102BP 8-STAGE PRESETTABLE SYNCHRONOUS DOWN COUNTER (2-Decade BCD Type)

TC40103BP 8-STAGE PRESETTABLE SYNCHRONOUS DOWN COUNTER (8-Bit Bynary Type)

The TC40102BP and TC40103BP are 8-stage presettable synchronous down counters. Output terminal $\overline{CO/ZD}$ is placed in active mode at "L" level when the contents of count become zero.

As the TC40102BP adopts BCD binary coded decimal notation, setting up to 99 counts is possible. The TC40103BP, with 8-bit binary construction, can set up to 255 counts. Each type has $\overline{CI/CE}$ inhibiting clock, \overline{APE} asynchronous preset control input, \overline{SPE} synchronous preset control input and \overline{RESET} control input setting counter to maximum counting mode. Clock input, with Schmitt function, can accept clock waveform with slow rise and fall edge.

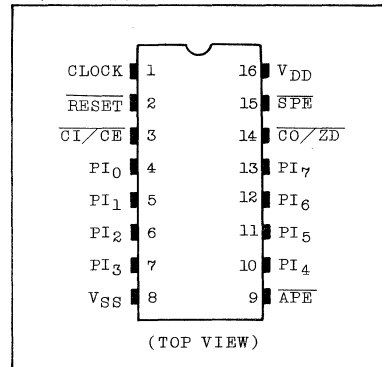


DIP 16(3D16A-F)

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



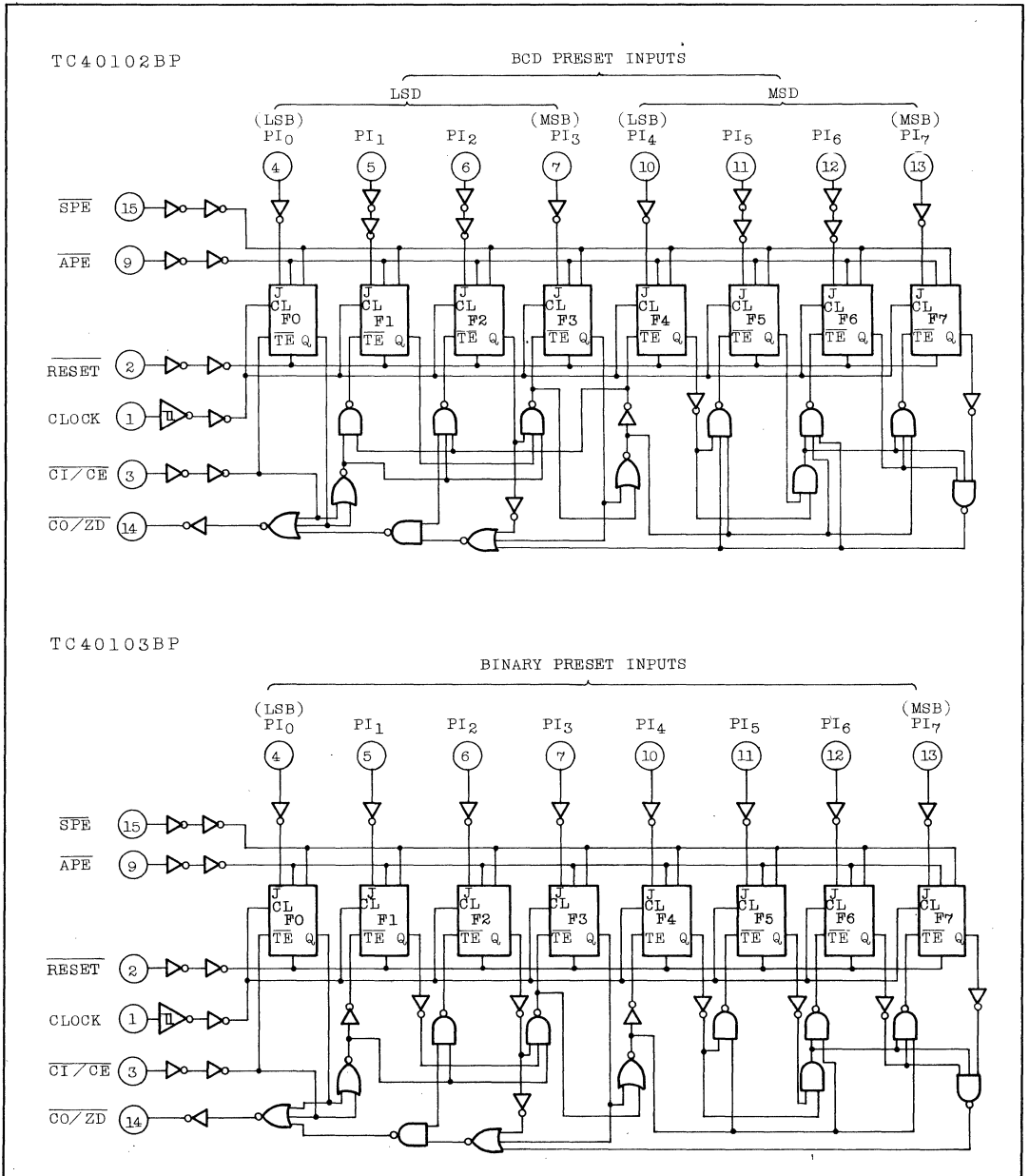
TRUTH TABLE

CONTROL INPUT				MODE	FUNCTIONAL DESCRIPTION
RESET	\overline{APE}	\overline{SPE}	$\overline{CI/CE}$		
H	H	H	H	Count inhibit	Even if clock is given, no count is made.
H	H	H	L	Regular count	Down count at rising edge of clock.
H	H	L	*	Synchronous preset	Data of PI terminal is preset at rising edge of clock.
H	L	*	*	Asynchronous preset	Data of PI terminal is asynchronously preset to clock.
L	*	*	*	Clear	Counter is set to maximum count.

Note 1. * : Don't care

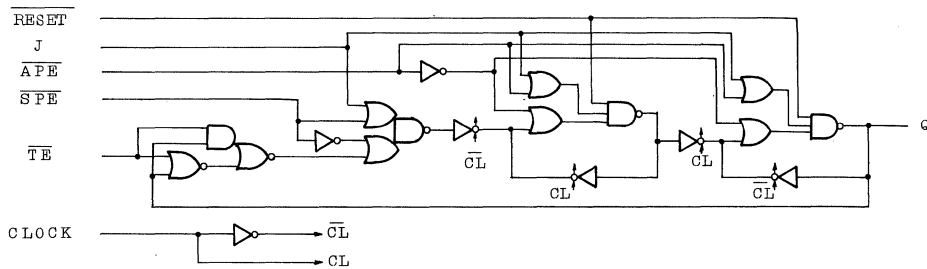
2. Maximum count: "99" for TC40102BP and "255" for TC40103BP.

LOGIC DIAGRAM



TC40102BP, TC40103BP

INTERNAL FLIP-FLOP (F0~F7) CIRCUIT DIAGRAM AND TRUTH TABLE OF COUNTER



INTERNAL FLIP-FLOP TRUTH TABLE

INPUT						OUTPUT
RESET	APE	SPE	J	TE	CLOCK	Q _{n+1}
L	*	*	*	*	*	H
H	L	*	L	*	*	H
H	L	*	H	*	*	L
H	H	L	L	*		H
H	H	L	H	*		L
H	H	L	*	*		Q _n
H	H	H	*	L		$\overline{Q_n}$
H	H	H	*	H	*	Q _n

FUNCTIONAL DESCRIPTION

The TC40102BP and TC40103BP are 8-stage presettable synchronous down counters. Carry Out/Zero Deffect ($\overline{CO/ZD}$) is output at the "L" level for the period of 1 bit when the readout becomes "0". The TC40102BP adopts binary coded decimal notation, making setting up to 99 counts possible. While the TC40103BP adopts 8-bit binary counter and can set up to 255 counts.

COUNT OPERATION

At the "H" level of control input of \overline{RESET} , \overline{SPE} and \overline{APE} , the counter carries out down count operation one by one at the rise of pulse given to CLOCK input. Count operation can be inhibited by setting Carry Input/Clock Enable ($\overline{CI/CE}$) to the "H" level. $\overline{CO/ZD}$ is output at the "L" level when the readout becomes "0", but is not output even if the readout becomes "0" when $\overline{CI/CE}$ is at the "H" level, thus maintaining the "H" level.

Synchronous cascade operation can be carried out by using $\overline{CI/CE}$ input and $\overline{CO/ZD}$ output.

FUNCTION DESCRIPTION (Cont'd)

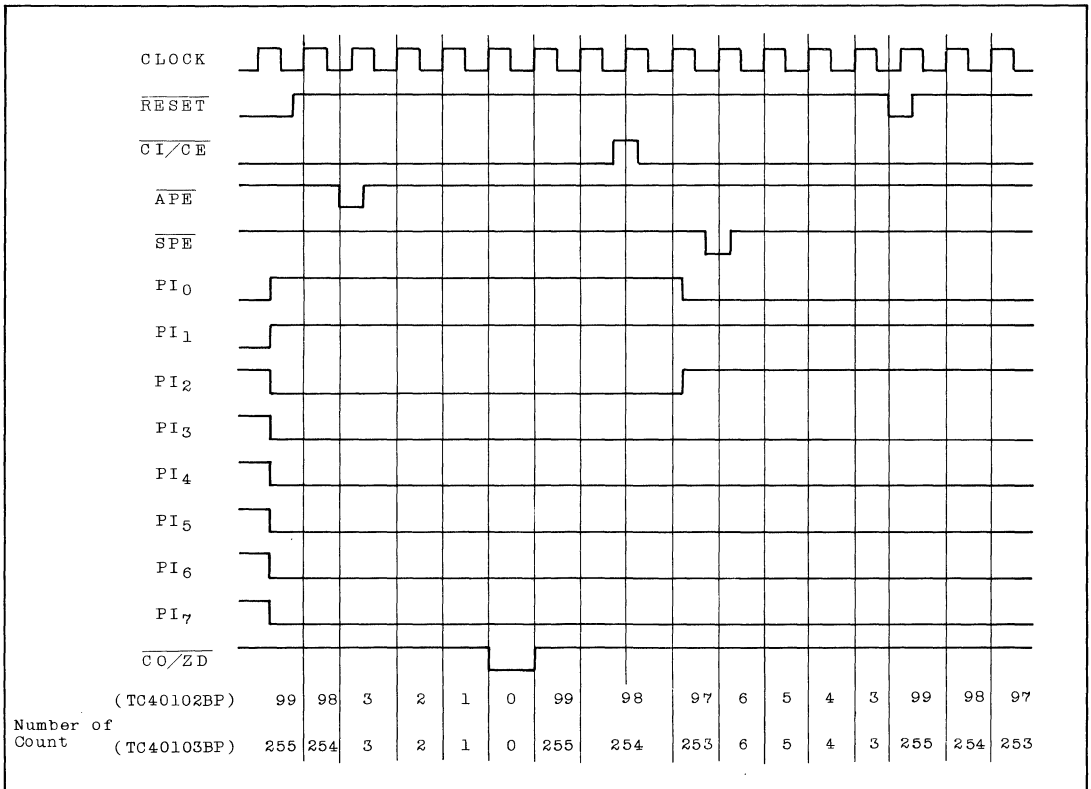
The contents of count jump to maximum count (99 for the TC40102BP and 255 for the TC40103BP) if clock is given when the readout is "0". Therefore, operation of 100-frequency division and that of 256-frequency division are carried out for the TC40102BP and TC40103BP, respectively, when clock input alone is given without various kinds of preset operations. To clock input is attached Schmitt gate.

PRESET OPERATION AND RESET OPERATION

When Reset ($\overline{\text{RESET}}$) input is set to the "L" level, the readout is set to the maximum count independently of other inputs. When Asynchronous Preset Enable ($\overline{\text{APE}}$) input is set to the "L" level, readouts given on P.10 to P.17 can be preset asynchronously to counter independently of inputs other than $\overline{\text{RESET}}$ input. When Synchronous Preset Enable ($\overline{\text{SPE}}$) is set to the "L" level, the readouts given on P.10 to P.17 can be preset to counter synchronously with the rise of clock.

As to these operation modes, refer to the truth table.

TIMING CHART



TC40102BP, TC40103BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

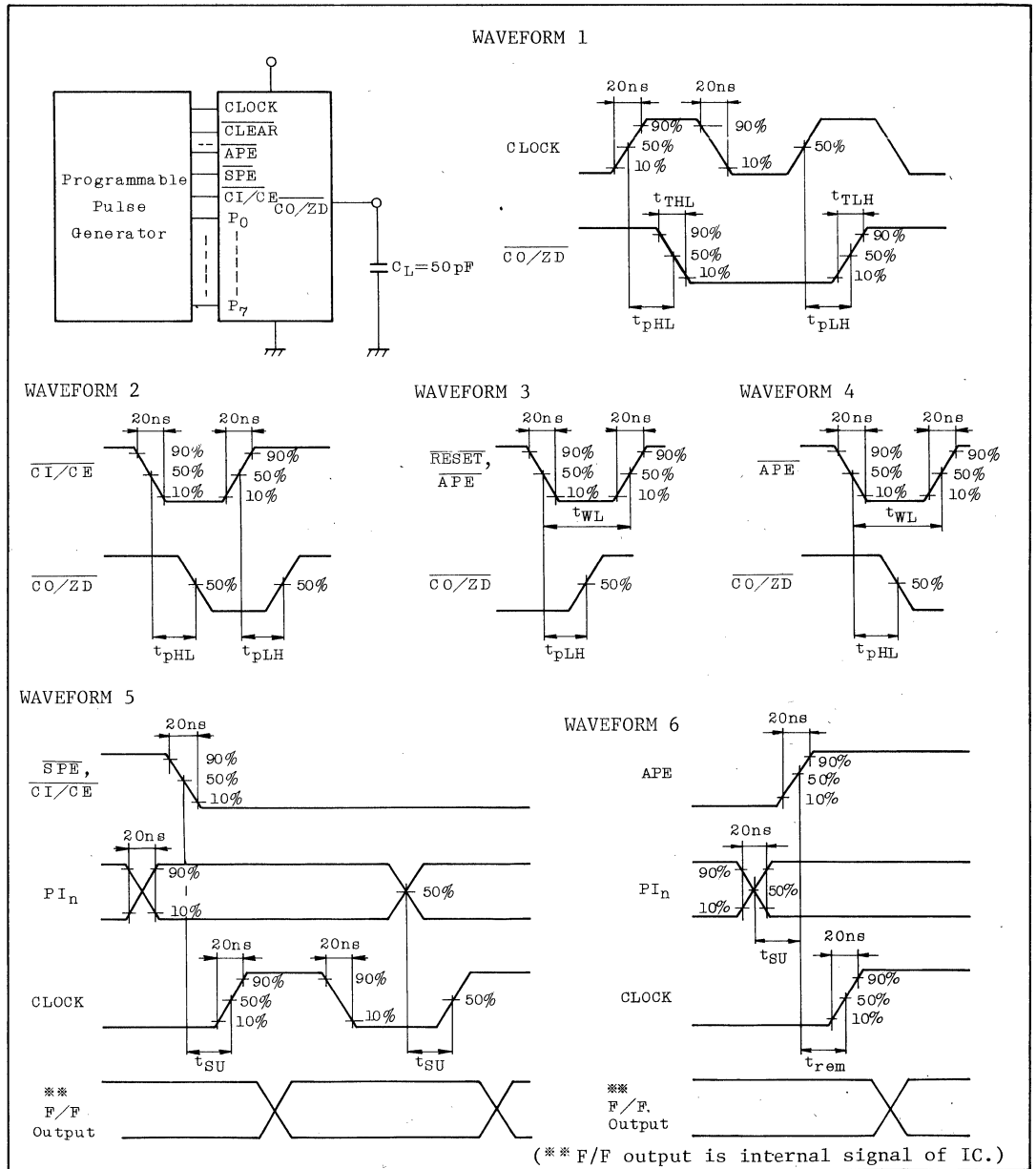
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - $\overline{CO/ZD}$)	t _{pLH} t _{pHL}		5	-	400	600	ns
			10	-	150	260	
			15	-	110	190	
Propagation Delay Time ($\overline{CI/CE}$ - $\overline{CO/ZD}$)	t _{pLH} t _{pHL}		5	-	200	400	ns
			10	-	90	180	
			15	-	65	130	
Propagation Delay Time (\overline{APE} - $\overline{CO/ZD}$)	t _{pLH} t _{pHL}		5	-	350	1300	ns
			10	-	130	600	
			15	-	100	400	
Propagation Delay Time (\overline{RESET} - $\overline{CO/ZD}$)	t _{pLH}		5	-	300	750	ns
			10	-	120	360	
			15	-	90	200	
Min. Clock Pulse Width	t _w		5	-	100	300	ns
			10	-	40	180	
			15	-	30	80	
Min. Pulse Width (\overline{RESET})	t _{wL}		5	-	140	320	ns
			10	-	60	160	
			15	-	45	100	

TC40102BP, TC40103BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width ($\overline{\text{APE}}$)	t_{WL}		5	-	120	360	ns
			10	-	45	160	
			15	-	35	120	
Max. Clock Frequency	f_{CL}		5	0.7	2	-	MHz
			10	1.8	5	-	
			15	2.4	8	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t_{rCL}		5	No Limit			μs
	t_{fCL}		10				
			15				
Min. Set-up Time ($\overline{\text{SPE}}$ - CLOCK)	t_{SU}		5	-	120	280	ns
			10	-	75	140	
			15	-	70	100	
Min. Set-up Time (PI - CLOCK)	t_{SU}		5	-	30	100	ns
			10	-	10	50	
			15	-	5	40	
Min. Set-up Time ($\overline{\text{CI/CE}}$ - CLOCK)	t_{SU}		5	-	300	500	ns
			10	-	100	250	
			15	-	70	150	
Min. Set-up Time (PI - $\overline{\text{APE}}$)	t_{SU}		5	-	150	300	ns
			10	-	60	120	
			15	-	40	80	
Min. Removal Time ($\overline{\text{APE}}$ -CLOCK)	t_{rem}		5	-	15	220	ns
			10	-	10	100	
			15	-	5	70	
Input Capacitance	C_{IN}			-	5	7.5	pF

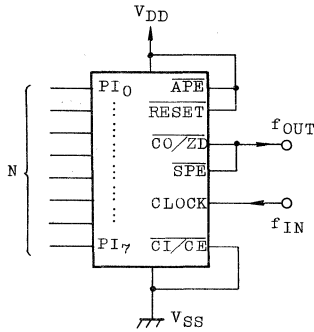
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



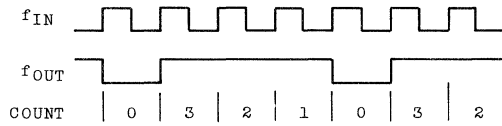
TC40102BP, TC40103BP

APPLICATION CIRCUIT

PROGRAMMABLE DIVIDE-BY-N COUNTER

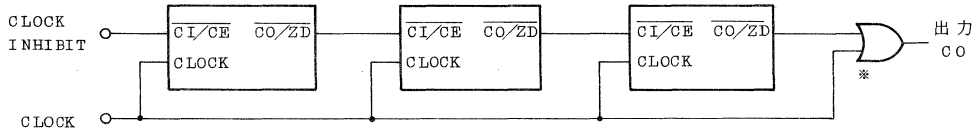


- $f_{OUT} = \frac{f_{IN}}{N+1}$
- Timing chart when N="3"
(PI0, PI1=VDD, PI2~PI7=VSS)



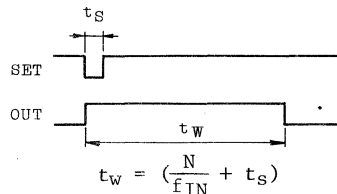
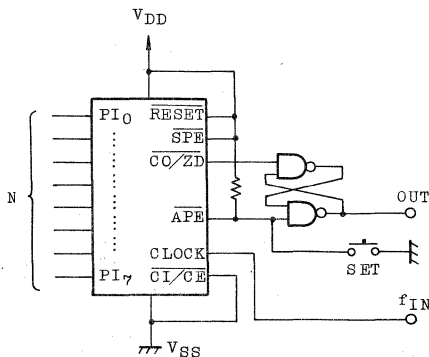
- TC40102BP...1/2 to 1/100 are dividable.
- TC40103BP...1/2 to 1/256 are dividable.

PARALLEL CARRY CASCADING



* At synchronous cascade connection, buzzard occurs at CO output after its second stage when digit place changes, due to delay arrival. Therefore, take gate from TC4071BP or the like, not from CO output at the rear stage directly.

PROGRAMMABLE TIMER



Note: The above formula does not take into account the phase of clock input. Therefore, the real pulse width is the distance between the above formula-1/fIN~ the above formula.

TC40104BP 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTER WITH 3-STATE OUTPUTS

TC40194BP 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTER WITH ASYNCHRONOUS MASTER RESET

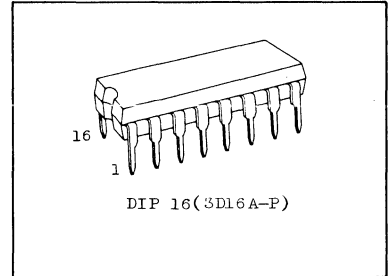
The TC40104BP and TC40194BP are 4-bit shift registers with parallel output, parallel input, shift right and shift left inputs.

To the TC40104BP is attached OUTPUT ENABLE input which can place output terminal into high impedance. Also, to the TC40194BP is attached RESET input which can clear the contents of registers asynchronously.

In parallel data preset mode, data of D₀~D₃ are not only preset in the internal register, but output to each Q output, at the rise of clock, Shift right and shift left inputs are inhibited during the time.

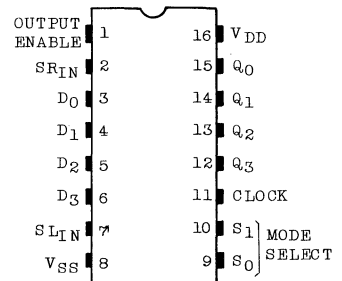
In shift right and shift left modes, data from shift right and shift left inputs are shifted to the right and to the left by 1 bit, respectively, synchronously with the rise of clock.

The TC40194BP is function and pin compatible with the 74194 of TTL.

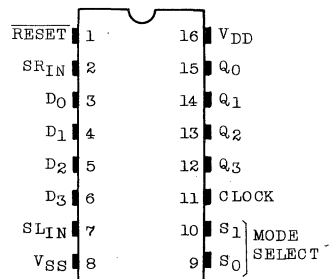


PIN ASSIGNMENT (TOP VIEW)

TC40104BP



TC40194BP

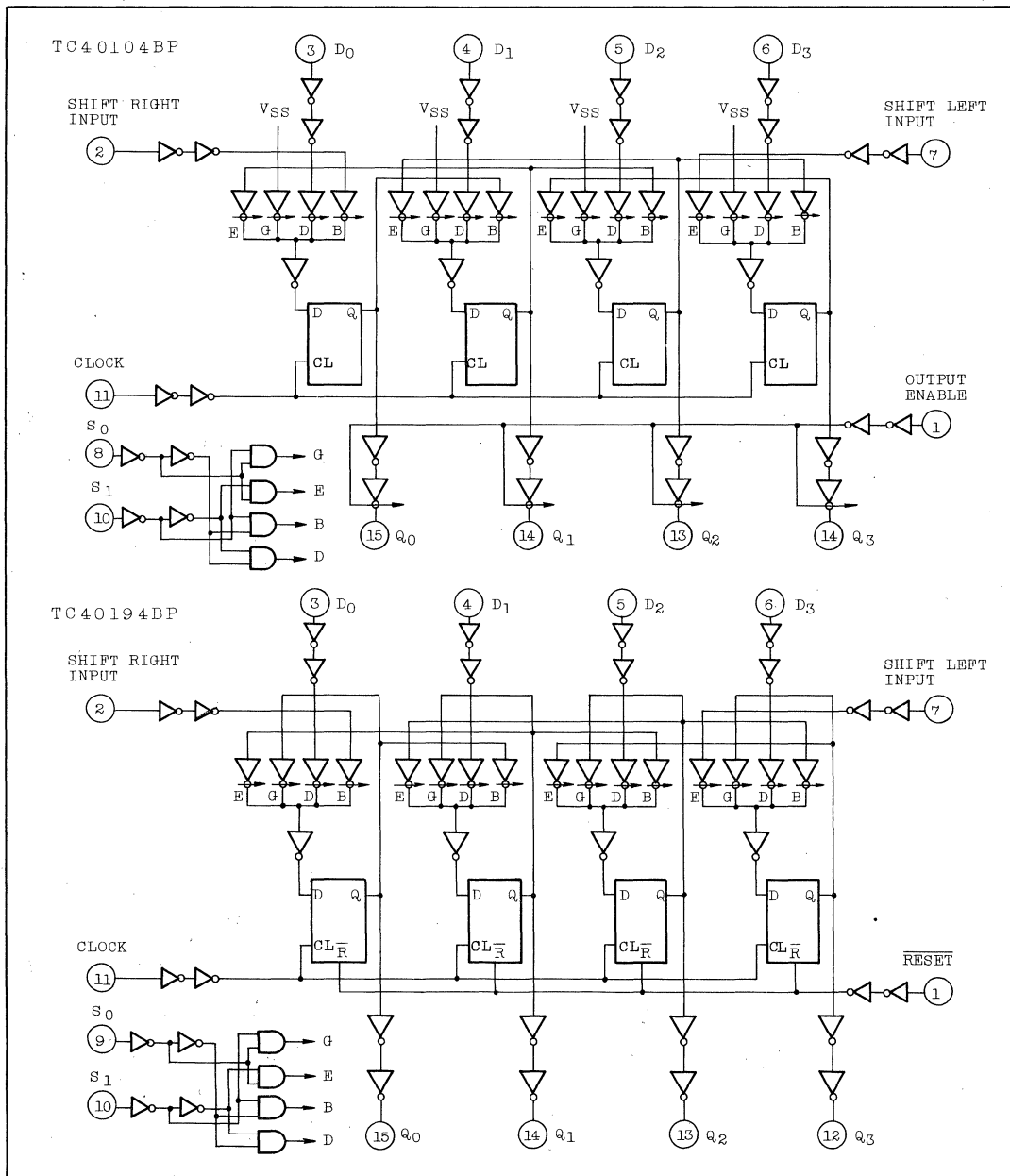


TRUTH TABLE

TC40104BP				
CLOCK	MODE SELECT		OUTPUT ENABLE	OPERATION MODE
	S ₀	S ₁		
	L	L	H	RESET
	H	L	H	SHIFT RIGHT(Q ₀ →Q ₁ →Q ₂ →Q ₃)
	L	H	H	SHIFT LEFT(Q ₃ →Q ₂ →Q ₁ →Q ₀)
	H	H	H	PARALLEL DATA PRESET
*	*	*	L	OUTPUT HIGH IMPEDANCE
* : Don't care				
TC40194BP				
CLOCK	MODE SELECT		RESET	OPERATION MODE
	S ₀	S ₁		
*	L	L	H	HOLD
	H	L	H	SHIFT RIGHT(Q ₀ →Q ₁ →Q ₂ →Q ₃)
	L	H	H	SHIFT LEFT(Q ₃ →Q ₂ →Q ₁ →Q ₀)
	H	H	H	PARALLEL DATA PRESET
*	*	*	L	RESET
* : Don't care				

TC40104BP, TC40194BP

LOGIC DIAGRAM



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	

TC40104BP, TC40194BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10-5	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10-5	-0.1	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{DH} =18V	18	-	0.4	-	10-4	0.4	-	12	μA
	"L" Level	I _{DL}	V _{DL} =0V	18	-	-0.4	-	-10-4	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

© Only TC40104BP * All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	220	440	ns
			10	-	90	200	
			15	-	60	140	
Three State Disable Time (OUTPUT ENABLE - Q) ©	t _{pZH} t _{pZL}	R _L =1kΩ	5	-	80	160	ns
			10	-	35	70	
			15	-	25	50	

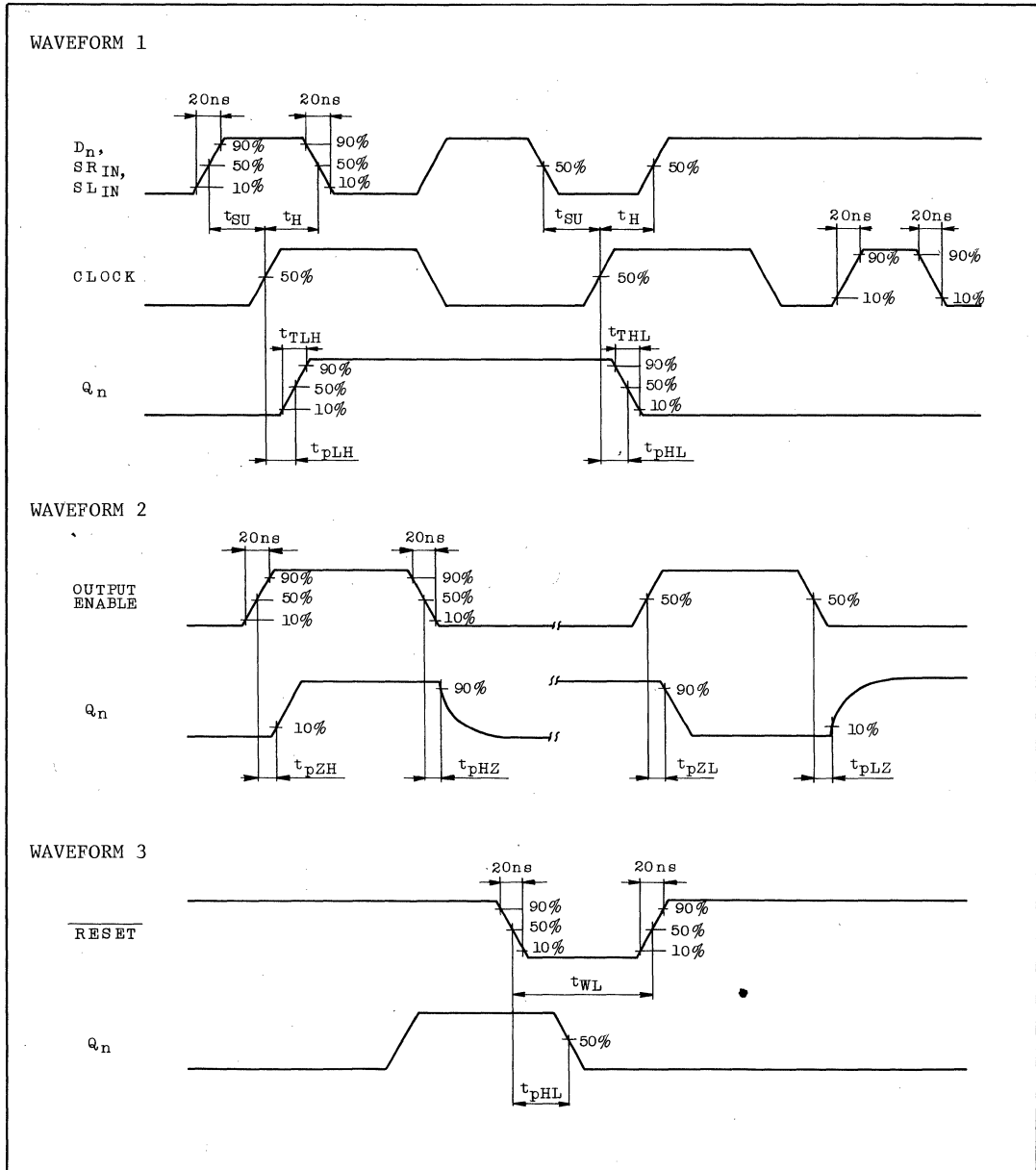
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Three State Disable Time (OUTPUT ENABLE - Q) ©	t _{pLZ} t _{pHZ}	R _L =1kΩ	5	-	55	110	ns
			10	-	30	60	
			15	-	25	50	
Propagation Delay Time (RESET - Q) *	t _{pHL}		5	-	160	460	ns
			10	-	65	180	
			15	-	50	130	
Min. Clock Pulse Width	t _w		5	-	70	180	ns
			10	-	40	80	
			15	-	25	50	
Min. Pulse Width (RESET) *	t _{wL}		5	-	100	200	ns
			10	-	40	80	
			15	-	25	50	
Max. Clock Frequency	f _{CL}		5	1.5	3	-	MHz
			10	4	8	-	
			15	6	11	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Set-up Time (D ₀ ~D ₃ , SR _{IN} , SL _{IN} -CLOCK)	t _{SU}		5	-	160	320	ns
			10	-	65	170	
			15	-	40	80	
Min. Set-up Time (S ₀ , S ₁ - CLOCK)	t _{SU}		5	-	200	400	ns
			10	-	80	160	
			15	-	60	120	
Min. Hold Time (D ₀ ~D ₃ , SR _{IN} , SL _{IN} - CLCOK)	t _H		5	-	-145	0	ns
			10	-	-55	0	
			15	-	-35	0	
Min. Hold Time (S ₀ , S ₁ - CLOCK)	t _H		5	-	-185	0	ns
			10	-	-70	0	
			15	-	-55	0	
Input Capacitance	C _{IN}			-	5	7.5	pF

© Only TC40104BP * Only TC40194BP

TC40104BP, TC40194BP

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



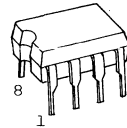
TC40107BP DUAL 2-INPUT NAND BUFFER/DRIVER

TC40107BP is a dual 2-input NAND gate, of which output is of open-drain structure by use of N-channel MOS FET. Being capable of driving a large current, it can be directly connected to a relay, a lamp, a light-emitting diode (LED), etc. Wired OR can be also made.

($I_{OL}=74\text{mA}$ (Typ.) at $V_{DD}=10\text{V}$ and $V_{OL}=0.5\text{V}$)

The package is a compact DIP 8-pin unit, which is easily mounted.

Since its output current is large, if the capacitor of an output line exceeds 500pF, a resistor of 25 Ω or more should be used in series with the capacitor.

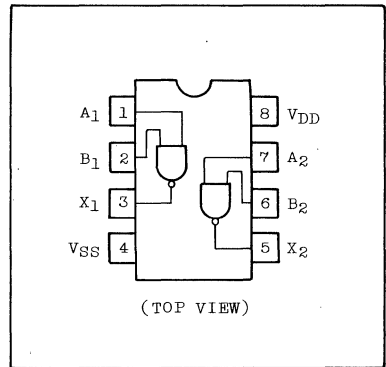


DIP 8 (3DBA-P)

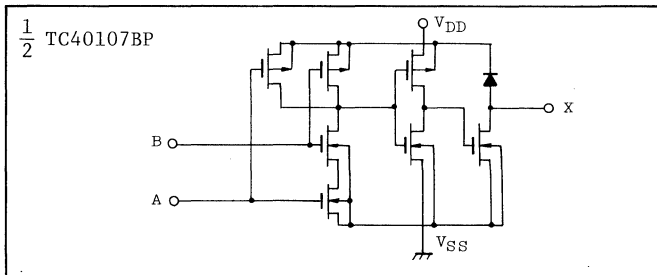
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Max. GND Current	I_{SS}	125	mA
Power Dissipation	P_D	300	mW
Operating Temperature Range	T_A	-40 ~ 85	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-65 ~ 150	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	260 $^{\circ}\text{C}$ · 10 sec	

PIN ASSIGNMENT



CIRCUIT DIAGRAM



TRUTH TABLE

INPUT		OUTPUT
A	B	X
L	L	HZ
L	H	HZ
H	L	HZ
H	H	L

HZ : High impedance

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0\text{V}$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
Load Capacitance	C_L	-	-	500	pF

TC40107BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _D D (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IH} =V _D D	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output Low Current	I _{OL}	V _{OL} =0.4V	5	20	-	16	32	-	14	-	mA	
		V _{OL} =1.0V	5	42	-	34	68	-	30	-		
		V _{OL} =0.5V	10	46	-	37	74	-	32	-		
		V _{OL} =1.0V	10	85	-	68	136	-	60	-		
		V _{OL} =0.5V	15	63	-	50	100	-	44	-		
		V _{IH} =V _D D										
Input High Voltage	V _{IH} *	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL} *	V _{OUT} =4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
3-State Output Leakage Current	I _{DH}	V _{OH} =18V	18	-	2	-	10 ⁻⁴	2	-	20	μA	
Quiescent Device Current	I _{DD} **	V _{IN} =V _D D, V _{SS} Outputs Open	5	-	1	-	0.001	1	-	7.5	μA	
			10	-	2	-	0.001	2	-	15		
			15	-	4	-	0.002	4	-	30		

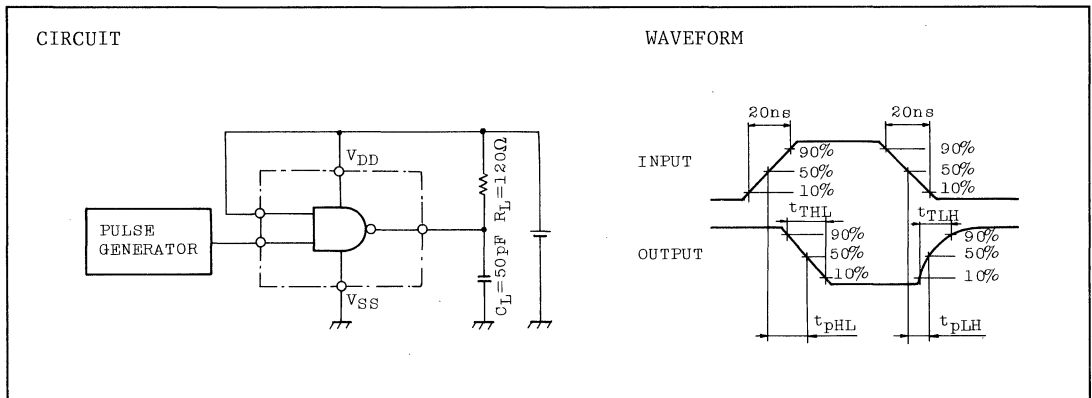
* Required external pull-up register R (=20kΩ)

** All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}	R _L =120Ω	5	-	35	100	ns
			10	-	25	70	
			15	-	20	50	
Output Transition Time (High to Low)	t _{THL}	R _L =120Ω	5	-	35	100	ns
			10	-	10	40	
			15	-	7	20	
Propagation Delay Time (Low to High)	t _{pLH}	R _L =120Ω	5	-	60	200	ns
			10	-	35	120	
			15	-	30	100	
Propagation Delay Time (High to Low)	t _{pHL}	R _L =120Ω	5	-	70	200	ns
			10	-	30	90	
			15	-	20	60	
Input Capacitance	C _{IN}			-	5	7.5	pF
Output Capacitance	C _{OUT}			-	30	-	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

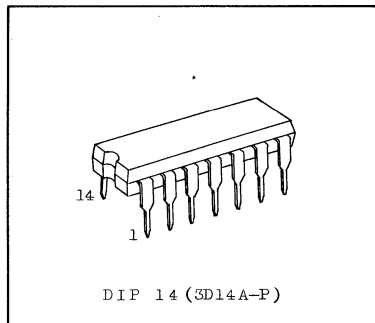


TC40117BP

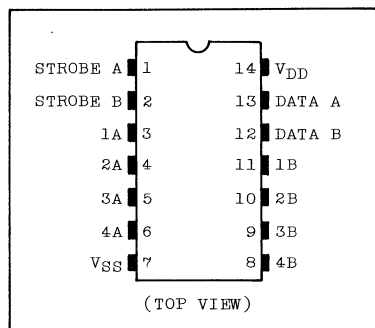
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC40117BP PROGRAMMABLE DUAL 4-BIT TERMINATOR

TC40117BP contains independent two 4-bit Programmable Terminators that are capable of terminating a data bus to a high or low state. They can also terminate any open or unused CMOS logic input to the last driven logic state when used with 3-state logic or during a power down condition. The terminator reduces power consumption by eliminating pull up or pull down resistors. When the STROBE input is held low, the terminated input/output latches the last DATA input until the terminated input/output changes state. When STROBE input is held high and DATA input is kept high or low, the terminated input/output stay in a high or low logic state respectively. It also has a wide operating voltage range of 2~18 Volt that allows designers to use it in the battery driving system.



PIN ASSIGNMENT



MAXIMUM RATINGS

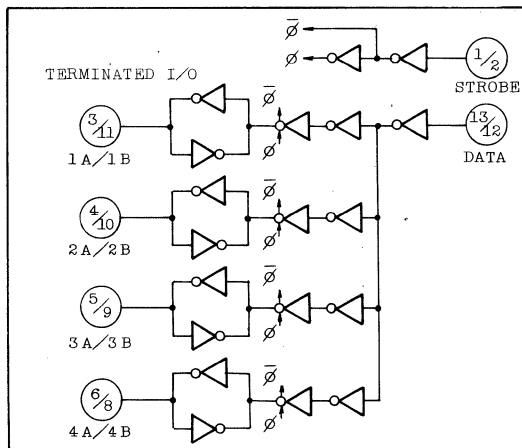
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{VSS} -0.5 ~ V _{VSS} +20	V
Input Voltage	V _{IN}	V _{VSS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{VSS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	PD	300	mW
Storage Temperature	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

TRUTH TABLE

INPUTS		TERMINATED I/O			
STROBE	DATA	1A(B)	2A(B)	3A(B)	4A(B)
H	L	L*	L*	L*	L*
H	H	H**	H**	H**	H**
L	X	*	*	*	*

H=High Level
L=Low Level
X=Don't Care
*Terminator retains the last data state during strobo if its inputs are high impedance state.
If inputs are not in high impedance state. Then Terminator follows the last driven state ("H" or "L" on its input/output)
. Equivalent to pull-down resistor
.. Equivalent to pull-up resistor

LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}		2	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Operating Temperature	T _A		-40	-	85	°C

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-12	-	-12	-35	-	-9	-	μA	
		V _{OH} =9.5V	10	-30	-	-30	-70	-	-25	-		
		V _{OH} =13.5V	15	-125	-	-125	-260	-	-102	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	12	-	12	35	-	9	-	μA	
		V _{OL} =0.5V	10	30	-	30	85	-	25	-		
		V _{OL} =1.5V	15	125	-	125	320	-	102	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	7.5	μA	
			10	-	0.5	-	0.001	0.5	-	15		
			15	-	1.0	-	0.002	1.0	-	30		

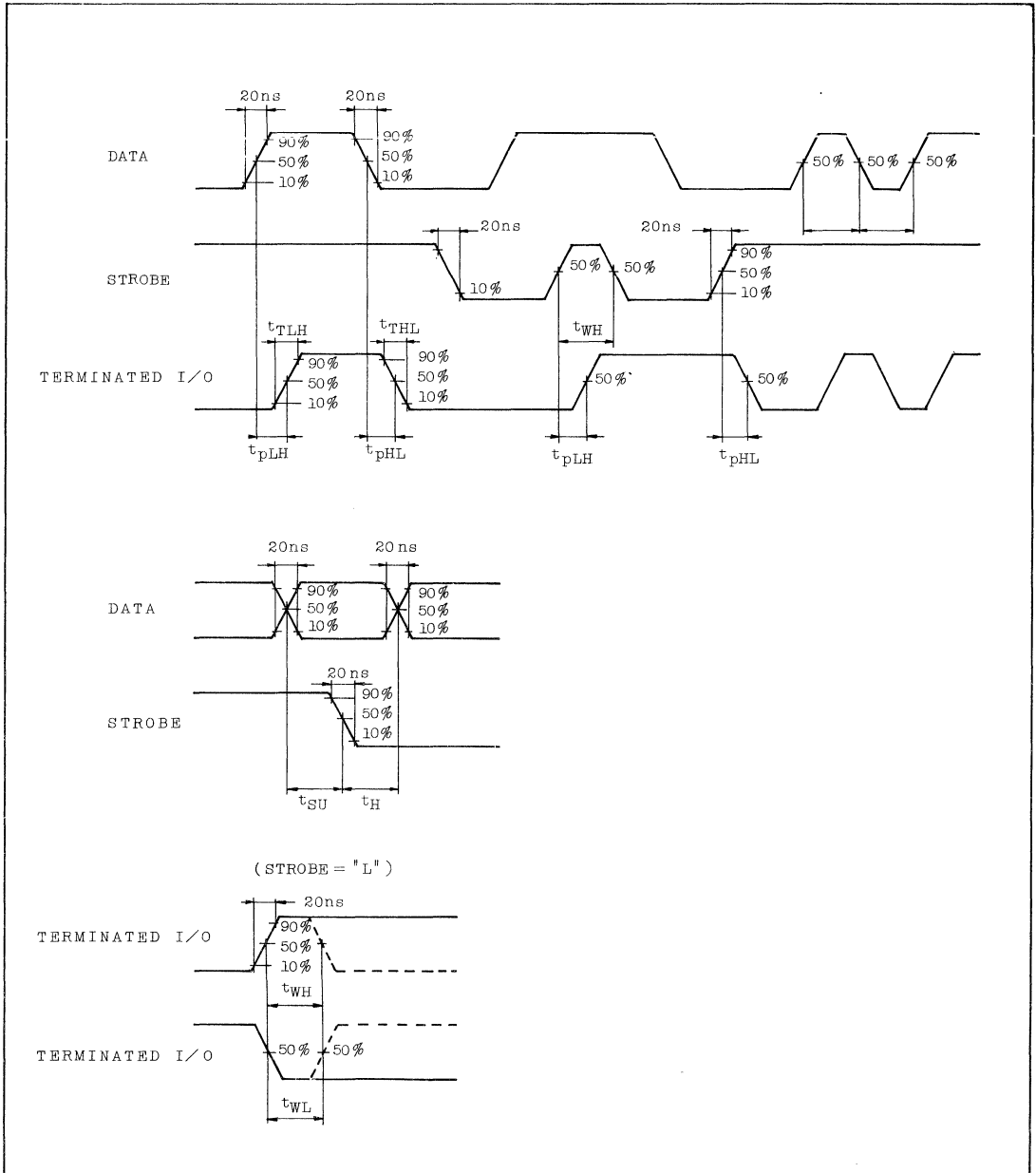
* All valid input combinations

TC40117BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	2.1	6.6	μs
			10	-	1.0	3.2	
			15	-	0.8	2.2	
Output Transition Time (High to Low)	t _{THL}		5	-	2.1	6.6	μs
			10	-	1.0	3.2	
			15	-	0.8	2.2	
Propagation Delay Time (STROBE, DATA-A,B)	t _{pLH}		5	-	0.9	3.0	μs
			10	-	0.45	1.25	
			15	-	0.35	1.0	
Propagation Delay Time (STROBE, DATA-A,B)	t _{pHL}		5	-	1.25	3.4	μs
			10	-	0.55	1.7	
			15	-	0.35	1.15	
Minimum Pulse Width (STROBE)	t _{WH}		5	-	0.9	3.0	μs
			10	-	0.35	1.2	
			15	-	0.25	0.95	
Minimum Pulse Width (DATA)	t _{WH} t _{WL}		5	-	3.6	7.2	μs
			10	-	1.8	3.6	
			15	-	1.35	2.7	
Minimum Pulse Width (TERMINATED I/O)	t _{WH} t _{WL}		5	-	30	-	ns
			10	-	45	-	
			15	-	55	-	
Minimum Set-Up Time (DATA-STROBE)	t _{SU}		5	-	930	1860	ns
			10	-	380	760	
			15	-	230	460	
Minimum Hold Time (DATA-STROBE)	t _H		5	-	-6	-	ns
			10	-	-4	-	
			15	-	-3	-	
Input Capacitance	C _{IN}			-	5	7.5	pF

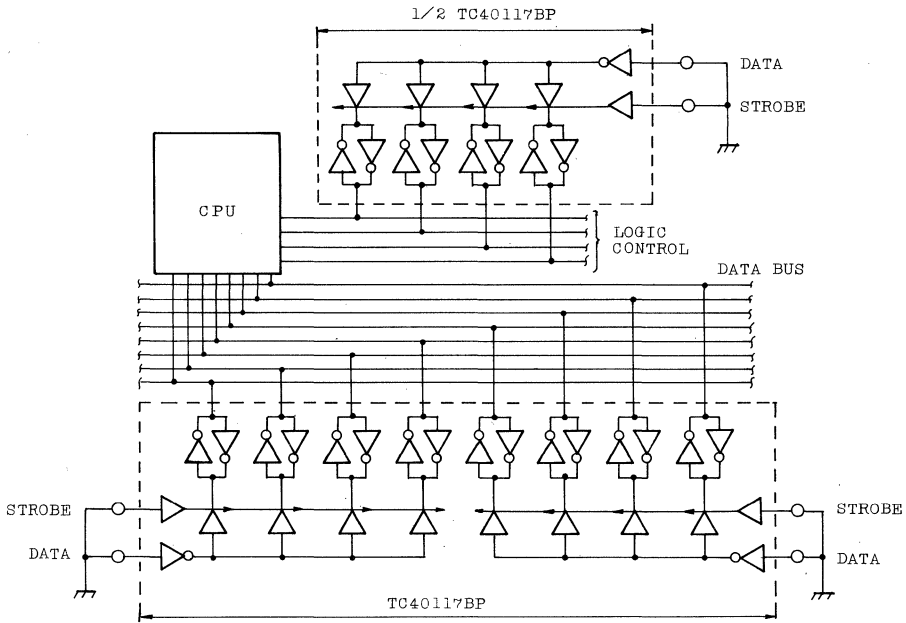
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



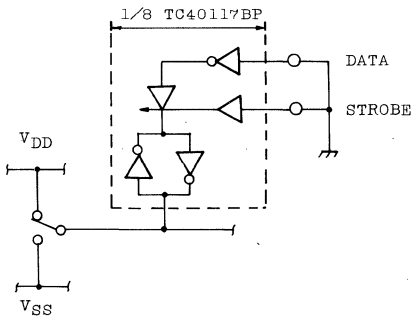
TC40117BP

TYPICAL APPLICATIONS

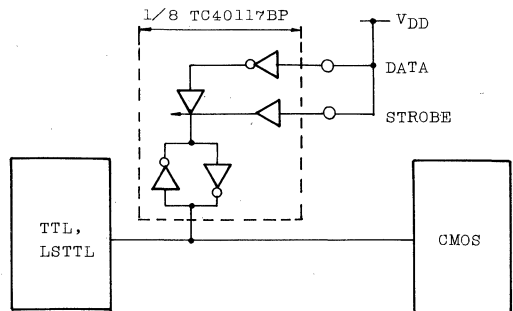
(1) APPLICATION FOR TERMINATING AN 8-BIT DATA BUS LINE OF CPU



(2) APPLICATION FOR ANTI-BOUNCE CIRCUIT



(3) APPLICATION FOR INTERFACE CIRCUIT BETWEEN TTL OUTPUT AND CMOS INPUT



SYNCHRONOUS PROGRAMMABLE 4-BIT COUNTER

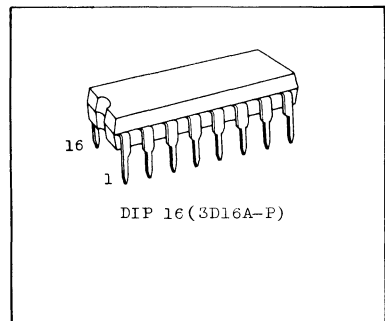
TC40160BP DECADE WITH ASYNCHRONOUS CLEAR

TC40161BP BINARY WITH ASYNCHRONOUS CLEAR

TC40162BP DECADE WITH SYNCHRONOUS CLEAR

TC40163BP BINARY WITH SYNCHRONOUS CLEAR

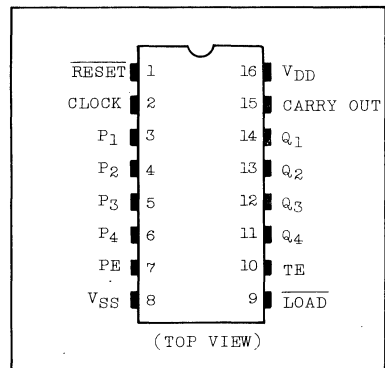
The TC40160BP, TC40161BP, TC40162BP, and TC40163BP are synchronously programmable 4-bit counters. The TC40160BP and TC40161BP are decimal counter and 4-bit binary counter respectively having asynchronous clear function which directly clears all the flip-flop outputs. The TC40162BP and TC40163BP are decimal counter and 4-bit binary counter respectively which are synchronous at the rising edges of clocks. CLEAR and LOAD of these counters are active at the "L" level. Further, these counters are functionally compatible with the 74160, 74161, 74162, and 74163 of TTL.



MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



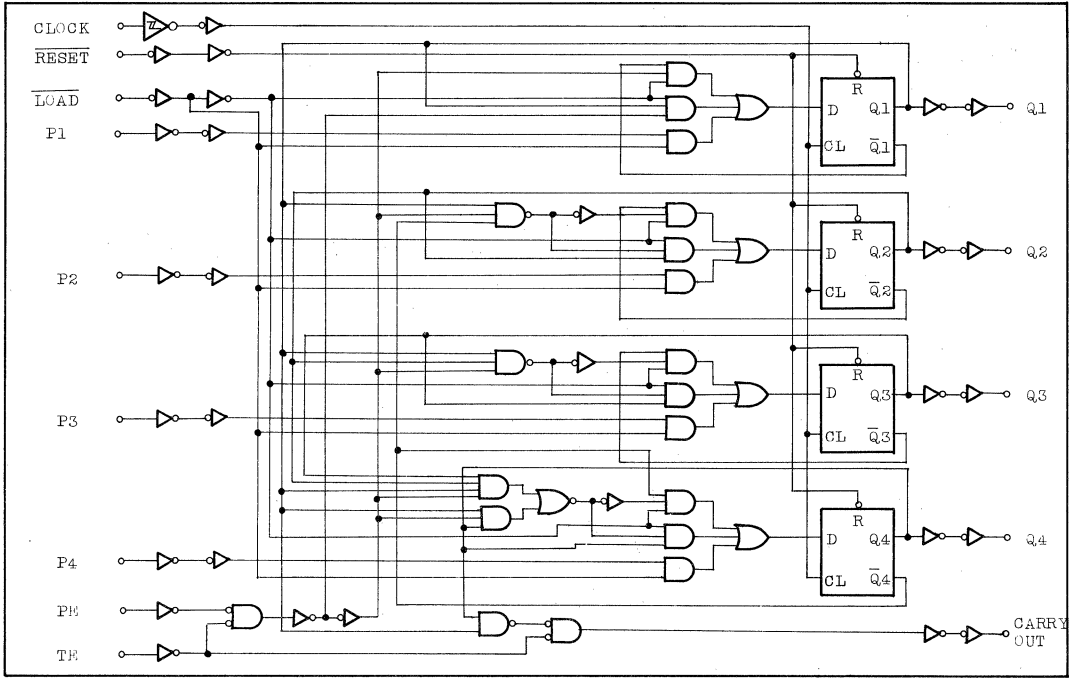
TRUTH TABLE

		INPUT								OUTPUT				
CLOCK	RESET	LOAD	PE	TE	P ₁	P ₂	P ₃	P ₄	Q ₁	Q ₂	Q ₃	Q ₄		
☆	L	*	*	*	*	*	*	*	L	L	L	L	*	
△	┌	L	*	*	D ₁	D ₂	D ₃	D ₄	D ₁	D ₂	D ₃	D ₄	*	
△	┌	H	L	L	*	*	*	*	.	.	.	.	*
△	┌	H	H	L	*	*	*	*	.	.	.	.	*
△	┌	H	H	H	*	*	*	*	.	.	.	.	*
△	┌	H	H	H	*	*	*	*	COUNT				*	
△	┌	H	*	*	*	*	*	*	.	.	.	.	*

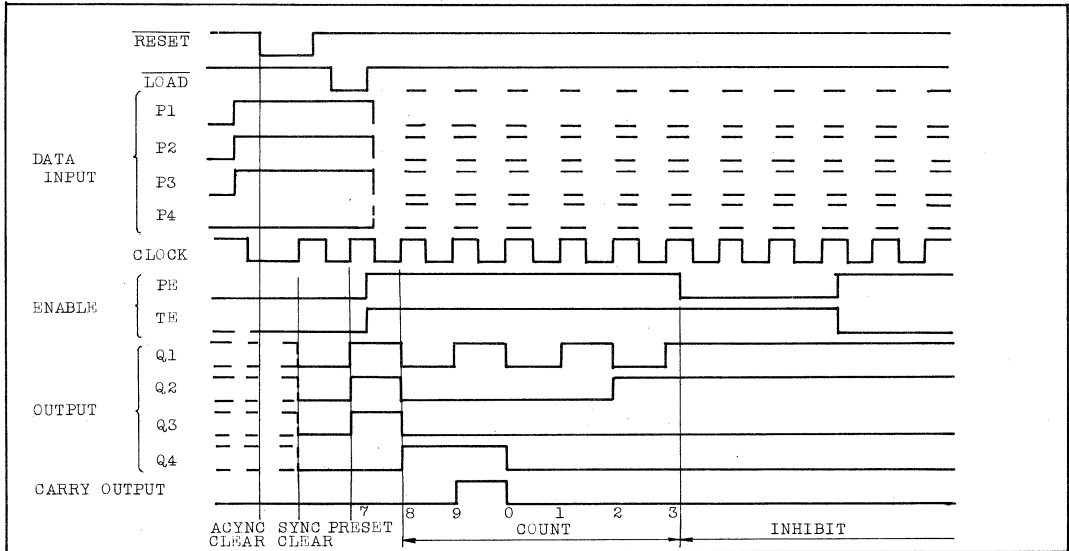
* : Don't care
 △ : Level change
 . : No change
 D : Data "H" or "L"
 ☆ : { Don't care (TC40160, TC40161)
 Rise edge (TC40162, TC40163) }

TC40160BP, TC40161BP, TC40162BP, TC40163BP

LIGIC DIAGRAM (TC40160BP, TC40162BP)

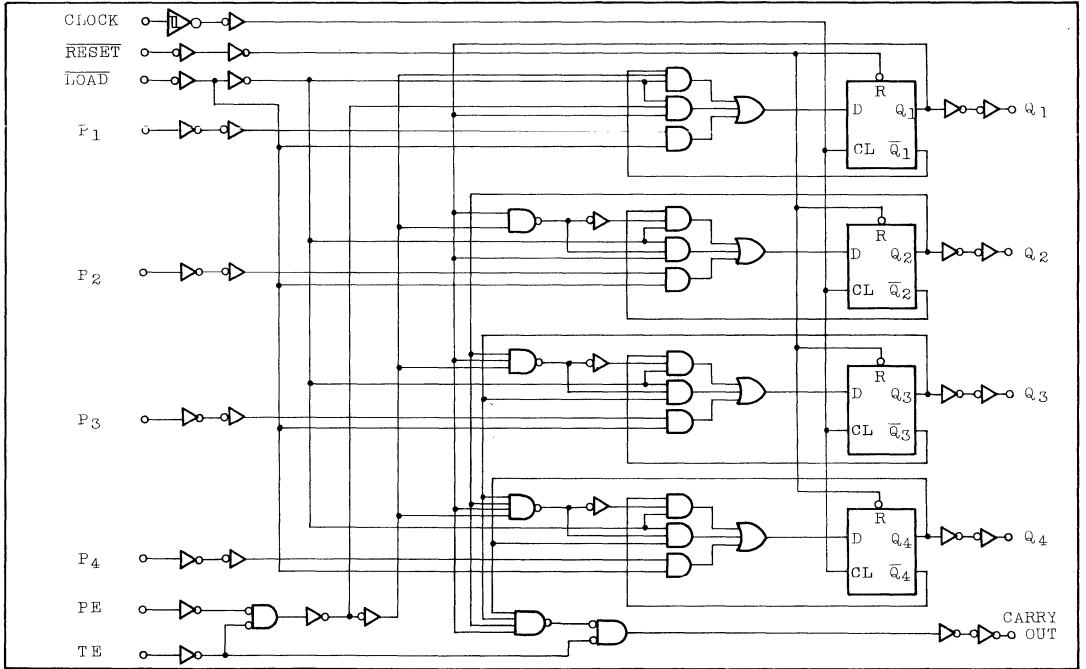


TIMING CHART (TC40160BP, TC40162BP)

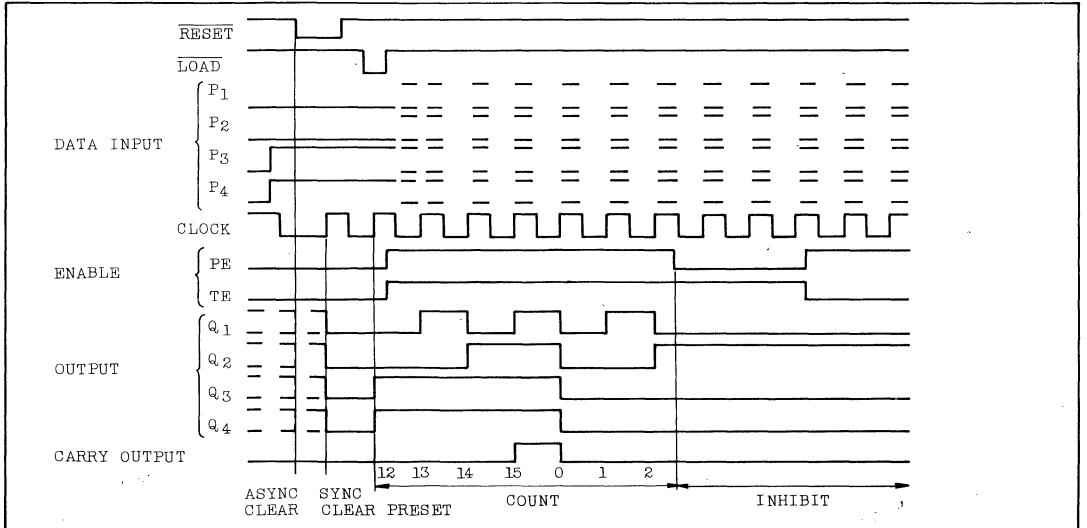


TC40160BP, TC40161BP, TC40162BP, TC40163BP

LOGIC DIAGRAM (TC40161BP, TC40163BP)



TIMING CHART (TC40161BP, TC40163BP)



TC40160BP, TC40161BP, TC40162BP, TC40163BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	+	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC40160BP, TC40161BP, TC40162BP, TC40163BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All Valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

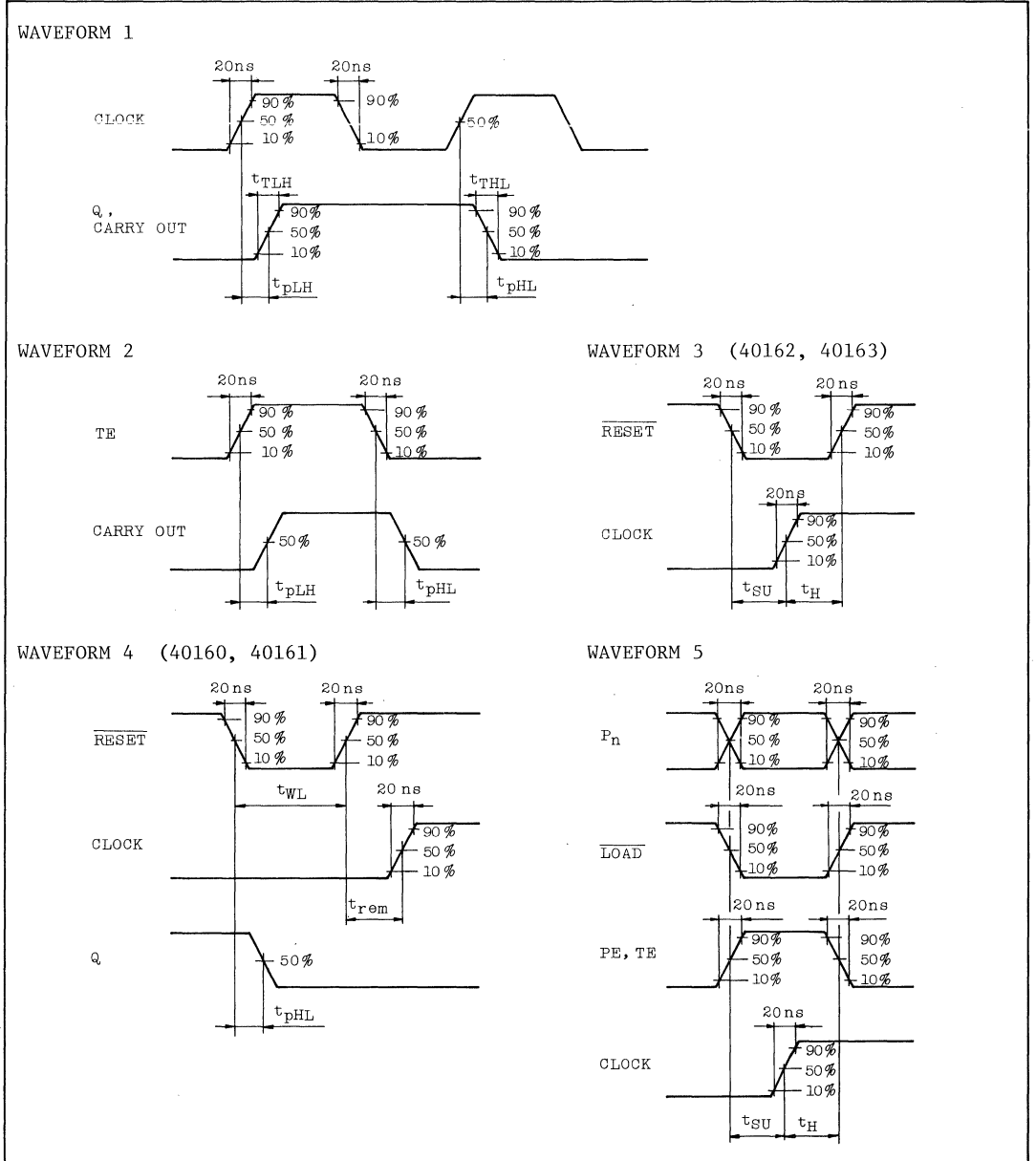
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	250	500	ns
			10	-	100	200	
			15	-	70	140	
Propagation Delay Time (CLOCK-CARRY OUT)	t _{pLH} t _{pHL}		5	-	300	600	ns
			10	-	120	240	
			15	-	80	160	
Propagation Delay Time (TE-CARRY OUT)	t _{pLH} t _{pHL}		5	-	170	340	ns
			10	-	65	130	
			15	-	45	90	
Propagation Delay Time ($\overline{\text{RESET}}$ - Q) 40160, 40161 Only	t _{pHL}		5	-	180	500	ns
			10	-	75	220	
			15	-	55	160	
Min. Clock Pulse Width	t _w		5	-	130	250	ns
			10	-	45	90	
			15	-	30	60	
Min. Pulse Width ($\overline{\text{RESET}}$) 40160, 40161 Only	t _{wL}		5	-	140	280	ns
			10	-	55	110	
			15	-	35	70	

TC40160BP, TC40161BP, TC40162BP, TC40163BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Max. Clock Frequency	f _{CL}		5	2	4	-	MHz
			10	5.5	11	-	
			15	8	16	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Set-up Time (P _n - CLOCK)	t _{SU}		5	-	55	240	ns
			10	-	20	90	
			15	-	15	60	
Min. Set-up Time ($\overline{\text{LOAD}}$ - CLOCK)	t _{SU}		5	-	75	240	
			10	-	30	90	
			15	-	20	60	
Min. Set-up Time (PE, TE - CLOCK)	t _{SU}		5	-	190	380	
			10	-	70	140	
			15	-	50	100	
Min. Set-up Time ($\overline{\text{RESET}}$ - CLOCK) 40162, 40163 Only	t _{SU}		5	-	50	310	
			10	-	20	110	
			15	-	15	70	
Min. Hold Time (P _n , $\overline{\text{LOAD}}$, PE, TE - CLOCK)	t _H		5	-	-	0	ns
			10	-	-	0	
			15	-	-	5	
Min. Hold Time ($\overline{\text{RESET}}$ - CLOCK) 40162, 40163 Only	t _H		5	-	-30	0	
			10	-	-10	0	
			15	-	-5	0	
Min. Removal Time ($\overline{\text{RESET}}$ - COLCK) 40160, 40161 Only	t _{rem}		5	-	80	200	ns
			10	-	25	100	
			15	-	15	70	
Input Capacitance	C _{IN}			-	5	7.5	pF

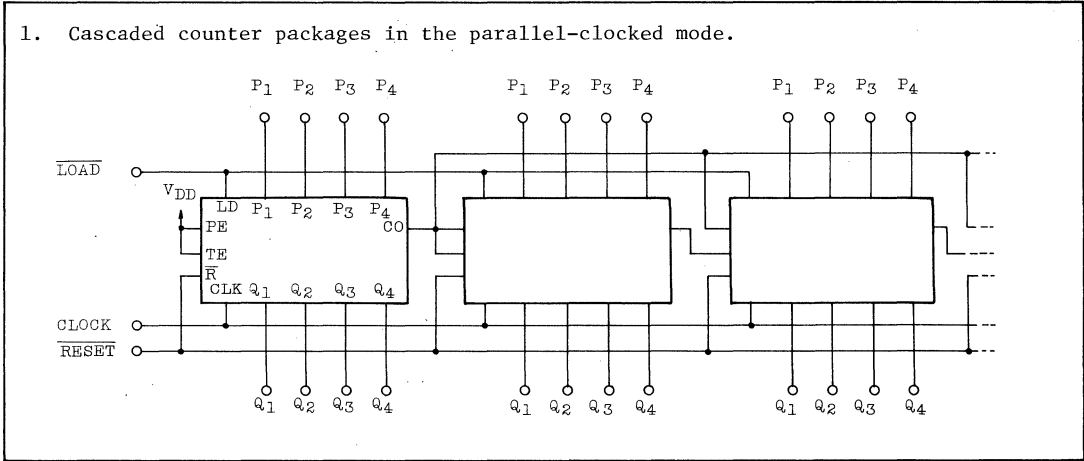
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC40160BP, TC40161BP, TC40162BP, TC40163BP

APPLICATION CIRCUIT

1. Cascaded counter packages in the parallel-clocked mode.



TC40174BP/TC40174BF HEX D-TYPE FLIP-FLOP

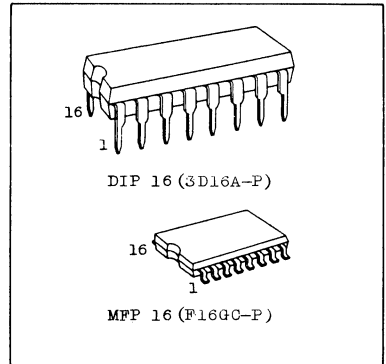
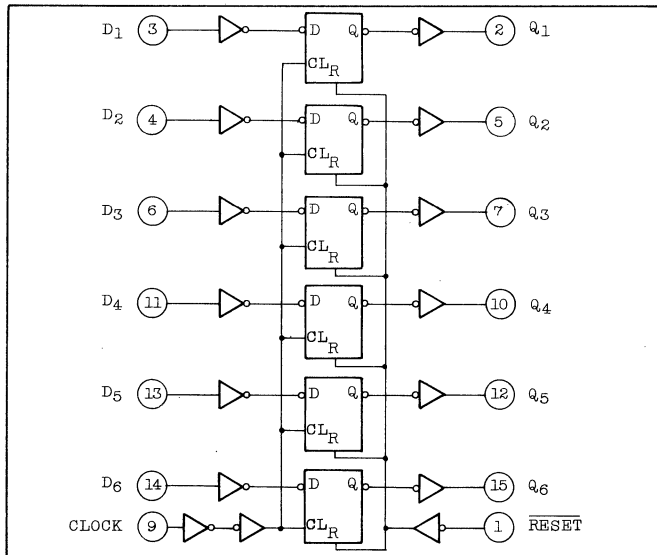
TC40174BP/TC40174BF contains six circuits of D type flip-flops having common clock terminal and clear terminal. The logical input applied to D_n input is transferred to Q_n output by the rising edge of CLOCK input.

RESET input is active with "L" level. This has the same functions as TTL 54174/74174 and the pin assignment is also same.

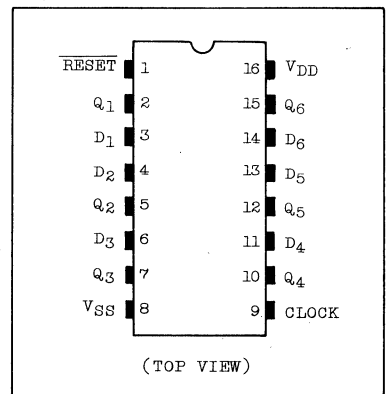
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

CLOCK Δ	INPUTS		OUTPUT
	D _n	RESET	Q _{n+1}
\uparrow	H	H	H
\downarrow	L	H	L
\downarrow	*	H	Q _n
*	*	L	L

Δ : Level change
 · : No change
 * : Don't care

TC40174BP/BF

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I_{OH}	$V_{OH}=4.6V$ $V_{OH}=2.5V$ $V_{OH}=9.5V$ $V_{OH}=13.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I_{OL}	$V_{OL}=0.4V$ $V_{OL}=0.5V$ $V_{OL}=1.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V_{IH}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V_{IL}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I_{IH}	$V_{IH}=18V$	18	-	0.1	-	10^{-5}	0.1	-	1.0	μA
	"L" Level	I_{IL}	$V_{IL}=0V$	18	-	-0.1	-	-10^{-5}	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.005	1	-	30	μA
			10	-	2	-	0.010	2	-	60	
			15	-	4	-	0.015	4	-	120	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

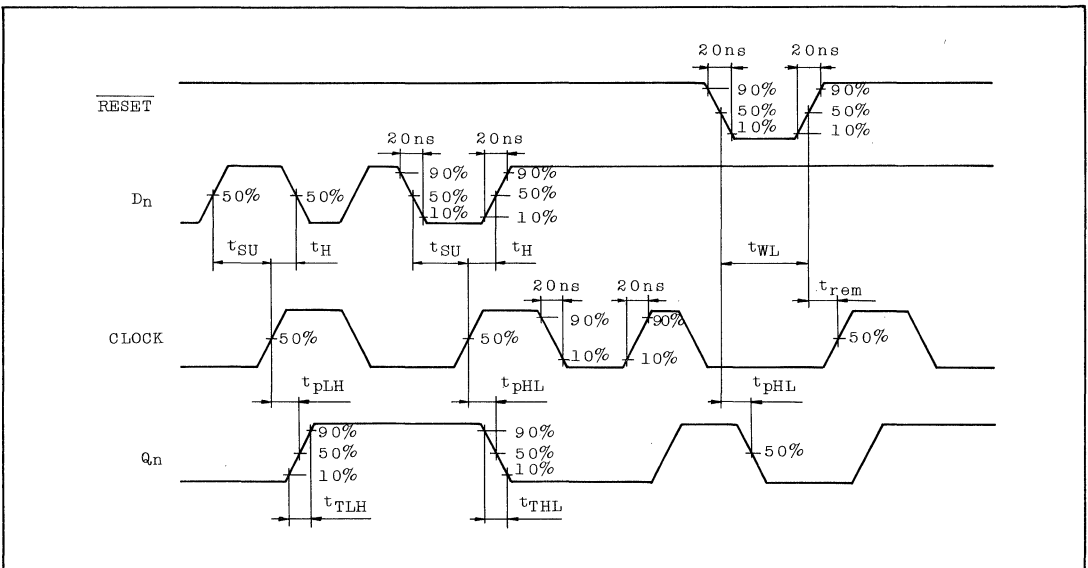
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q)	t _{pLH} t _{pHL}		5	-	150	300	ns
			10	-	65	140	
			15	-	45	100	
Propagation Delay Time (<u>RESET</u> - Q)	t _{pHL}		5	-	170	340	ns
			10	-	70	140	
			15	-	50	100	
Min. Clock Pulse Width	t _w		5	-	55	130	ns
			10	-	20	60	
			15	-	15	40	
Min. Pulse Width (<u>RESET</u>)	t _{wL}		5	-	45	100	ns
			10	-	20	50	
			15	-	10	40	
Max. Clock Frequency	f _{CL}		5	3.5	9	-	MHz
			10	6	25	-	
			15	8	34	-	
Max. Clock Input Rise Time.	t _{rCL}		5	20	-	-	μs
Max. Clock Input Fall Time.	t _{fCL}		10	15	-	-	
			15	15	-	-	

TC40174BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	25	50	ns
			10	-	12	25	
			15	-	7	15	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	-8	80	ns
			10	-	0	40	
			15	-	3	30	
Min. Removal Time (RESET - CLOCK)	t _{rem}		5	-	7	40	ns
			10	-	4	20	
			15	-	3	15	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC40175BP/TC40175BF QUAD D-TYPE FLIP-FLOP

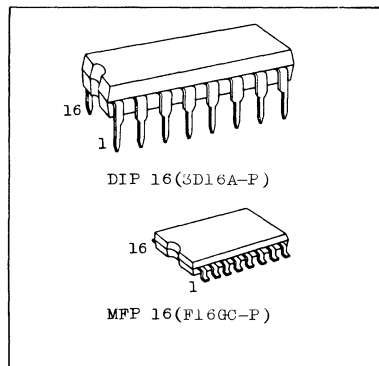
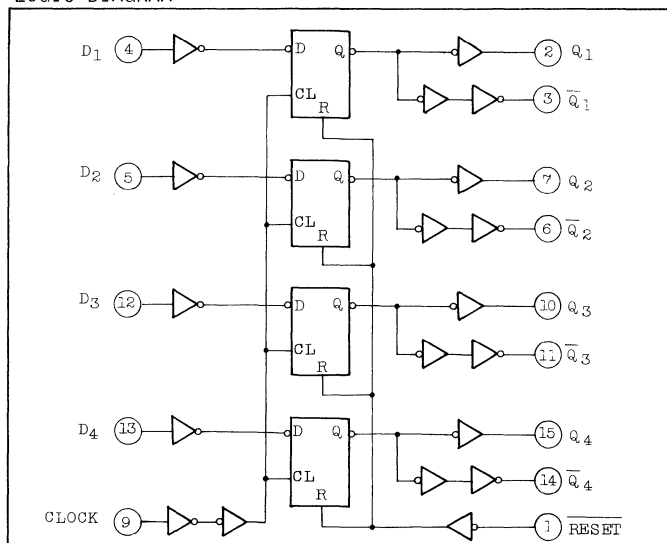
TC40175BP/TC40175BF contains four circuits of D type flip-flop having common clock terminal and clear terminal. The logical input applied to D_n input is transferred to Q_n output by the rising edge of CLOCK input.

RESET input is active with "L" level. This has the same functions as TTL 54175/74175 and the pin assignment is also same.

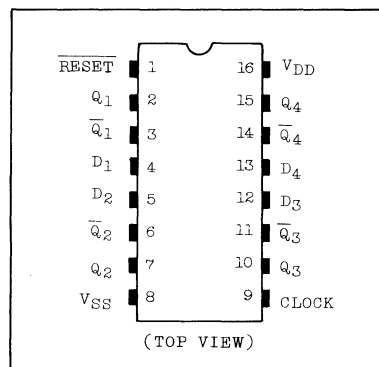
MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

INPUTS			OUTPUTS	
CLOCK Δ	D _n	RESET	Q _{n+1}	Q _{n+1}
┌	H	H	H	L
┌	L	H	L	H
┌	*	H	Q _n	Q _n
*	*	L	L	H

Δ : Level change
· : No change
* : Don't care

TC40175BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			5	0.61	-	0.51	1.5	-	0.42	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			5	-	1.5	-	2.25	1.5	-	1.5		
			10	-	3.0	-	4.5	3.0	-	3.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I_{DD}	$V_{IN}=V_{SS}, V_{DD}$ *	5	-	1	-	0.005	1	-	30	A
			10	-	2	-	0.010	2	-	60	
			15	-	4	-	0.015	4	-	120	

* All valid input combinations.

 DYNAMIC ELECTRICAL CHARACTERISTICS ($T_a=25^\circ C$, $V_{SS}=0V$, $C_L=50pF$)

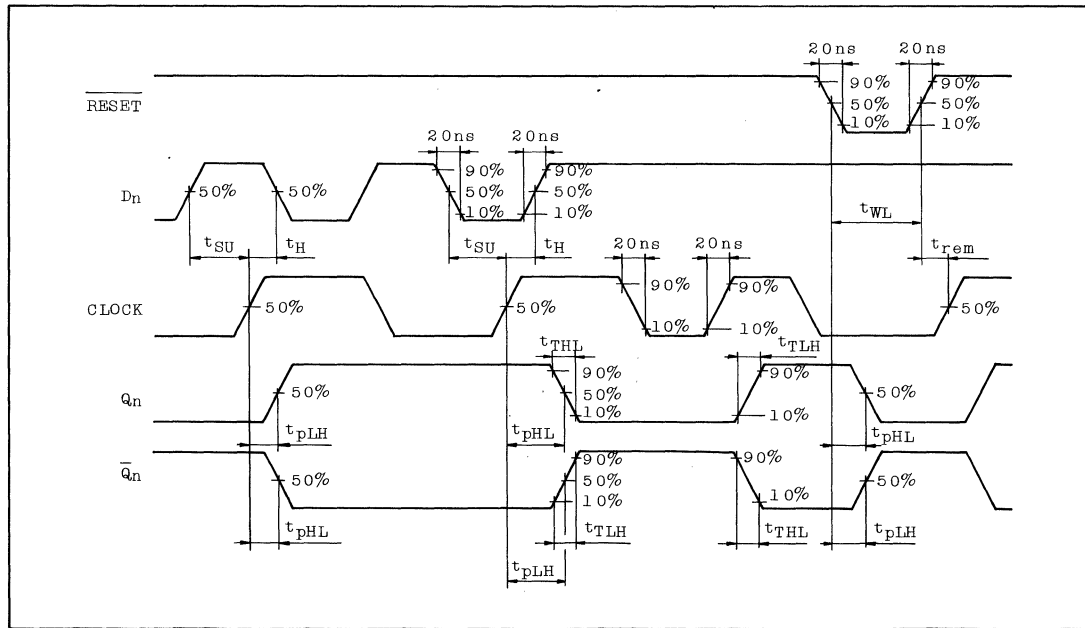
CHARACTERISTIC	SYMBOL	TEST CONDITION	V_{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t_{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t_{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - Q, \bar{Q})	t_{pLH} t_{pHL}		5	-	170	340	ns
			10	-	70	140	
			15	-	50	100	
Propagation Delay Time (RESET - Q, \bar{Q})	t_{pLH} t_{pHL}		5	-	190	380	ns
			10	-	80	160	
			15	-	55	110	
Min. Clock Pulse Width	t_w		5	-	55	130	ns
			10	-	20	60	
			15	-	15	40	
Min. Pulse Width (RESET)	t_{WL}		5	-	40	100	ns
			10	-	20	50	
			15	-	15	40	
Max. Clock Frequency	f_{CL}		5	3.5	9	-	MHz
			10	6	25	-	
			15	8	34	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t_{rCL} t_{fCL}		5	20	-	-	μs
			10	15	-	-	
			15	15	-	-	

TC40175BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Set-up Time (DATA - CLOCK)	t _{SU}		5	-	30	60	ns
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (DATA - CLOCK)	t _H		5	-	-5	80	ns
			10	-	0	40	
			15	-	3	30	
Min. Removal Time ($\overline{\text{RESET}}$ - CLOCK)	t _{rem}		5	-	7	40	ns
			10	-	4	20	
			15	-	3	15	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



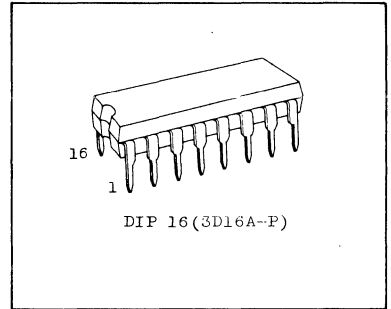
TC40192BP PRESETTABLE BCD UP/DOWN COUNTER (Dual Clock with Reset)

TC40193BP PRESETTABLE BINARY UP/DOWN COUNTER (Dual Clock with Reset)

TC40192BP/TC40193BP is a synchronous 4-bit up/down counter.

The RESET input is active at "H" level, and the PRESET ENABLE input is active at "L" level; both of them perform asynchronous operation.

In the clock, the up-count input and the down-count input are independent each other, and each input performs count operation at the rising edge of the pulse. And the clock in the counter takes the logic sum of counting up and counting down; therefore, one clock input can be used as a clock inhibit input. The functions and pin assignment of TC40192BP and TC40193BP are compatible with those of 74192 and 74193 of TTL.

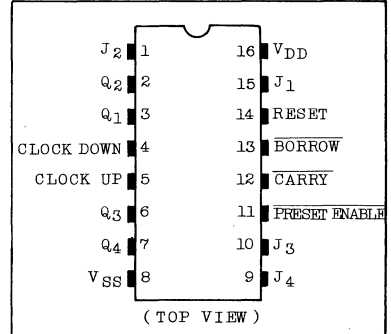


DIP 16 (3D16A-P)

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



TRUTH TABLE

(TC40192BP, TC40193BP)

CLOCK UP	CLOCK DOWN	PRESET ENABLE	RESET	ACTION
↓	H	H	L	COUNT UP
↑	H	H	L	NO COUNT
H	↓	H	L	COUNT DOWN
H	↑	H	L	NO COUNT
*	*	L	L	PRESET
*	*	*	H	RESET

* : Don't care

(TC40192BP)

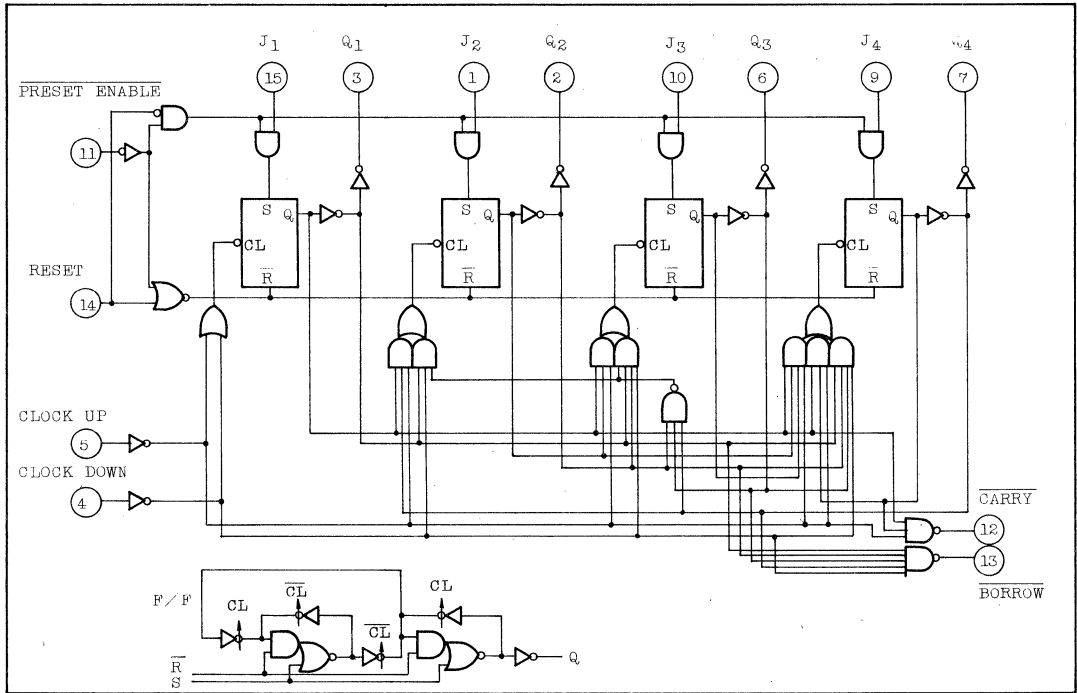
COUNT	Q ₁	Q ₂	Q ₃	Q ₄
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H

(TC40193BP)

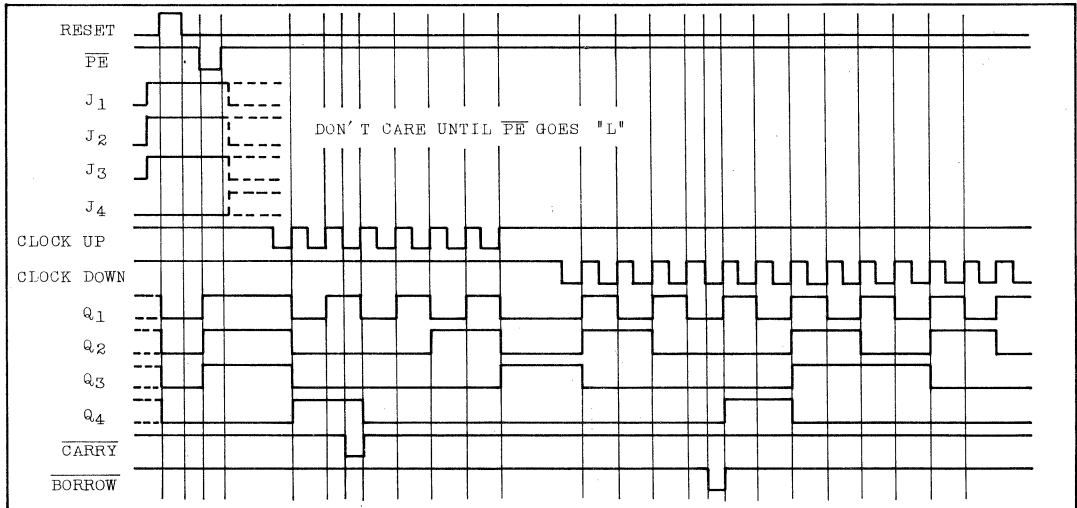
COUNT	Q ₁	Q ₂	Q ₃	Q ₄
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
A	L	H	L	H
B	H	H	L	H
C	L	L	H	H
D	H	L	H	H
E	L	H	H	H
F	H	H	H	H

TC40192BP, TC40193BP

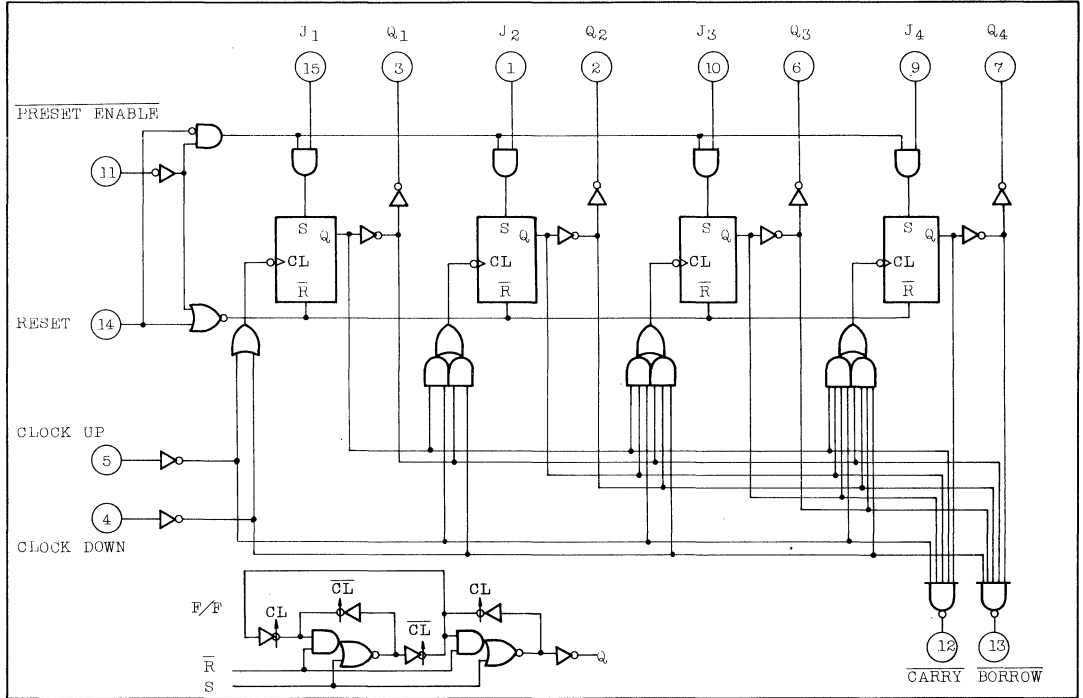
LOGIC DIAGRAM (TC40192BP)



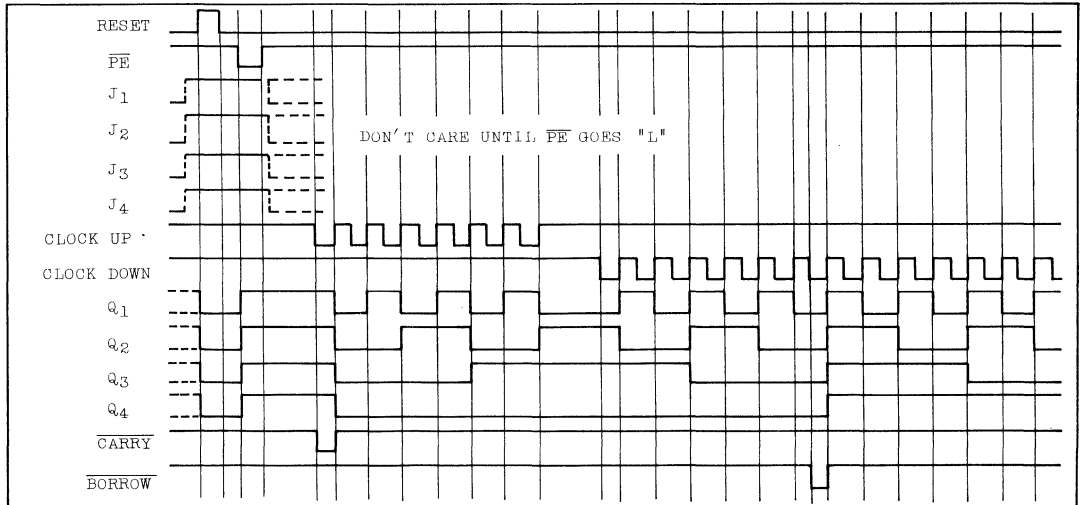
TIMING CHART (TC40192BP)



LOGIC DIAGRAM (TC40193BP)



TIMING CHART (TC40193BP)



TC40192BP, TC40193BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	-0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

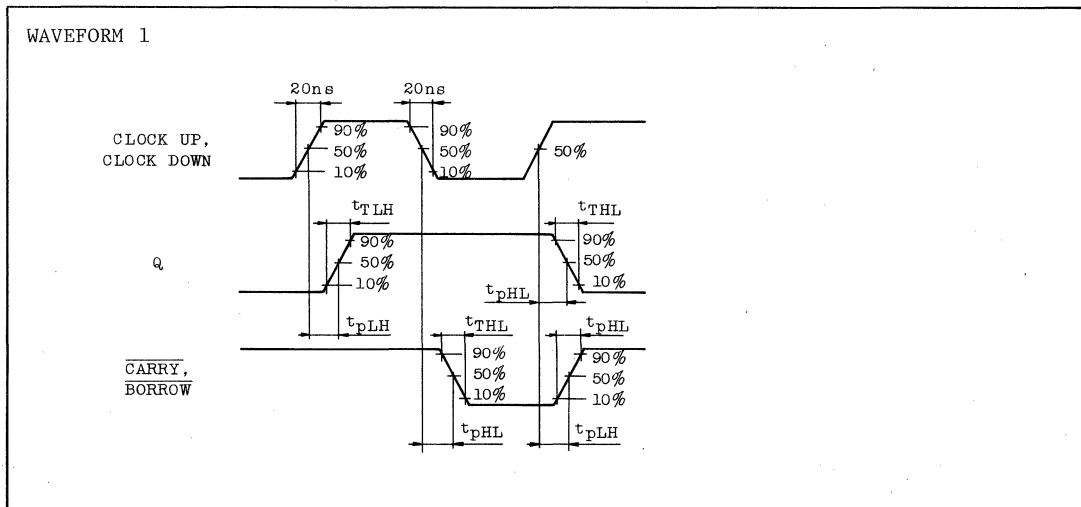
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK UP, CLOCK DOWN - Q)	t _{pLH} t _{pHL}		5	-	450	900	ns
			10	-	180	360	
			15	-	130	260	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	400	800	ns
			10	-	160	320	
			15	-	120	240	
Propagation Delay Time (\overline{PE} - Q)	t _{pLH} t _{pHL}		5	-	420	840	ns
			10	-	170	340	
			15	-	120	240	
Propagation Delay Time (CLOCK UP - \overline{CARRY} , CLOCK DOWN - BORROW)	t _{pLH} t _{pHL}		5	-	220	440	ns
			10	-	95	190	
			15	-	70	140	
Propagation Delay Time (RESET, \overline{PE} - BORROW, CARRY)	t _{pLH} t _{pHL}		5	-	490	980	ns
			10	-	190	380	
			15	-	130	260	
Min. Clock Pulse Width	t _w		5	-	250	500	ns
			10	-	100	200	
			15	-	70	140	

TC40192BP, TC40193BP

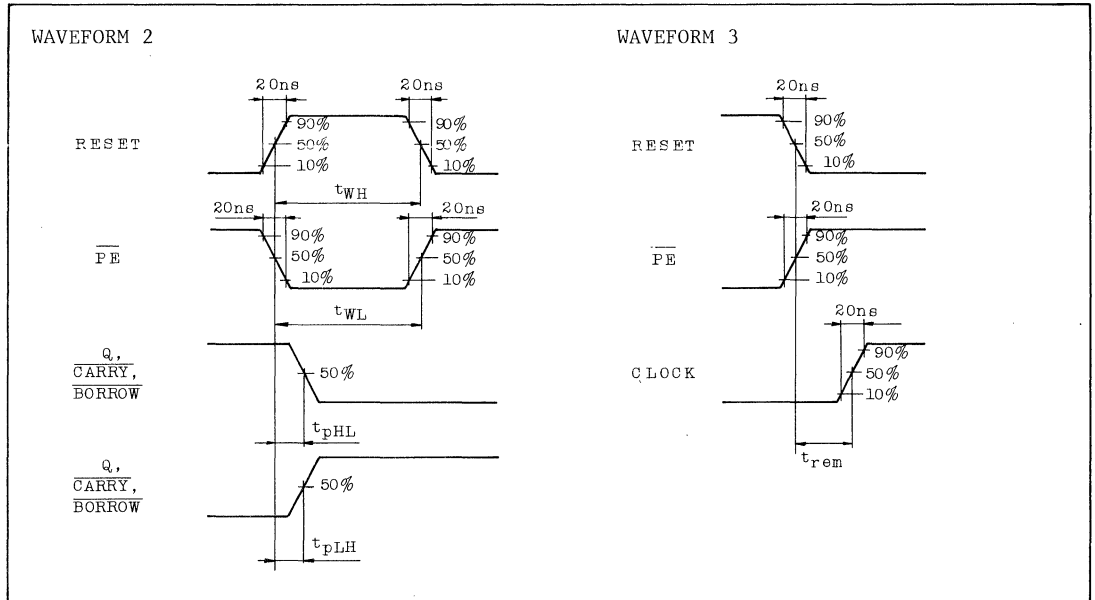
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width (RESET)	t _{WH}		5	-	100	480	ns
			10	-	40	300	
			15	-	35	260	
Min. Pulse Width ($\overline{\text{PE}}$)	t _{WL}		5	-	80	240	
			10	-	30	170	
			15	-	25	140	
Max. Clock Frequency	f _{CL}		5	1	2	-	MHz
			10	2.5	5	-	
			15	3.5	7	-	
Max. Clock Input Rise Time. Max. Clock Input Fall Time.	t _{rCL}		5	20	-	-	μs
			10	2.5	-	-	
	t _{fCL}		15	1	-	-	
Min. Removal Time (RESET, $\overline{\text{PE}}$ - CLOCK)	t _{rem}		5	-	-40	80	ns
			10	-	-16	40	
			15	-	-14	30	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4501BP

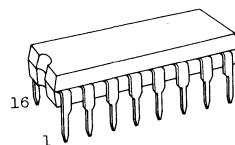
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4501BP TRIPLE GATE (Dual 4-Input NAND Gate and 2-Input NOR/OR Gate or 8-Input AND/NAND Gate)

The TC4501BP is a combined gate which contains dual 4-input NAND gate and 2-input NOR/OR gate in one package.

Since all the outputs of these gates are provided with the buffers of inverters, the input/output transmission characteristics have been improved and the noise immunity has been elevated. Further, an increase in propagation delay time caused by an increase in load capacity is kept to a minimum.

The TC4501BP can be used as 8-input positive AND/NAND gate by externally connecting the output of NAND gate to the input of NOR/OR gate.

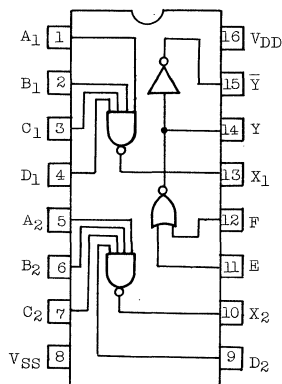


DIP16(3D16A-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

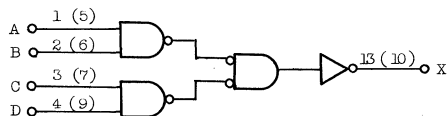
PIN ASSIGNMENT



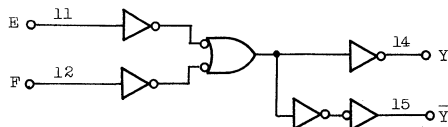
(TOP VIEW)

LOGIC DIAGRAM

NAND



NOR/OR



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL		MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}		3	-	18	V
Input Voltage	V _{IN}		0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	3.8	μA	
			10	-	0.5	-	0.001	0.5	-	7.5		
			15	-	1.0	-	0.002	1.0	-	15		

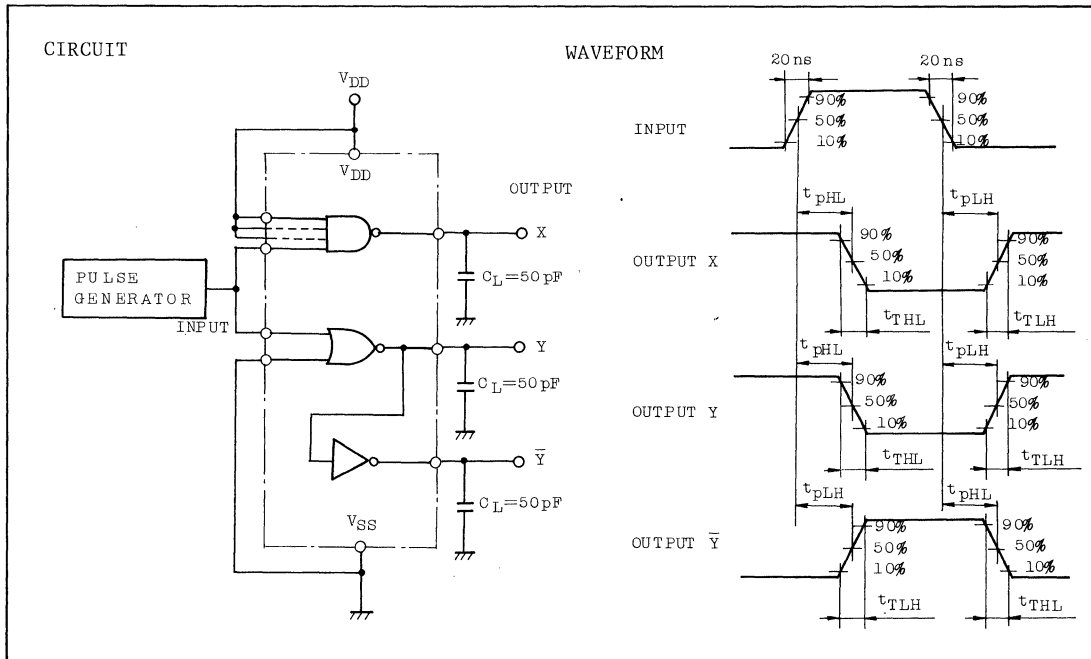
* All valid input combinations.

TC4501BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC		SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)		t _{TLH}		5	-	80	200	ns
				10	-	50	100	
				15	-	40	80	
Output Transition Time (High to Low)		t _{THL}		5	-	80	200	
				10	-	50	100	
				15	-	40	80	
NAND	Propagation Delay Time (Low to High)	t _{pLh}		5	-	80	260	
	10			-	50	140		
NAND	Propagation Delay Time (High to Low)	t _{pHL}		5	-	80	260	
	10			-	50	140		
NOR	Propagation Delay Time (Low to High)	t _{pLH}		5	-	100	230	
	10			-	50	130		
NOR	Propagation Delay Time (High to Low)	t _{pHL}		5	-	100	230	
	10			-	50	130		
NOR-Inverter	Propagation Delay Time (Low to High)	t _{pLH}		5	-	130	260	
	10			-	70	140		
NOR-Inverter	Propagation Delay Time (High to Low)	t _{pHL}		5	-	130	260	
	10			-	70	140		
NOR-Inverter	Propagation Delay Time (High to Low)	t _{pHL}		15	-	50	100	
	15			-	40	90		
Input Capacitance		C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4502BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4502BP STROBED HEX INVERTER/BUFFER

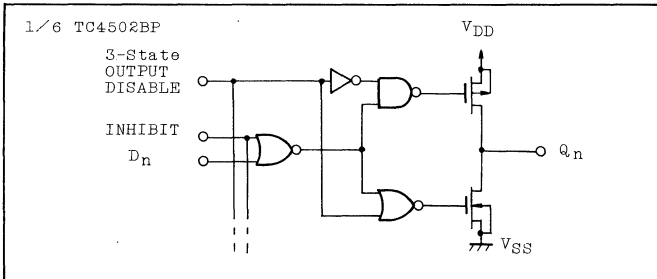
The TC4502BP is a strobed hex inverter/buffer with 3-state output. When DISABLE input is set to "H" level, six outputs become high impedance independently of the other inputs/when DISABLE input is set to "L" level and INHIBIT input "H" level, all the outputs go to "L" level.

Further, since each output is capable of directly driving one standard TTL, the TC4502BP is suited for a bus interface, a data transmission circuit, a multiplexer, etc.

MAXIMUM RATINGS

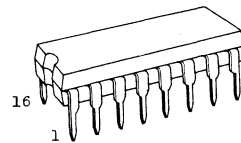
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

CIRCUIT DIAGRAM



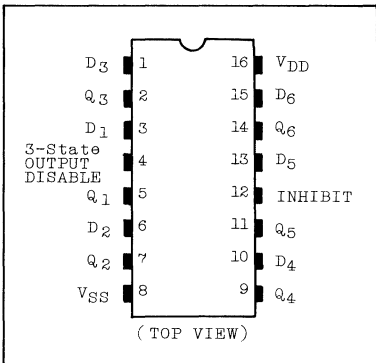
TRUTH TABLE

INPUTS			OUTPUT	HZ: High impedance *: Don't care
DISABLE	INHIBIT	D _n	Q _n	
H	*	*	HZ	
L	H	*	L	
L	L	L	H	
L	L	H	L	

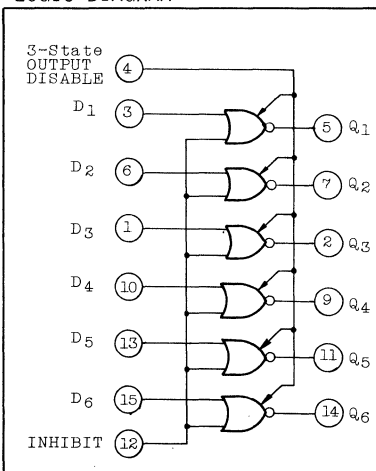


DIP 16 (3D16A-P)

PIN ASSIGNMENT



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.73	-	-0.65	-1.4	-	-0.58	-	mA	
		V _{OH} =2.5V	5	-2.4	-	-2.1	-1.3	-	-1.9	-		
		V _{OH} =9.5V	10	-1.8	-	-1.65	-3.2	-	-1.35	-		
		V _{OH} =13.5V	15	-4.8	-	-4.3	-1.1	-	-3.5	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	3.8	-	3.2	7.3	-	2.9	-	mA	
		V _{OL} =0.5V	10	9.6	-	8.0	1.7	-	6.6	-		
		V _{OL} =1.5V	15	25.0	-	24.0	5.7	-	20.0	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =0V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

TC4502BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC		SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
					MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current		I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	30	μA
				10	-	2	-	0.004	2	-	60	
				15	-	4	-	0.008	4	-	120	

* All valid input combinations.

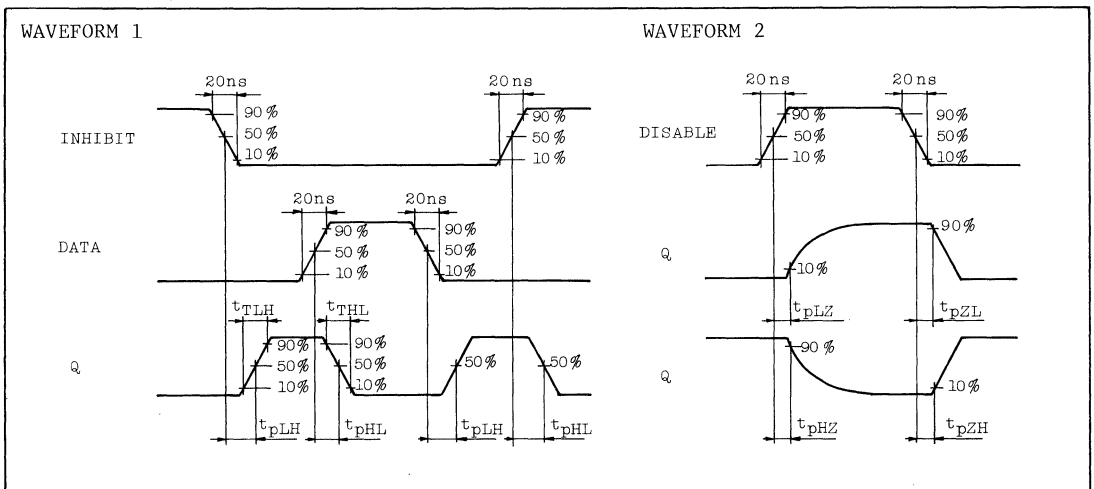
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	40	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	35	80	ns
			10	-	15	40	
			15	-	10	30	
Propagation Delay Time (DATA, INHIBIT - Q)	t _{pLH}		5	-	200	400	ns
			10	-	80	180	
			15	-	60	130	
Propagation Delay Time (DATA, INHIBIT - Q)	t _{pHL}		5	-	135	270	ns
			10	-	55	110	
			15	-	40	80	
Three State Disable Time (DISABLE - Q)	t _{pHZ}	R _L =1kΩ	5	-	65	120	ns
			10	-	30	60	
			15	-	25	50	
Three State Disable Time (DISABLE - Q)	t _{pZH}	R _L =1kΩ	5	-	80	220	ns
			10	-	30	100	
			15	-	20	80	
Three State Disable Time (DISABLE - Q)	t _{pLZ}	R _L =1kΩ	5	-	100	250	ns
			10	-	50	130	
			15	-	40	110	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Three State Disable Time (DISABLE - Q)	t _{pZL}	R _L =1kΩ	5	-	80	250	ns
			10	-	30	110	
			15	-	20	80	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4503BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

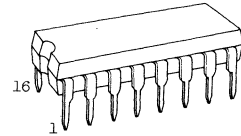
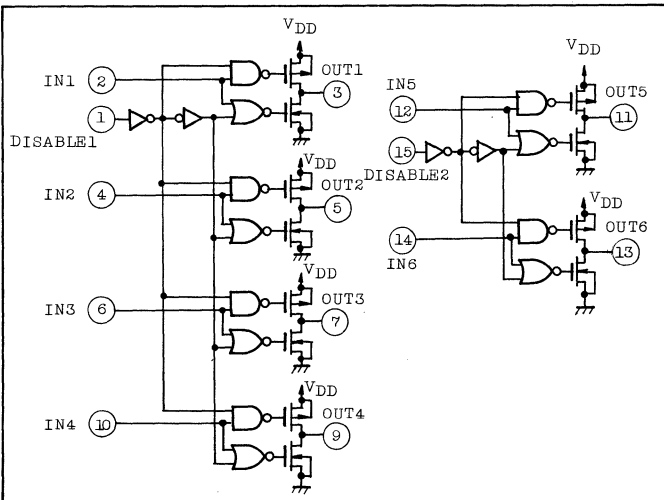
TC4503BP/TC4503BF HEX NON-INVERTING 3-STATE BUFFER

TC4503BP/BF contains six circuits of non-inverting buffers having three state output. Since DISABLE inputs to disable the outputs are provided separately, one common for four circuits and another common for other two circuits, this is suitable for controlling four bit data lines. Large output current enables to directly control one TTL input.

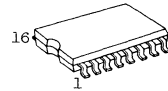
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

CIRCUIT DIAGRAM

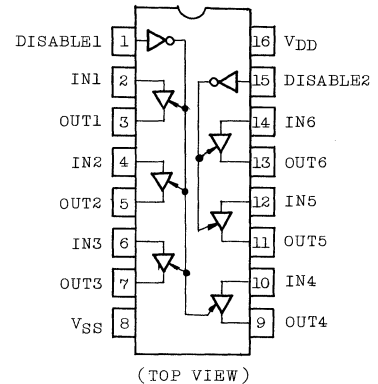


DIP16(3D16A-P)



MFP16(F16GC-P)

PIN ASSIGNMENT



TRUTH TABLE

DISABLE INPUT	INPUT	OUTPUT
L	L	L
L	H	H
H	*	HZ

* : Don't care

HZ: High Impedance

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-1.16	-	-1.02	-2.4	-	-0.7	-	mA	
			5	-5.7	-	-4.8	-10.0	-	-3.4	-		
			10	-3	-	-2.6	-5.5	-	-1.9	-		
			15	-8	-	-6.8	-20.0	-	-4.9	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	2.5	-	2.1	3.8	-	1.4	-	mA	
			10	6.4	-	5.5	9.8	-	3.9	-		
			15	18.9	-	16.1	37.8	-	11.4	-		
			15	18.9	-	16.1	37.8	-	11.4	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{DD} , V _{SS} *	5	-	1.0	-	0.002	1.0	-	30	μA	
			10	-	2.0	-	0.004	2.0	-	60		
			15	-	4.0	-	0.008	4.0	-	120		

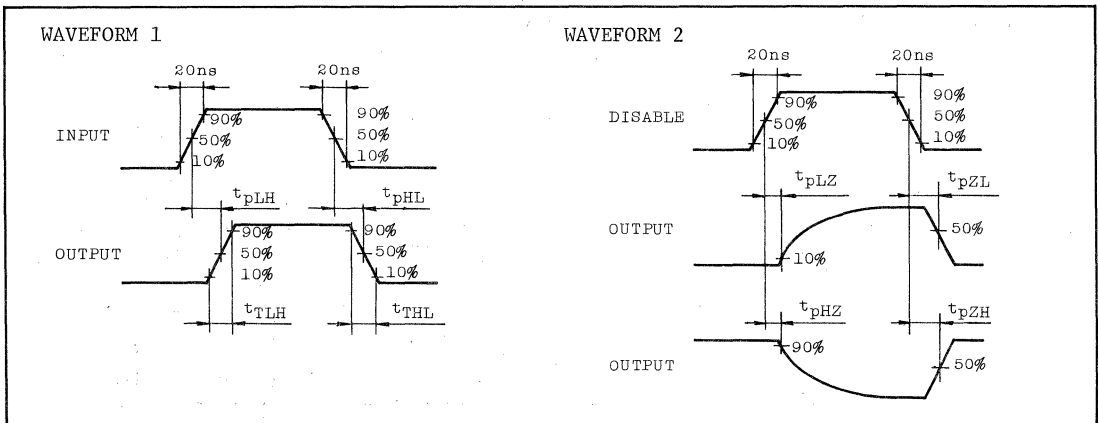
* All valid input combinations.

TC4503BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	30	90	ns
			10	-	20	45	
			15	-	15	35	
Output Transition Time (High to Low)	t _{THL}		5	-	25	70	
			10	-	13	40	
			15	-	10	25	
Propagation Delay Time (IN - OUT)	t _{pLH}		5	-	45	150	
			10	-	25	70	
			15	-	20	50	
Propagation Delay Time (IN - OUT)	t _{pHL}		5	-	43	110	
			10	-	23	50	
			15	-	18	35	
Three State Disable Time (DISABLE - OUT)	t _{pHZ}	R _L =1kΩ	5	-	50	140	
			10	-	30	60	
			15	-	25	50	
Three State Disable Time (DISABLE - OUT)	t _{pLZ}	R _L =1kΩ	5	-	60	140	
			10	-	35	60	
			15	-	30	50	
Three State Disable Time (DISABLE - OUT)	t _{pZH}	R _L =1kΩ	5	-	65	130	
			10	-	35	50	
			15	-	30	40	
Three State Disable Time (DISABLE - OUT)	t _{pZL}	R _L =1kΩ	5	-	70	130	
			10	-	35	50	
			15	-	30	40	
Input Capacitance	C _{IN}			-	7.5	15	pF

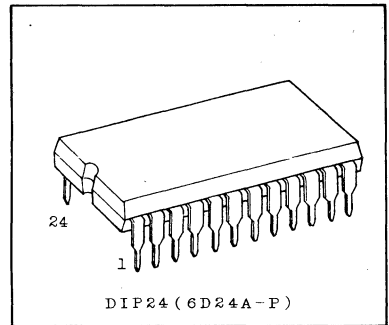
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4508BP DUAL 4-BIT LATCH

TC4508BP contains two independent circuits of latches having output disable function and clear function. When STROBE input is "H", the data input appears at the output as it is and if STROBE input is changed from "H" to "L", the output retains the data input existed at the time of falling edge of STROBE. When STROBE is "L", the outputs are not affected by DATA inputs.

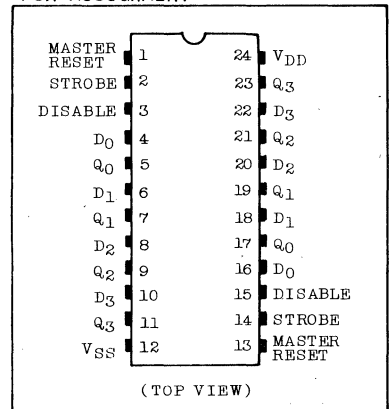
If RESET input is set to "H", Q outputs are cleared to "L" level regardless of STROBE. If DISABLE input is set to "H", Q outputs have high impedance regardless of other inputs.



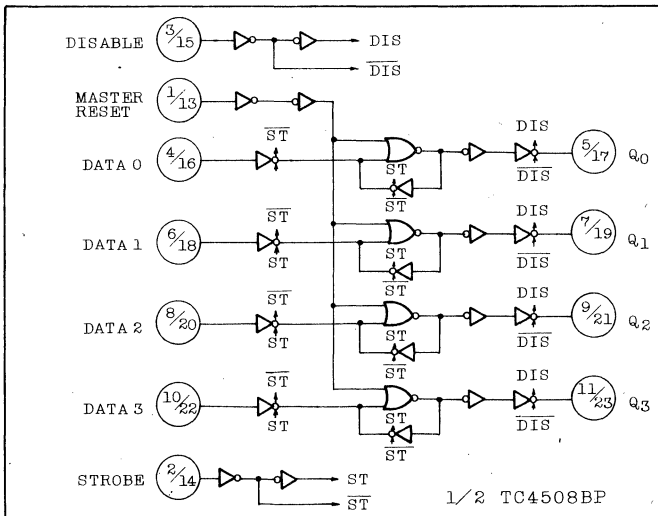
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40~85	°C
Storage Temperature Range	T _{stg}	-60~150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

RESET	STROBE	DISABLE	DATA INPUTS				OUTPUTS			
			D ₀	D ₁	D ₂	D ₃	Q ₀	Q ₁	Q ₂	Q ₃
*	*	H	*	*	*	*	HZ			
H	*	L	*	*	*	*	L	L	L	L
L	L	L	*	*	*	*	LATCHED			
L	H	L	A	B	C	D	A	B	C	D

* : Don't Care
HZ : High Impedance

TC4508BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	12	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-12	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

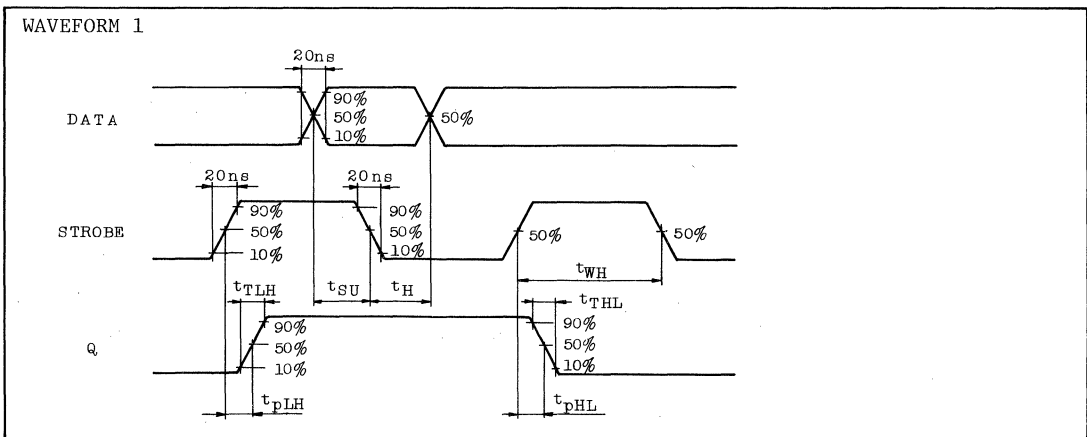
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (STROBE - Q)	t _{pLH} t _{pHL}		5	-	180	360	ns
			10	-	75	150	
			15	-	55	110	
Propagation Delay Time (DATA - Q)	t _{pLH} t _{pHL}		5	-	160	320	ns
			10	-	65	130	
			15	-	45	90	
Propagation Delay Time (RESET - Q)	t _{pLH} t _{pHL}		5	-	160	320	ns
			10	-	65	130	
			15	-	45	90	
Three State Disable Time (DISABLE - Q)	t _{pHZ}	R _L =1kΩ	5	-	45	170	ns
			10	-	25	100	
			15	-	20	70	
Three State Disable Time (DISABLE - Q)	t _{pZH}	R _L =1kΩ	5	-	55	170	ns
			10	-	25	100	
			15	-	15	70	

TC4508BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

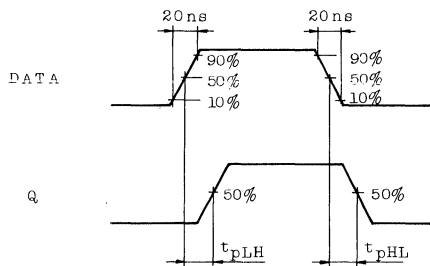
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Three State Disable Time (DISABLE - Q)	t _{pLZ}	R _L =1kΩ	5	-	50	130	ns
			10	-	30	80	
			15	-	25	60	
Three State Disable Time (DISABLE - Q)	t _{pZL}	R _L =1kΩ	5	-	70	170	ns
			10	-	30	100	
			15	-	20	70	
Min. Pulse Width (RESET)	t _{WH}		5	-	50	200	ns
			10	-	20	100	
			15	-	15	70	
Min. Pulse Width (STROBE)	t _{WH}		5	-	40	140	ns
			10	-	20	70	
			15	-	15	40	
Min. Set-up Time (DATA - STROBE)	t _{SU}		5	-	30	60	ns
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (DATA - STROBE)	t _H		5	-	-10	10	ns
			10	-	-5	10	
			15	-	0	10	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

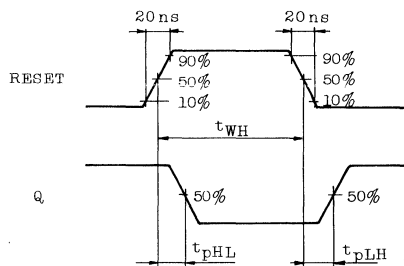


WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

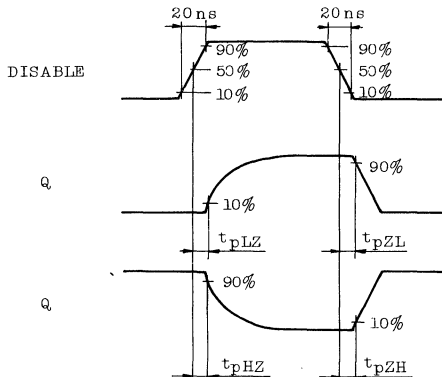
WAVEFORM 2



WAVEFORM 3



WAVEFORM 4



TC4510BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

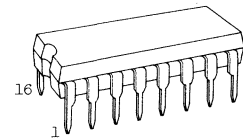
TC4510BP/TC4510BF PRESETTABLE BCD UP/DOWN COUNTER

TC4510BP/BF is UP/DOWN decade counter having asynchronous RESET and PRESET functions. When RESET input is set to "H" level, the content of counter is reset to "0" and when RESET is set to "L" and P.E. to "H", inputs A_{IN} through D_{IN} are preset to the counter.

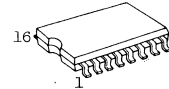
If TC4510BP/BF's are connected in cascade using CARRY INPUT and CARRY OUTPUT, decimal counter of N digits with the parallel carry capability can be composed. Switching of counting up or down is achieved by UP/DOWN INPUT. The counter advances its counting condition at the rising edge of CLOCK.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260 • 10 sec	

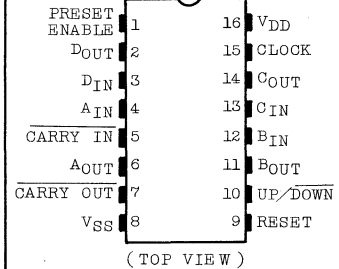


DIP16 (3D16A-P)

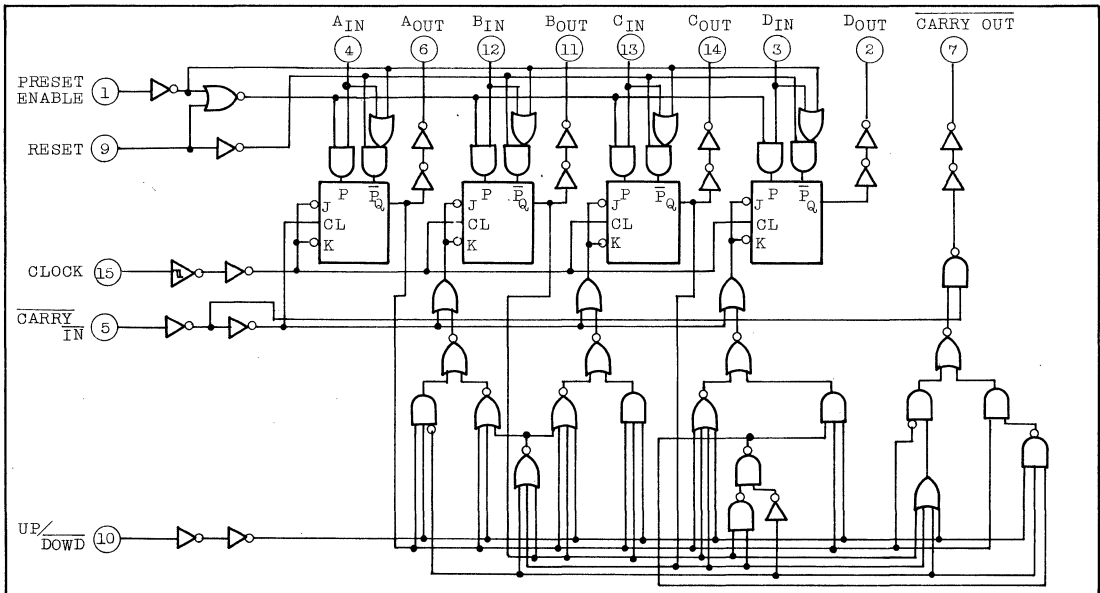


MFP16 (F16GC-P)

PIN ASSIGNMENT



LOGIC DIAGRAM

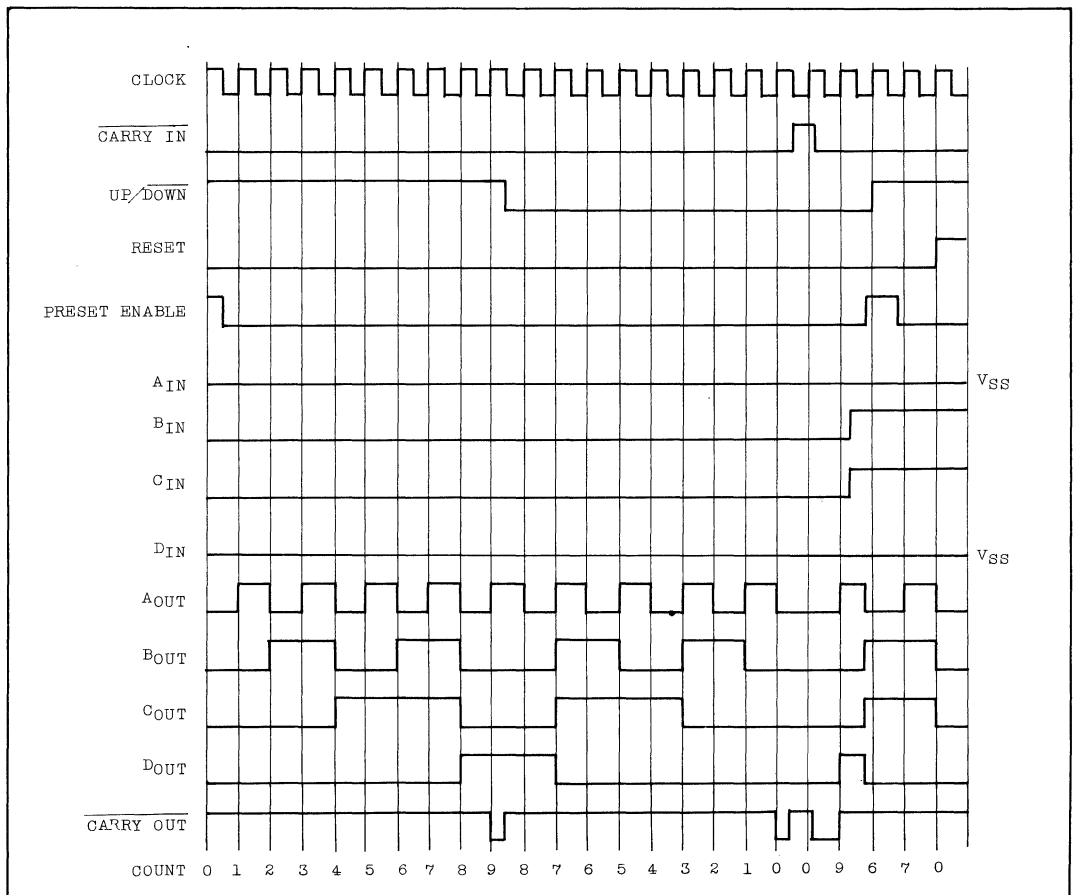


TRUTH TABLE

CARRY IN	UP/DOWN	PRESET ENABLE	RESET	FUNCTION
H	*	L	L	NO COUNT
L	H	L	L	UP COUNT
L	L	L	L	DOWN COUNT
*	*	H	L	PRESET
*	*	*	H	RESET

* Don't care

TIMING DIAGRAM



TC4510BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

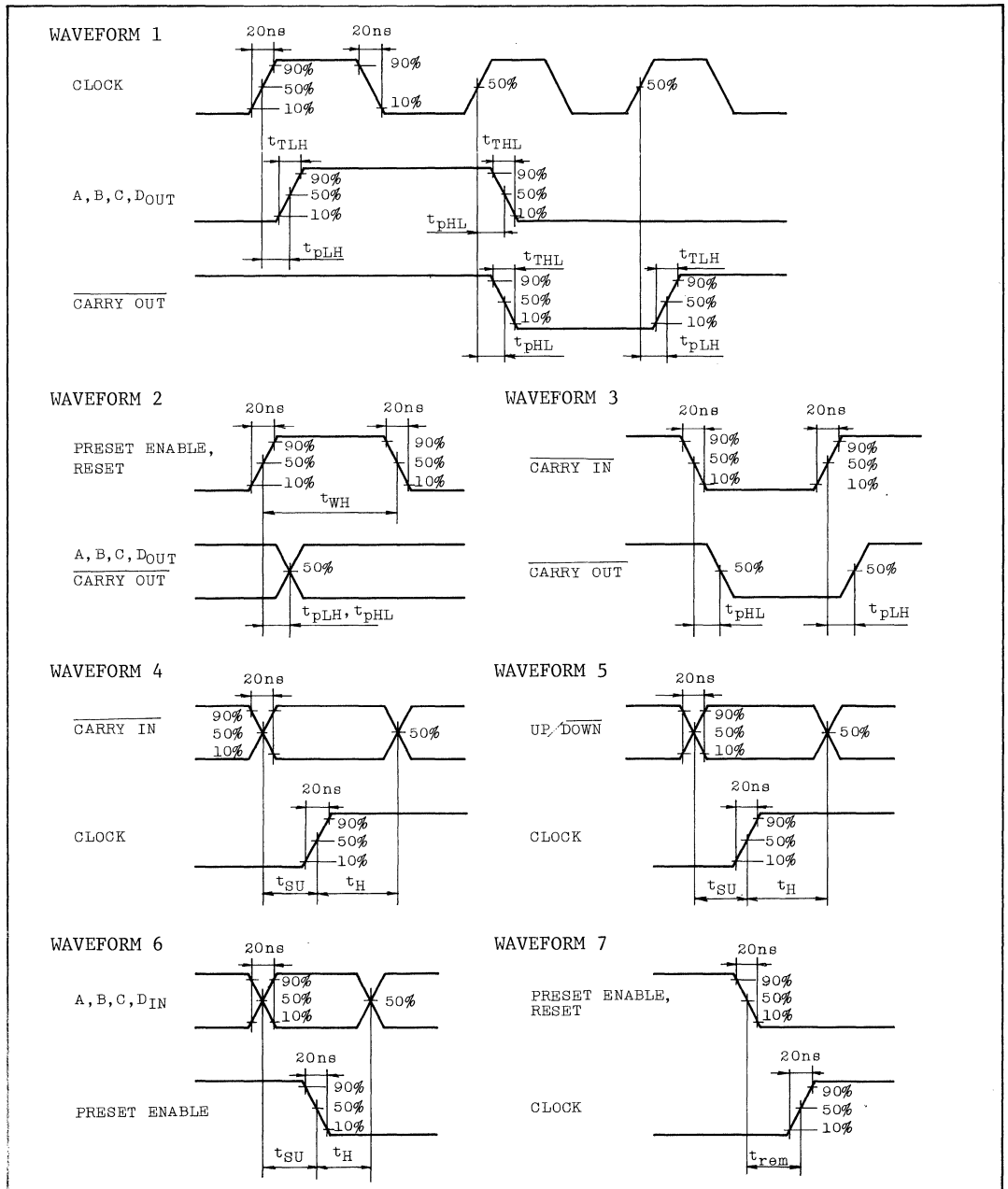
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK-A,B,C,DOUT)	t _{pLH} t _{pHL}		5	-	180	400	
			10	-	85	200	
			15	-	60	150	
Propagation Delay Time (CLOCK-CARRY OUT)	t _{pLH} t _{pHL}		5	-	220	480	
			10	-	100	240	
			15	-	75	180	
Propagation Delay Time (PRESET ENABLE, RESET-A,B,C,DOUT)	t _{pLH} t _{pHL}		5	-	180	420	
			10	-	85	210	
			15	-	65	160	
Propagation Delay Time (PRESET ENABLE, RESET-CARRY OUT)	t _{pLH} t _{pHL}		5	-	240	640	
			10	-	110	320	
			15	-	80	250	
Propagation Delay Time (CARRY IN - CARRY OUT)	t _{pLH} t _{pHL}		5	-	85	250	
			10	-	45	120	
			15	-	35	100	
Max. Clock Frequency	f _{CL}		5	2	5	-	MHz
			10	4	10	-	
			15	5.5	14	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	NO Limit			μs
			10				
			15				
Min. Clock Pulse Width	t _w		5	-	40	150	ns
			10	-	20	75	
			15	-	15	60	

TC4510BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width (PRESET ENABLE, RESET)	t _{WH}		5	-	55	200	ns
			10	-	25	100	
			15	-	20	75	
Min. Set-up Time (UP/DOWN-CLOCK)	t _{SU}		5	-	95	360	
			10	-	45	160	
			15	-	30	110	
Min. Hold Time (UP/DOWN-CLOCK)	t _H		5	-	-	30	
			10	-	-	30	
			15	-	-	30	
Min. Set-up Time (CARRY IN-CLOCK)	t _{SU}		5	-	75	150	
			10	-	35	60	
			15	-	25	45	
Min. Hold Time (CARRY IN-CLOCK)	t _H		5	-	-	60	
			10	-	-	30	
			15	-	-	30	
Min. Set-up Time (A,B,C,D-PRESET ENABLE)	t _{SU}		5	-	35	70	
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (A,B,C,D-PRESET ENABLE)	t _H		5	-	15	70	
			10	-	10	40	
			15	-	5	40	
Min. Removal Time (PRESET ENABLE, RESET-CLOCK)	t _{rem}		5	-	40	150	
			10	-	20	80	
			15	-	15	60	
Input Capacitance	C _{IN}			5	7.5	pF	

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

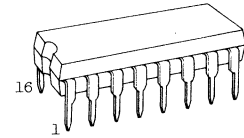


TC4511BP/BF

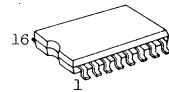
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4511BP/TC4511BF BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER

TC4511BP/BF is decoder which converts the input of BCD code into the 7 segment display element driving signal and the output has complementary connection of NPN bipolar transistor and N-channel MOS FET. Therefore, not only capability of directly driving cathode common type LED, this has capability of driving various display elements with simple interface circuits. \overline{LT} input and \overline{BI} input are to force all the outputs to be "H" (illuminated) and "L" (not illuminated) respectively regardless of BCD input. As the latch controlled by common LE input is inserted in each of four input lines, static display of dynamic information can be achieved. When an invalid BCD input, "10" or higher is applied, all the outputs become "L" (not illuminated).



DIP16(3D16A-P)

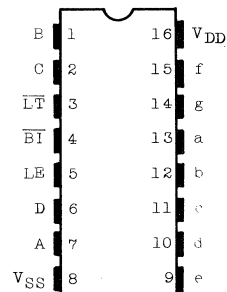


MFP16(F16GC-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Output High Current	I _{OH}	-50	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



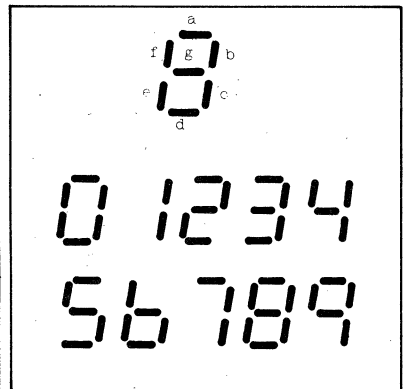
(TOP VIEW)

TRUTH TABLE

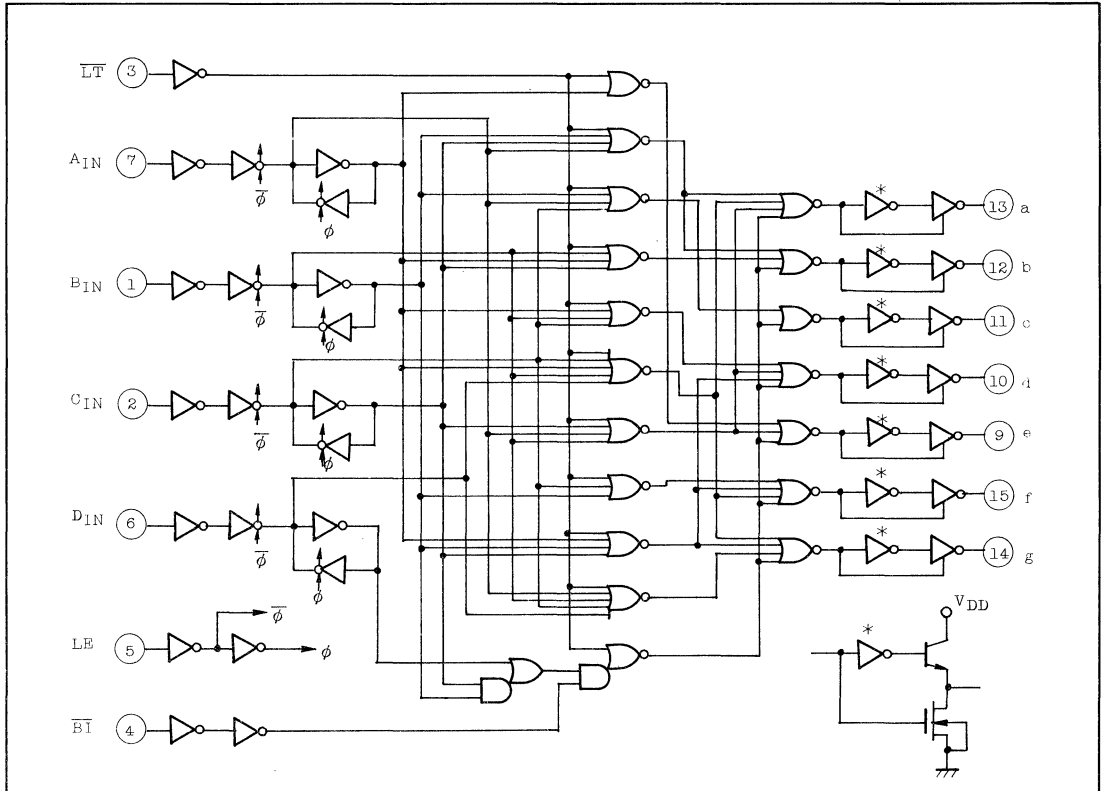
INPUT							OUTPUT							DISPLAY MODE
LE	\overline{BI}	\overline{LT}	D	C	B	A	a	b	c	d	e	f	g	
*	*	L	*	*	*	*	H	H	H	H	H	H	H	8
*	L	H	*	*	*	*	L	L	L	L	L	L	L	BLANK
L	H	H	L	L	L	L	H	H	H	H	H	H	L	0
L	H	H	L	L	L	H	L	H	H	L	L	L	L	1
L	H	H	L	L	H	L	H	H	L	H	H	L	H	2
L	H	H	L	L	H	H	H	H	H	L	L	L	H	3
L	H	H	L	H	L	L	L	H	H	L	L	H	H	4
L	H	H	L	H	L	H	H	L	H	H	L	H	H	5
L	H	H	L	H	H	L	L	L	H	H	H	H	H	6
L	H	H	L	H	H	H	L	H	H	L	L	L	L	7
L	H	H	H	L	L	L	H	H	H	H	H	H	H	8
L	H	H	H	L	L	H	H	H	L	L	L	H	H	9
L	H	H	H	L	H	L	L	L	L	L	L	L	L	BLANK
L	H	H	H	L	H	H	L	L	L	L	L	L	L	BLANK
L	H	H	H	H	*	*	L	L	L	L	L	L	L	BLANK
H	H	H	*	*	*	*	△△							△△

* : DON'T CARE △△: DEPENDS UPON THE BCD CODE PREVIOUSLY APPLIED WHEN LE "L"

DISPLAY



LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.1	-	4.1	4.41	-	4.2	-	V
			10	9.1	-	9.1	9.41	-	9.2	-	
			15	14.1	-	14.1	14.41	-	14.2	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Voltage	V _{OH}	I _{OH} =0mA	5	4.10	-	4.10	4.41	-	4.20	-	V	
		I _{OH} =10mA		3.90	-	3.90	4.25	-	3.90	-		
		I _{OH} =20mA		3.55	-	3.55	4.19	-	3.30	-		
		V _{IN} =V _{DD} , V _{SS}		10	9.10	-	9.10	9.41	-	9.20		-
		I _{OH} =0mA	9.00		-	9.00	9.25	-	9.00	-		
		I _{OH} =20mA	8.70		-	8.70	9.20	-	8.40	-		
		V _{IN} =V _{DD} , V _{SS}		15	14.10	-	14.10	14.41	-	14.20		-
I _{OH} =0mA	14.00	-	14.00		14.26	-	14.00	-				
I _{OH} =20mA	13.75	-	13.75		14.21	-	13.50	-				
|I _{OUT}| < 1μA												
Output Low Voltage	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.2	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.2	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	12.0	-	2.8	-		
		V _{IN} =V _{DD} , V _{SS}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.50	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.50	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{DD} , V _{SS}		5	-	5	-	0.005	5	-	150	μA
		*		10	-	10	-	0.010	10	-	300	
				15	-	20	-	0.015	20	-	600	

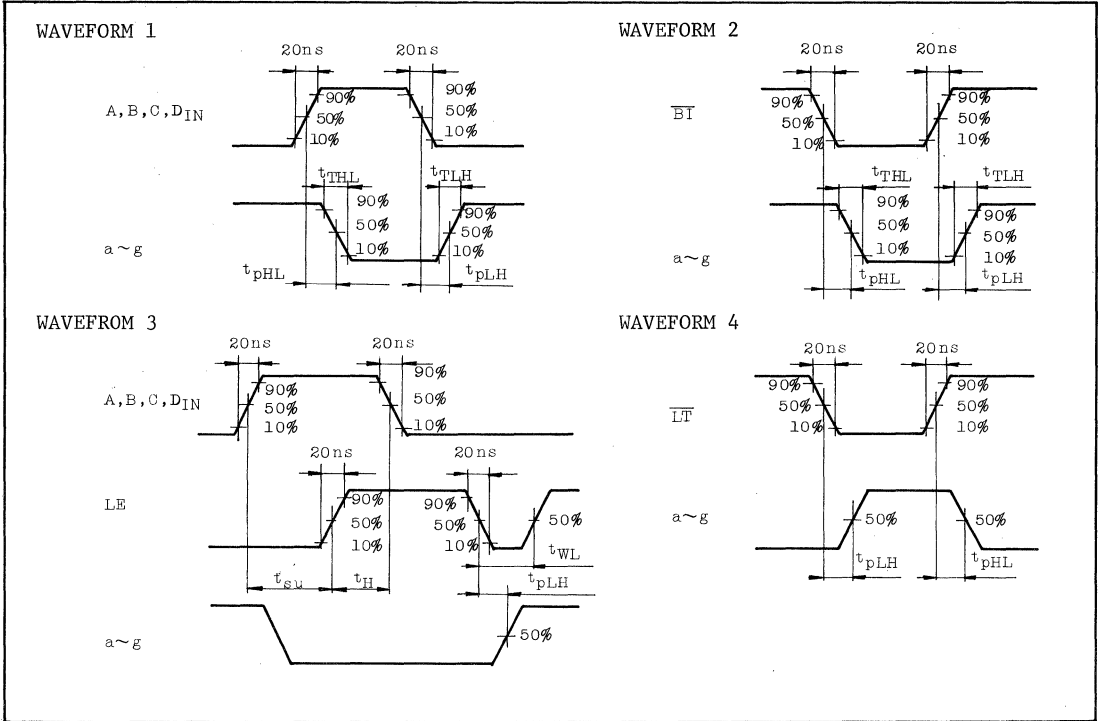
* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF, RL=10kΩ)

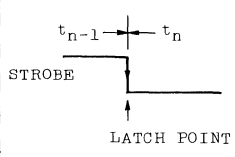
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	25	80	ns
			10	-	15	60	
			15	-	15	50	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (DATA - OUT)	t _{pLH}		5	-	200	1040	
			10	-	90	420	
			15	-	65	300	
Propagation Delay Time (DATA - OUT)	t _{pHL}		5	-	230	1040	
			10	-	110	420	
			15	-	80	300	
Propagation Delay Time ($\overline{\text{BI}}$ - OUT)	t _{pLH}		5	-	75	640	
			10	-	45	260	
			15	-	35	200	
Propagation Delay Time ($\overline{\text{BI}}$ - OUT)	t _{pHL}		5	-	90	300	
			10	-	50	260	
			15	-	45	200	
Propagation Delay Time ($\overline{\text{LT}}$ - OUT)	t _{pLH}		5	-	60	300	
			10	-	40	150	
			15	-	35	100	
Propagation Delay Time ($\overline{\text{LT}}$ - OUT)	t _{pHL}		5	-	75	300	
			10	-	45	150	
			15	-	35	100	
Propagation Delay Time (LE - OUT)	t _{pLH}		5	-	180	600	
			10	-	90	300	
			15	-	65	250	
Propagation Delay Time (LE - OUT)	t _{pHL}		5	-	230	600	
			10	-	110	300	
			15	-	85	250	
Min. Pulse Width (LE)	t _{wL}		5	-	40	300	
			10	-	20	150	
			15	-	15	120	
Min. Set-up Time (DATA - LE)	t _{su}		5	-	35	150	
			10	-	15	70	
			15	-	10	40	
Min. Hold Time (DATA - LE)	t _H		5	-	-	0	
			10	-	-	0	
			15	-	-	0	
Input Capacitance	C _{IN}			-	5	7.5	pF

TC4511BP/BF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TRUTH TABLE

INHIBIT	DATA INPUT				SELECTED OUTPUT TC4514BP - "H" TC4515BP - "L"	○ STROBE="H" ; See Truth table ○ STROBE="L" ; Outputs hold the data when STROBE goes "LOW" 
	DATA1	DATA2	DATA3	DATA4		
L	L	L	L	L	S0	○ * Don't care
L	H	L	L	L	S1	
L	L	H	L	L	S2	
L	H	H	L	L	S3	
L	L	L	H	L	S4	
L	H	L	H	L	S5	
L	L	H	H	L	S6	
L	H	H	H	L	S7	
L	L	L	L	H	S8	
L	H	L	L	H	S9	
L	L	H	L	H	S10	
L	H	H	L	H	S11	
L	L	L	H	H	S12	
L	H	L	H	H	S13	
L	L	H	H	H	S14	
L	H	H	H	H	S15	
H	*	*	*	*	TC4514BP-ALL OUTPUTS "L" TC4515BP-ALL OUTPUTS "H"	

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

TC4514BP, TC4515BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	1.13	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

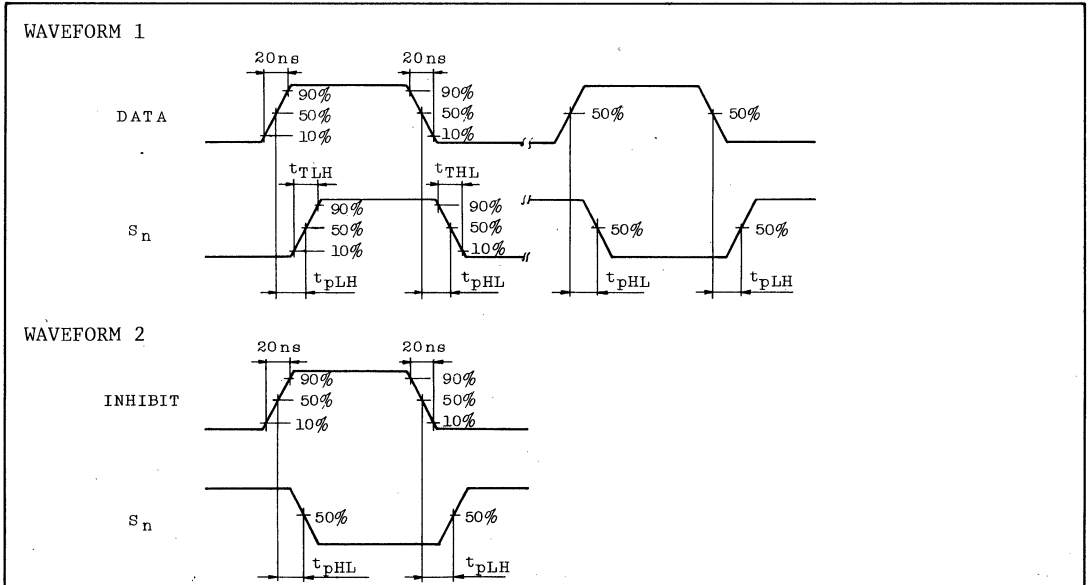
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

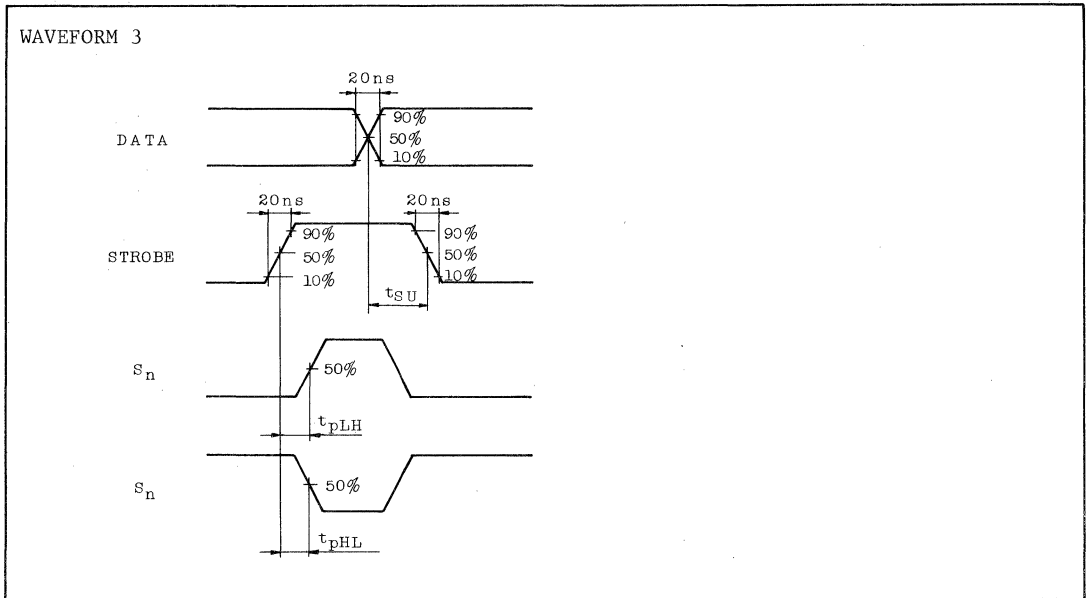
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
			5					10	15
Output Transition Time (High to Low)	t_{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (STROBE, DATA - Sn)	t_{pLH}		5	-	260	970	ns
	t_{pHL}		10	-	110	370	
			15	-	80	270	
Propagation Delay Time (INHIBIT - Sn)	t_{pLH}		5	-	150	500	ns
	t_{pHL}		10	-	65	220	
			15	-	50	170	
Min. Pulse Width (STROBE)	t_{WH}		5	-	40	250	ns
			10	-	20	100	
			15	-	15	75	
Min. Hold Time (DATA - STROBE)	t_{SU}		5	-	20	150	ns
			10	-	10	70	
			15	-	5	40	
Input Capacitance	CIN			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4514BP, TC4515BP

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



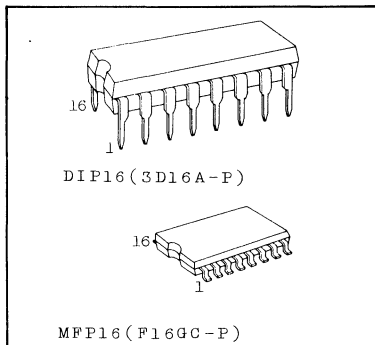
TC4516BP/TC4516BF PRESETTABLE BINARY UP/DOWN COUNTER

TC4516BP/BF is UP/DOWN 4 bit binary counter having asynchronous and PRESET functions.

When RESET input is set to "H" level, the content of counter is reset to "0" and when RESET is set to "L" and P.E. to "H", inputs A_{IN} through D_{IN} are preset into the counter.

If TC4516BP/BF's are connected in cascade using CARRY INPUT and CARRY OUTPUT, 4 × N bits binary counter with parallel counter can be composed.

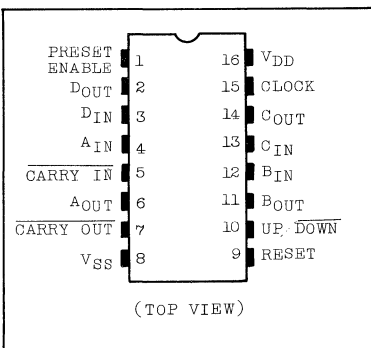
Switching of counting up or down is achieved by UP/DOWN input. The counter advances its counting condition at the rising edge of CLOCK.



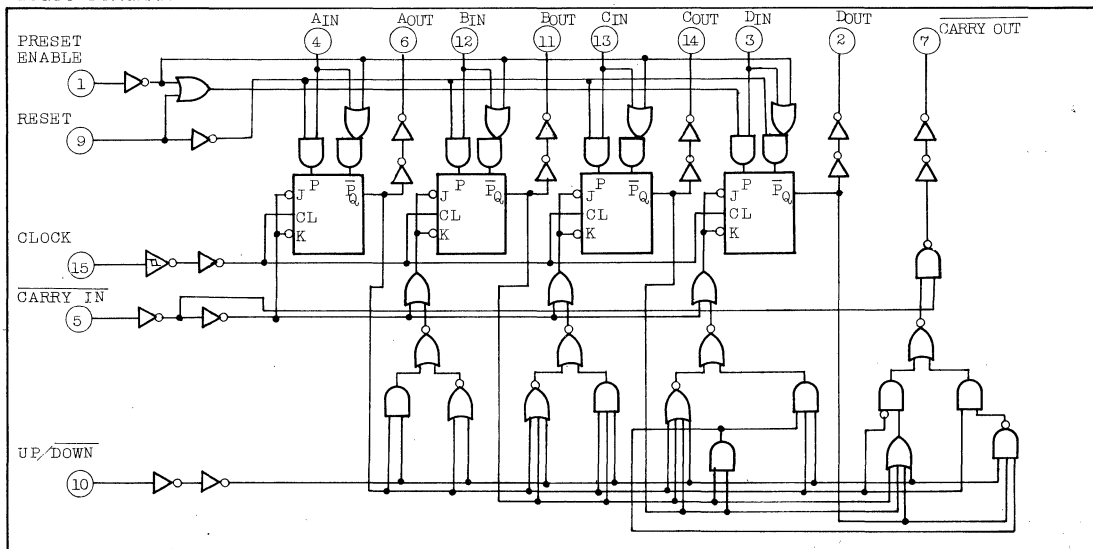
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



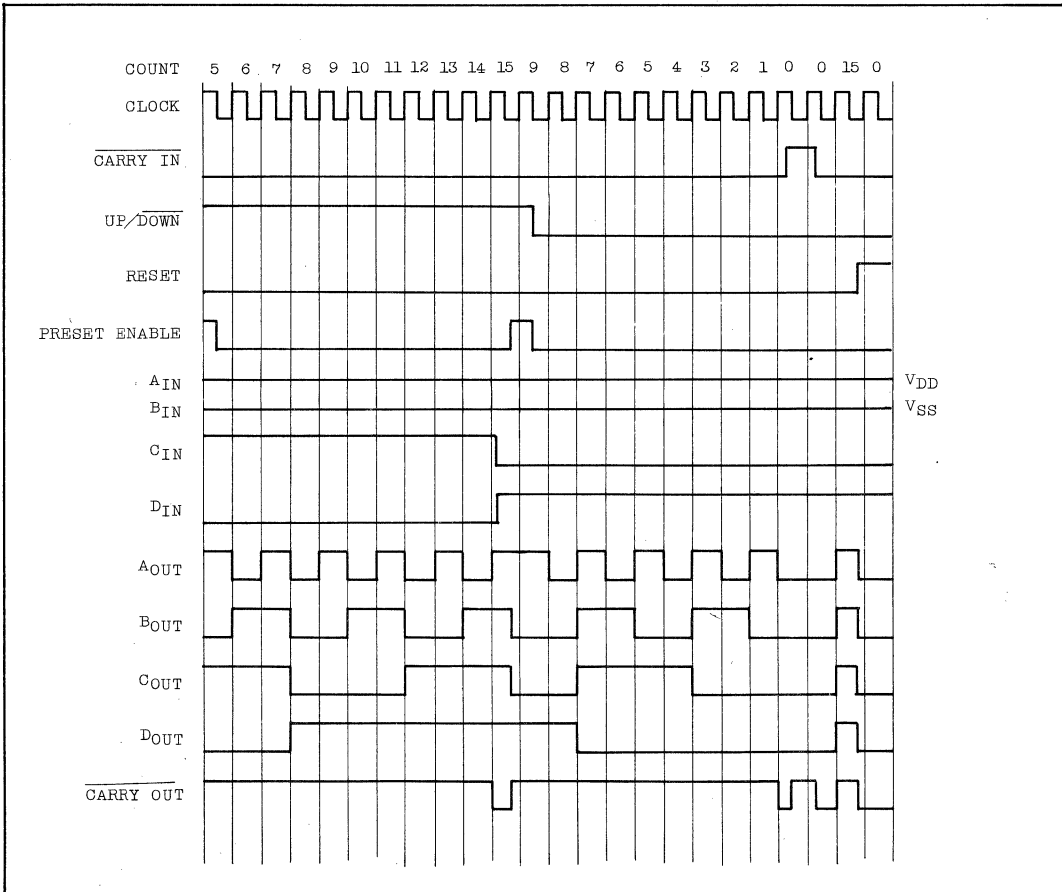
TC4516BP/BF

TRUTH TABLE

CARRY IN	UP/DOWN	PRESET ENABLE	RESET	FUNCTION
H	*	L	L	NO COUNT
L	H	L	L	UP COUNT
L	L	L	L	DOWN COUNT
*	*	H	L	PRESET
*	*	*	H	RESET

* Don't care

TIMING DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

TC4516BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS

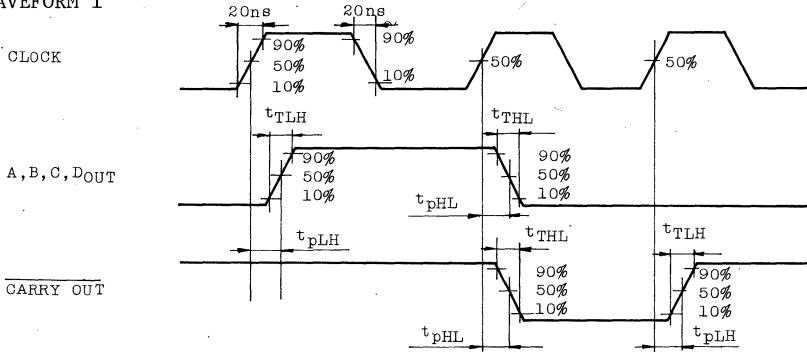
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK-A, B, C, D _{OUT})	t _{pLH} t _{pHL}		5	-	180	400	
			10	-	85	200	
			15	-	60	150	
Propagation Delay Time (CLOCK-CARRY OUT)	t _{pLH} t _{pHL}		5	-	220	480	
			10	-	100	240	
			15	-	75	180	
Propagation Delay Time (PRESET ENABLE, RESET-A, B, C, D _{OUT})	t _{pLH} t _{pHL}		5	-	180	420	
			10	-	85	210	
			15	-	65	160	
Propagation Delay Time (PRESET ENABLE RESET-CARRY OUT)	t _{pLH} t _{pHL}		5	-	240	640	
			10	-	110	320	
			15	-	80	250	
Propagation Delay Time (CARRY IN - CARRY OUT)	t _{pLH} t _{pHL}		5	-	85	250	
			10	-	45	120	
			15	-	35	100	
Max. Clock Frequency	f _{CL}		5	2	5	-	MHz
			10	4	10	-	
			15	5.5	14	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	NO Limit			μs
			10				
			15				
Min. Clock Pulse Width	t _w		5	-	40	150	ns
			10	-	20	75	
			15	-	15	60	
Min. Pulse Width (PRESET ENABLE, RESET)	t _{WH}		5	-	55	200	
			10	-	25	100	
			15	-	20	75	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

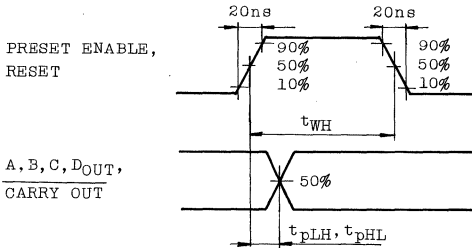
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Min. Set-up Time (UP/DOWN-CLOCK)	t _{SU}		5	-	95	360	ns
			10	-	45	160	
			15	-	30	110	
Min. Hold Time (UP/DOWN-CLOCK)	t _H		5	-	-	30	
			10	-	-	30	
			15	-	-	30	
Min. Set-up Time (CARRY IN - CLOCK)	t _{SU}		5	-	75	150	
			10	-	35	60	
			15	-	25	45	
Min. Hold Time (CARRY IN - CLOCK)	t _H		5	-	-	60	
			10	-	-	30	
			15	-	-	30	
Min. Set-Up Time (A,B,C,D-PRESET ENABLE)	t _{SU}		5	-	35	70	
			10	-	15	30	
			15	-	10	20	
Min. Hold Time (A,B,C,D-PRESET ENABLE)	t _H		5	-	15	70	
			10	-	10	40	
			15	-	5	40	
Min. Removal Time (PRESET ENABLE, RESET-CLOCK)	t _{rem}		5	-	40	150	
			10	-	20	80	
			15	-	15	60	
Input Capacitance	C _{IN}				5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

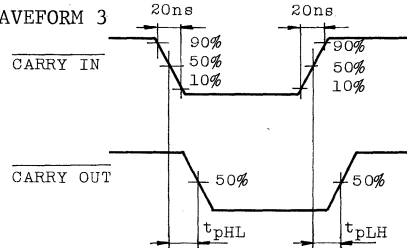
WAVEFORM 1



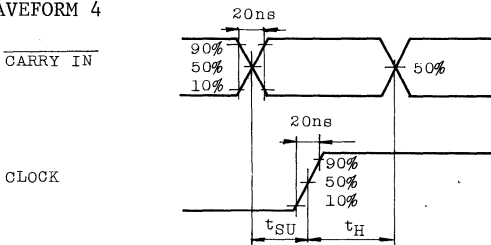
WAVEFORM 2



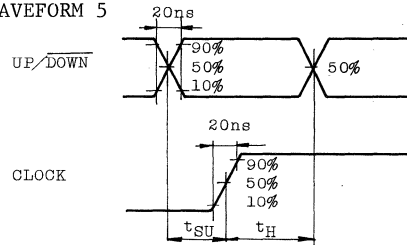
WAVEFORM 3



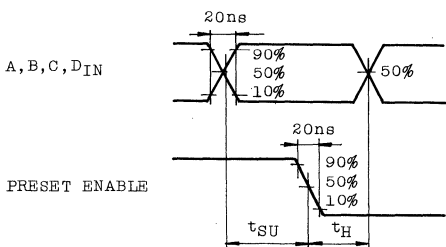
WAVEFORM 4



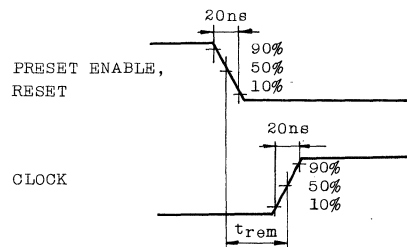
WAVEFORM 5



WAVEFORM 6

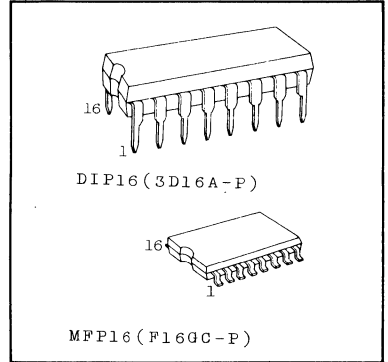


WAVEFORM 7



TC4518BP/TC4518BF DUAL BCD UP COUNTER
TC4520BP/TC4520BF DUAL BINARY UP COUNTER

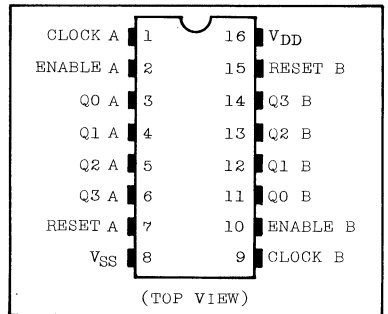
TC4518BP/BF and TC4520BP/BF are up counters of BCD or 4 bit binary.
Since both of TC4518BP/BF and TC4520BP/BF contain two independent circuits of counters with the same functions in one package, counting or frequency division of two BCD digits or eight binary bits can be achieved with one IC. The counters can be reset to "0" (Q0 ~ Q3="L") by giving "H" level signal to RESET input regardless of other inputs. The counting condition is changed by the rising edge of CLOCK input if ENABLE="H" or by the falling edge of ENABLE if CLOCK="L".



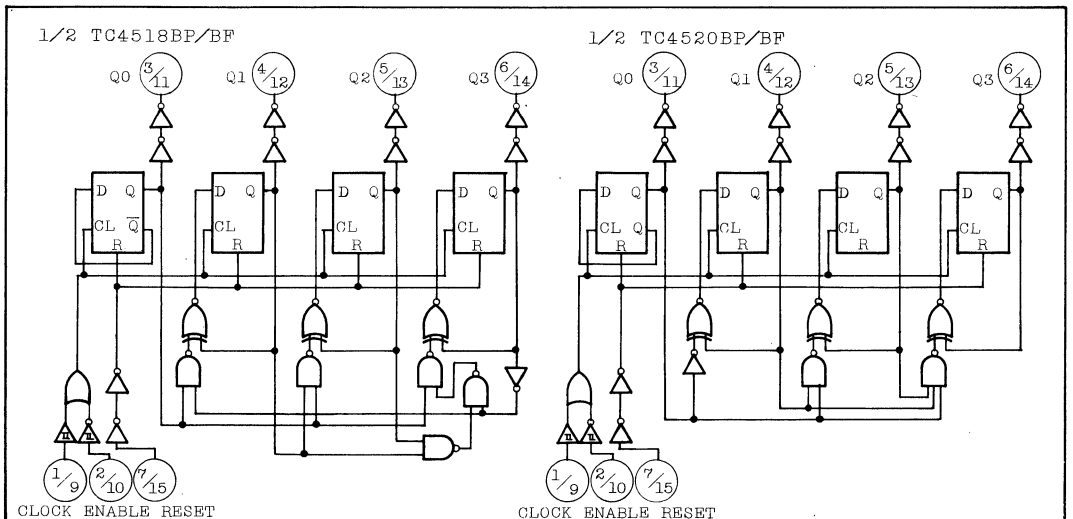
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10sec	

PIN ASSIGNMENT

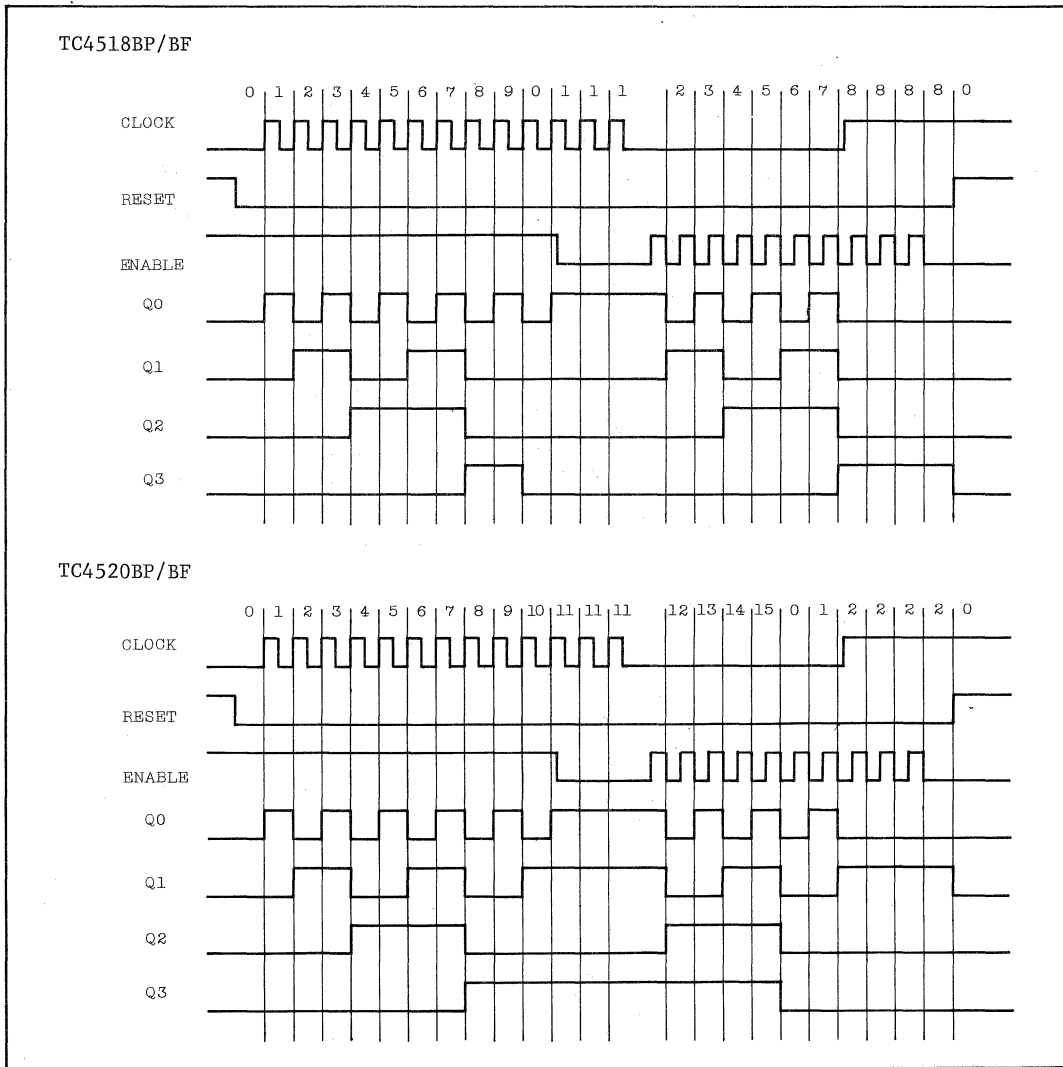


LOGIC DIAGRAM



TC4518BP/BF, TC4520BP/BF

TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	1.5	-	1.3	3.2	-	1.1	-	mA	
			10	4.0	-	3.4	12.0	-	2.8	-		
			15									
			5									
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	3.0	-	4.0	3.0	-	3.0	V	
			10	-	4.0	-	6.75	4.0	-	4.0		
			15	-		-			-			
			5	-		-			-			
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

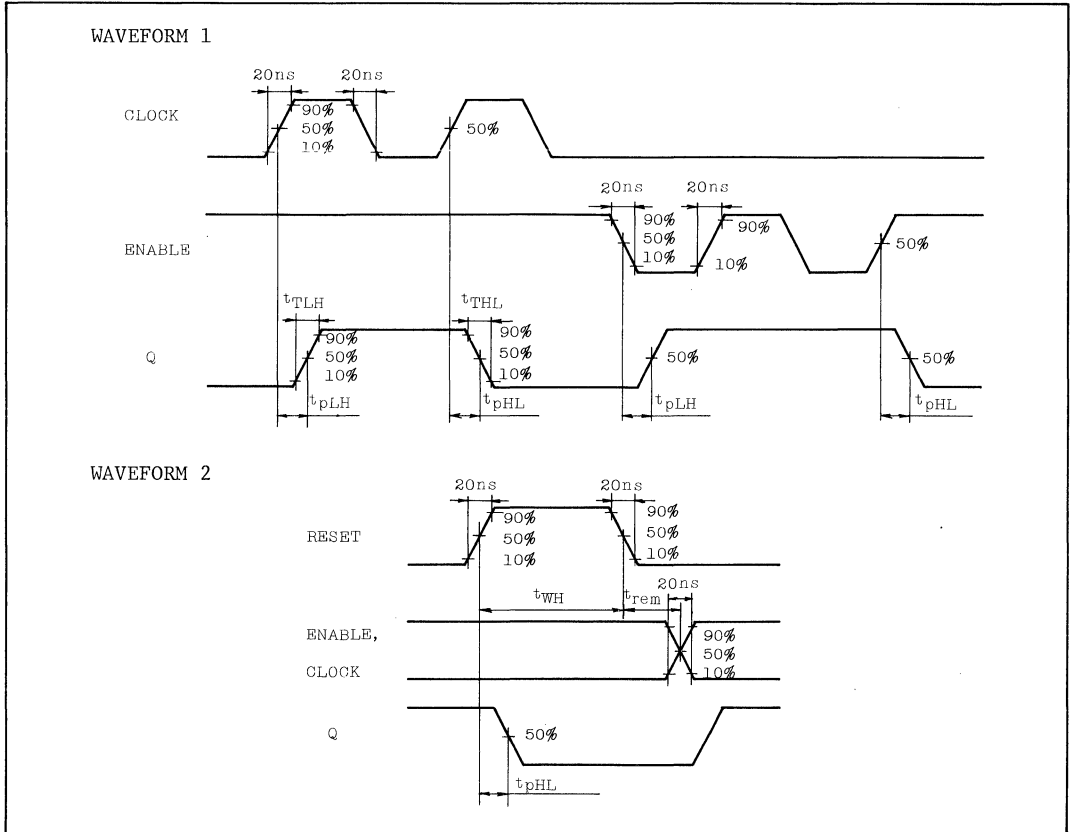
* All valid input combinations.

TC4518BP/BF, TC4520BP/BF

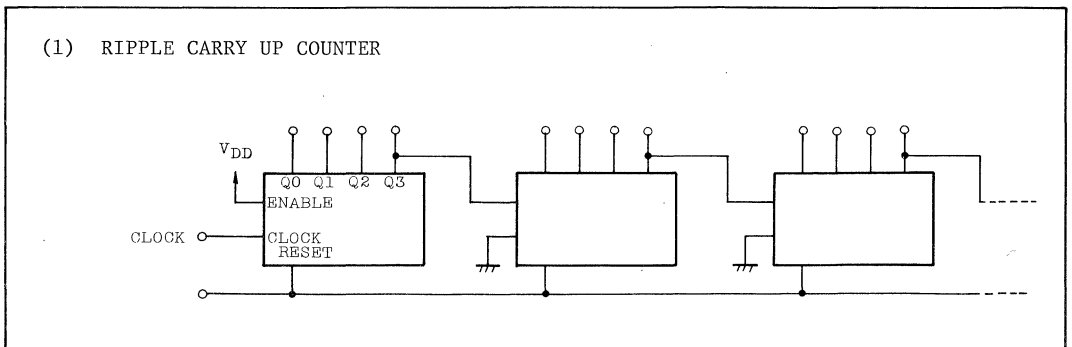
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (CLOCK, ENABLE - Q)	t _{pLH} t _{pHL}		5	-	160	560	
			10	-	75	230	
			15	-	60	160	
Propagation Delay Time (RESET - Q)	t _{pHL}		5	-	110	560	
			10	-	55	230	
			15	-	40	160	
Max. Clock Frequency	f _{CL}		5	1.5	6	-	MHz
			10	3	14	-	
			15	4	18	-	
Max. Clock Input Rise/ Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10	No Limit			
			15	No Limit			
Max. Input Rise/Fall Time (ENABLE)	t _r t _f		5	No Limit			
			10	No Limit			
			15	No Limit			
Min. Clock Pulse Width	t _w		5	-	30	200	
			10	-	15	100	
			15	-	10	70	
Min. Pulse Width (ENABLE)	t _w		5	-	35	250	
			10	-	20	110	
			15	-	15	80	
Min. Pulse Width (RESET)	t _{WH}		5	-	45	250	
			10	-	20	110	
			15	-	15	80	
Min. Removal Time	t _{rem}		5	-	-	0	
			10	-	-	0	
			15	-	-	0	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



APPLICATION CIRCUIT

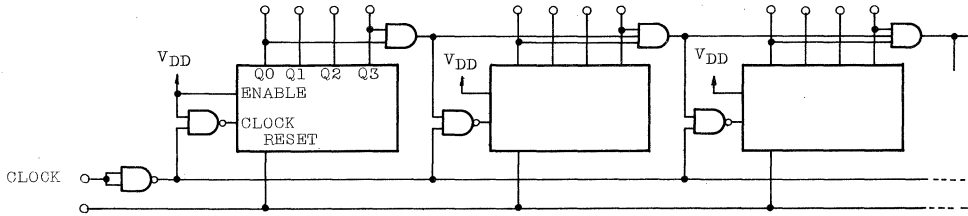


TC4518BP/BF, TC4520BP/BF

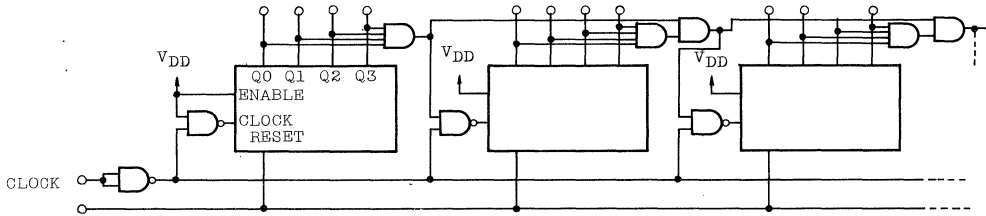
APPLICATION CIRCUIT (Continued)

(2) PARALLEL CARRY UP COUNTER

TC4518BP/BF



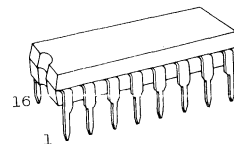
TC4520BP/BF



TC4519BP 4-BIT AND/OR SELECTOR

The TC4519BP is a combined gate available as 4-bit AND/OR select gate, quad 2-channel data selector or quad exclusive-NOR gate according to the conditions of two control inputs A and B.

Since all the outputs are provided with the buffers of two-stage inverters, the input/output transmission characteristics have been improved and the noise immunity has been elevated. Thus, as increase in propagation delay time caused by an increase in load capacity is kept to a minimum.

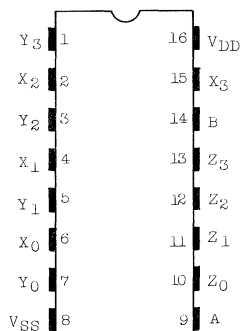


DIP16(3D16A-P)

ABSOLUTE MAXIMUM RATINGS

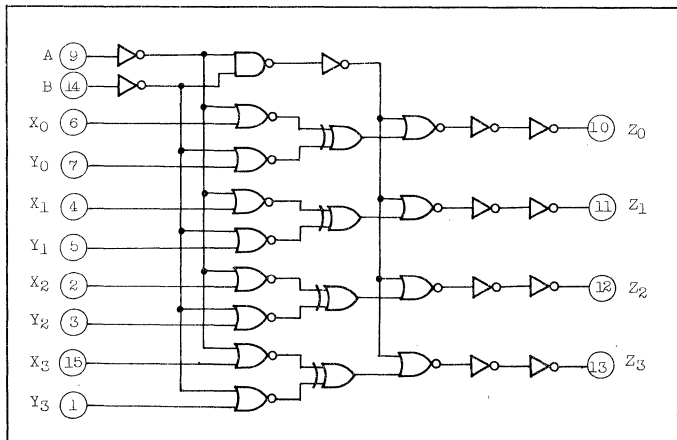
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

CONTROL INPUTS		OUTPUT
A	B	Z _n
L	L	L
L	H	Y _n
H	L	X _n
H	H	X _n ○Y _n

$$X_n \circ Y_n \equiv X_n \text{ (Exclusive-NOR) } Y_n \\ = X_n \cdot Y_n + \bar{X}_n \cdot \bar{Y}_n$$

TC4519BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

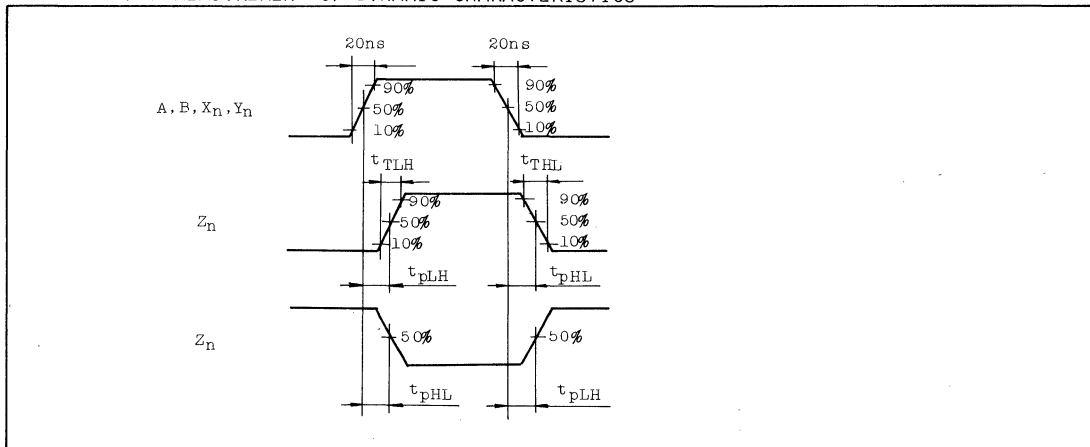
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A, B, X _n , Y _n - Z _n)	t _{pLH}		5	-	190	500	
			10	-	80	225	
	t _{pHL}		15	-	60	165	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4521BP

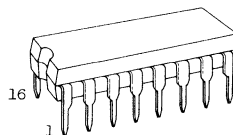
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4521BP 24-STAGE FREQUENCY DIVIDER

TC4521BP is frequency divider consisting of 24 stages of flip-flops. The input section is equipped with an inverter to enable to use either RC oscillator circuit or crystal oscillator circuit and to accept pulse from external clock source.

Each flip-flop is inverted by the falling edge of the output of previous stage flip-flop and this can count up to the maximum of $2^{24}=16,777,216$.

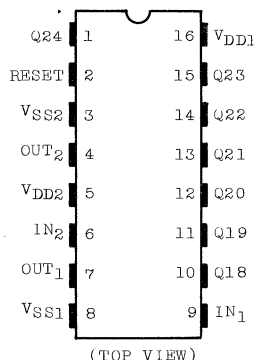
Since six outputs, 2^{18} , 2^{19} , 2^{20} , 2^{21} , 2^{22} and 2^{23} are available besides of 2^{24} , adjustment of frequency divided output can be achieved.



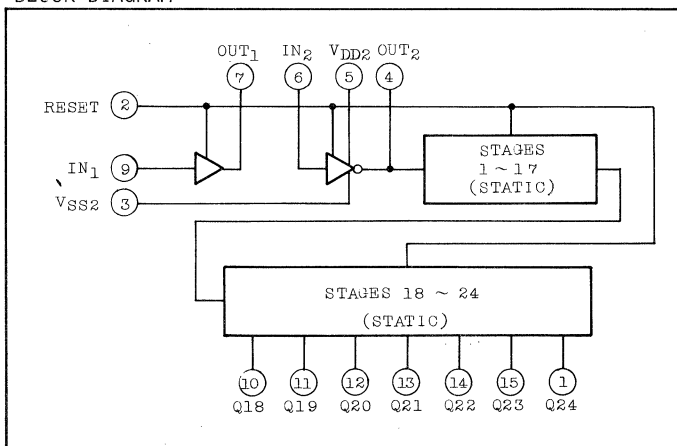
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V _{DD1}	V _{SS1} -0.5 ~ V _{SS1} +20	V
	V _{DD2}	V _{SS1} -0.5 ~ V _{DD1} +0.5	
Input Voltage	V _{IN}	V _{SS1} -0.5 ~ V _{DD1} +0.5	V
Output Voltage	V _{OUT}	V _{SS1} -0.5 ~ V _{DD1} +0.5	
DC Input Voltage	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{so1}	260°C • 10 sec	

PIN ASSIGNMENT



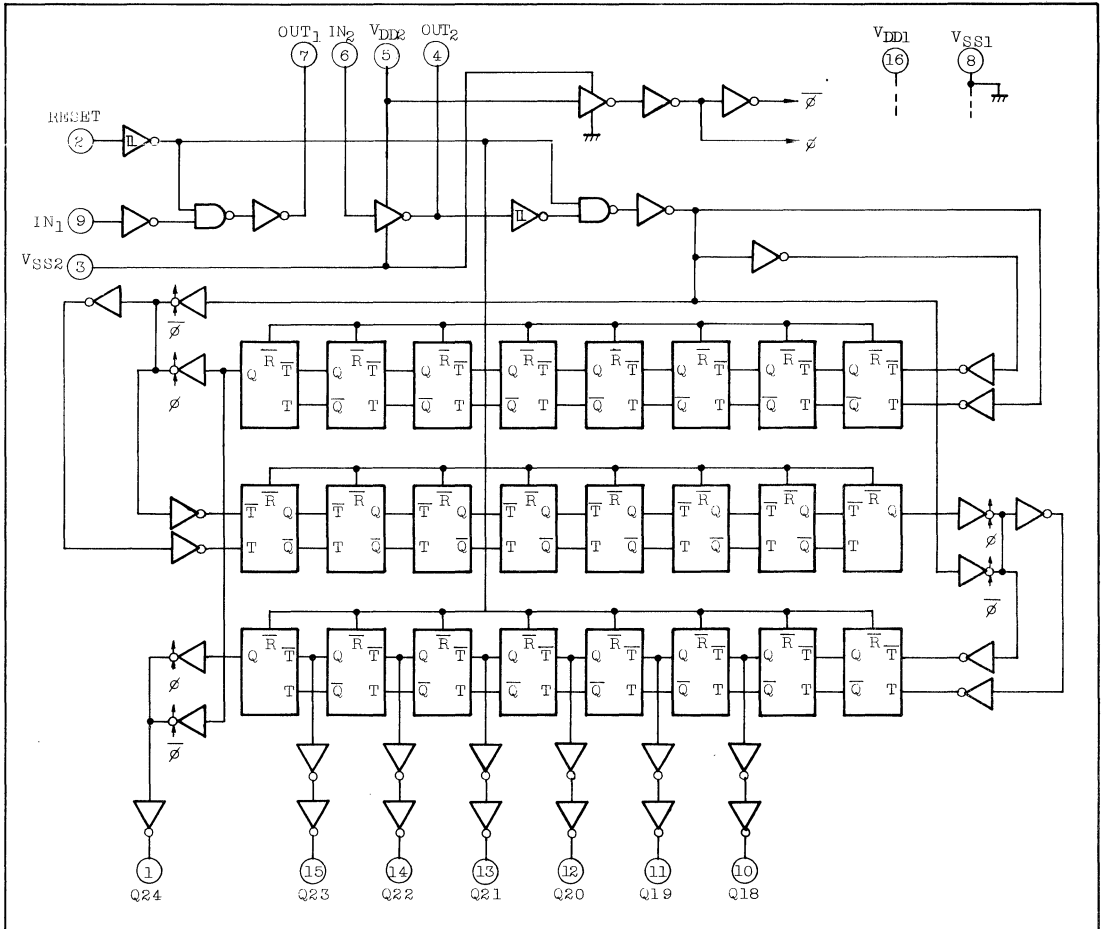
BLOCK DIAGRAM



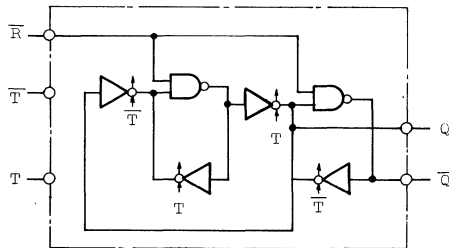
COUNT CAPACITY

OUTPUT	COUNT CAPACITY
Q18	$2^{18} = 262,144$
Q19	$2^{19} = 524,288$
Q20	$2^{20} = 1,048,576$
Q21	$2^{21} = 2,097,152$
Q22	$2^{22} = 4,194,304$
Q23	$2^{23} = 8,388,608$
Q24	$2^{24} = 16,777,216$

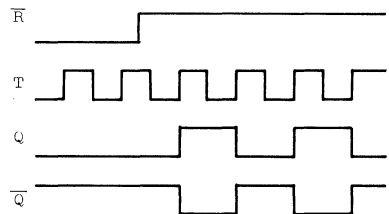
LOGIC DIAGRAM



INTERNAL FLIP FLOP LOGIC DIAGRAM



FLIP FLOP TIMING CHART



TC4521BP

RECOMMENDED OPERATING CONDITIONS (V_{SS1}=V_{SS2}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD1} , V _{DD2}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD1}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS1}=V_{SS2}=0V, V_{DD1}=V_{DD2})

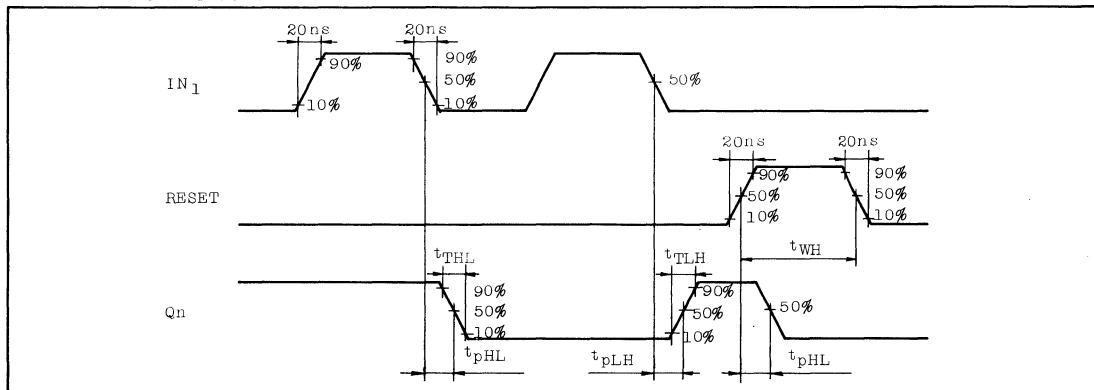
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS1=VSS2=0V, VDD1=VDD2, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD(V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (IN2 - Q18)	t _{pLH} t _{pHL}		5	-	1.1	9.0	μs
			10	-	0.5	3.5	
			15	-	0.3	2.7	
Propagation Delay Time (IN2 - Q24)	t _{pLH} t _{pHL}		5	-	1.4	12	μs
			10	-	0.6	4.5	
			15	-	0.4	3.5	
Propagation Delay Time (RESET - Qn)	t _{pHL}		5	-	220	2600	ns
			10	-	100	1000	
			15	-	70	750	
Max. Clock Frequency	f _{CL}		5	3	9.5	-	MHz
			10	6	17.5	-	
			15	8	23.5	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	t _{rCL} t _{fCL}		5	No Limit			μs
			10				
			15				
Min. Clock Pulse Width	t _W		5	-	55	385	ns
			10	-	25	150	
			15	-	16	120	
Min. Pulse Width (RESET)	t _{WH}		5	-	60	385	ns
			10	-	26	150	
			15	-	20	120	
Input Capacitance	C _{IN}			-	5	7.5	pF

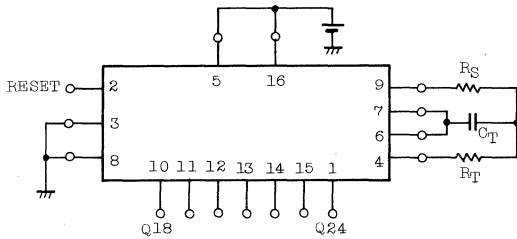
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4521BP

APPLICATION CIRCUIT

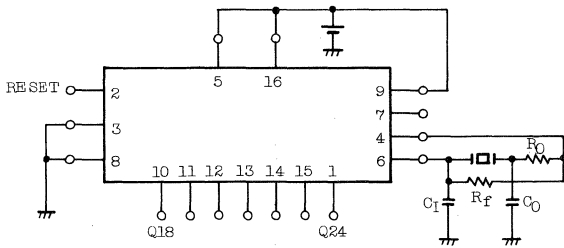
* When CR oscillation is used as time reference



$$R_S \cong 2 R_T$$

$$f_{OSC} \cong \frac{1}{2.2 R_T C_T}$$

* When crystal oscillation circuit is used as the time reference



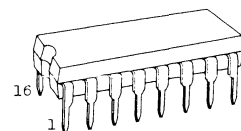
Typical data

X'tal (Hz)	C _I , C _O (pF)	R _O (Ω)
32.768k	23	500k
100k	60	100k
1M	45 ~ 50	100
4.194304M	12 ~ 15	0

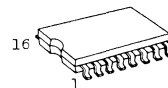
$$R_f = 10M\Omega$$

TC4522BP PROGRAMMABLE DIVIDE-BY-N 4-BIT COUNTER (BCD)
TC4526BP/TC4526BF PROGRAMMABLE DIVIDE-BY-N 4-BIT COUNTER (Binary)

TC4522BP, TC4526BP/BF is a 4-bit, synchronus, down counter having clear, preset and inhibit function. The counting operation of each counter is made at the rising edge of CLOCK. The counter can advance its counting operation at the falling edge of INHIBIT input by setting the CLOCK input to "H" level. The programmable frequency division circuit can be formed by using the PRESET ENABLE input. Also the circuit can be expanded by means of cascade connection by use of the CASCADE FEEDBACK input and "0" output. (Refer to application circuit). This counter is suitable to programmable frequency-dividers, synthesizers, etc.



DIP16 (3D16A-P)

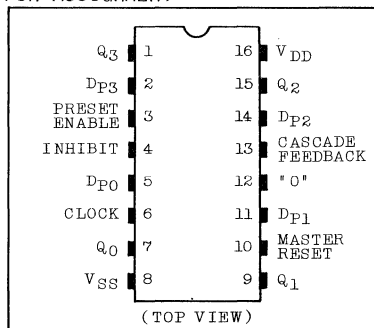


MFP16 (F16GC-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40~85	°C
Storage Temperature Range	T _{stg}	-65~150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



TRUTH TABLE

(TC4522BP, TC4526BP/BF)

CLOCK	INHIBIT	PRESET ENABLE	MASTER RESET	ACTION
L	*	L	L	NO COUNT
	L	L	L	COUNT
*	H	L	L	NO COUNT
H		L	L	COUNT
*	*	H	L	PRESET
*	*	*	H	RESET

* Don't Care

(TC4522BP)

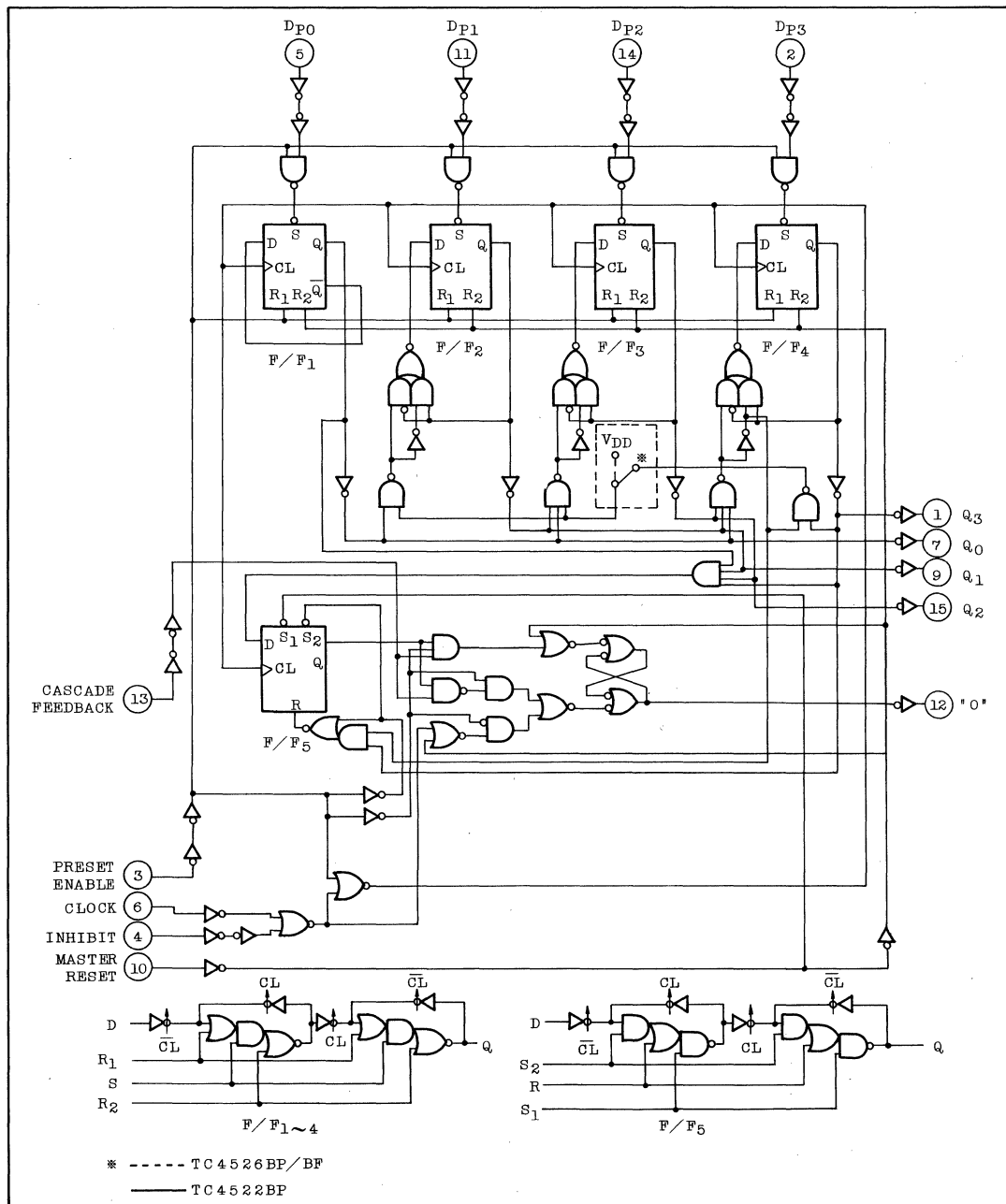
Count	Q ₀	Q ₁	Q ₂	Q ₃
9	H	L	L	H
8	L	L	L	H
7	H	H	H	L
6	L	H	H	L
5	H	L	H	L
4	L	L	H	L
3	H	H	L	L
2	L	H	L	L
1	H	L	L	L
0	L	L	L	L

(TC4526BP/BF)

Count	Q ₀	Q ₁	Q ₂	Q ₃
15	H	H	H	H
14	L	H	H	H
13	H	L	H	H
12	L	L	H	H
11	H	H	L	H
10	L	H	L	H
9	H	L	L	H
8	L	L	L	H
7	H	H	H	L
6	L	H	H	L
5	H	L	H	L
4	L	L	H	L
3	H	H	L	L
2	L	H	L	L
1	H	L	L	L
0	L	L	L	L

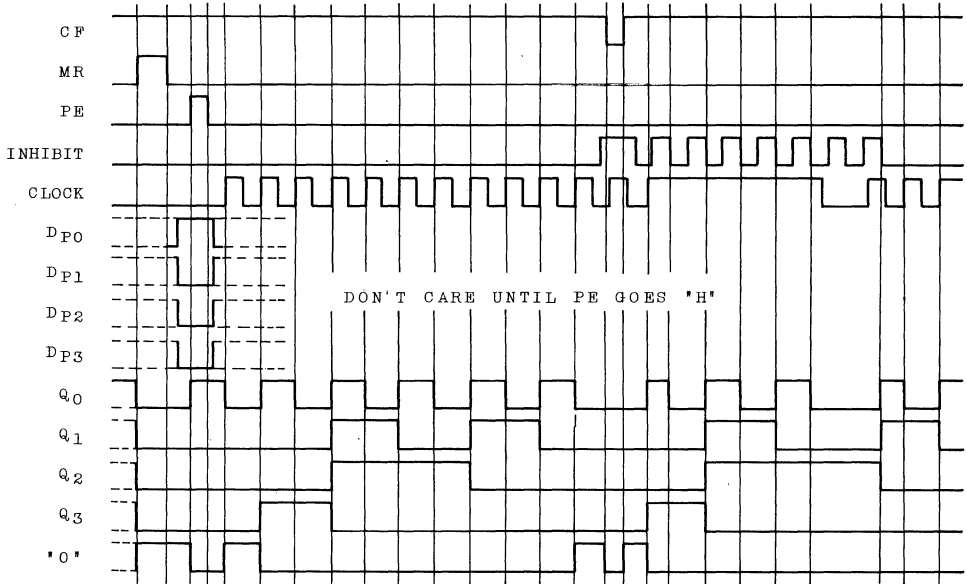
TC4522BP, TC4526BP/BF

LOGIC DIAGRAM

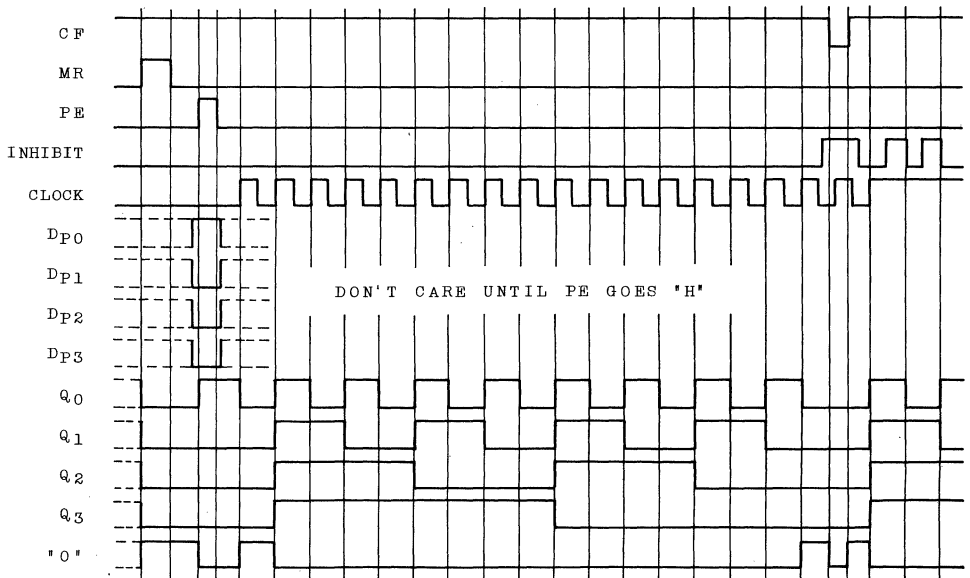


TIMING CHART

(TC4522BP)



(TC4526BP/BF)



TC4522BP, TC4526BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	0.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.5	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			5	-	1.5	-	2.25	1.5	-	1.5		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			18	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	#A
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

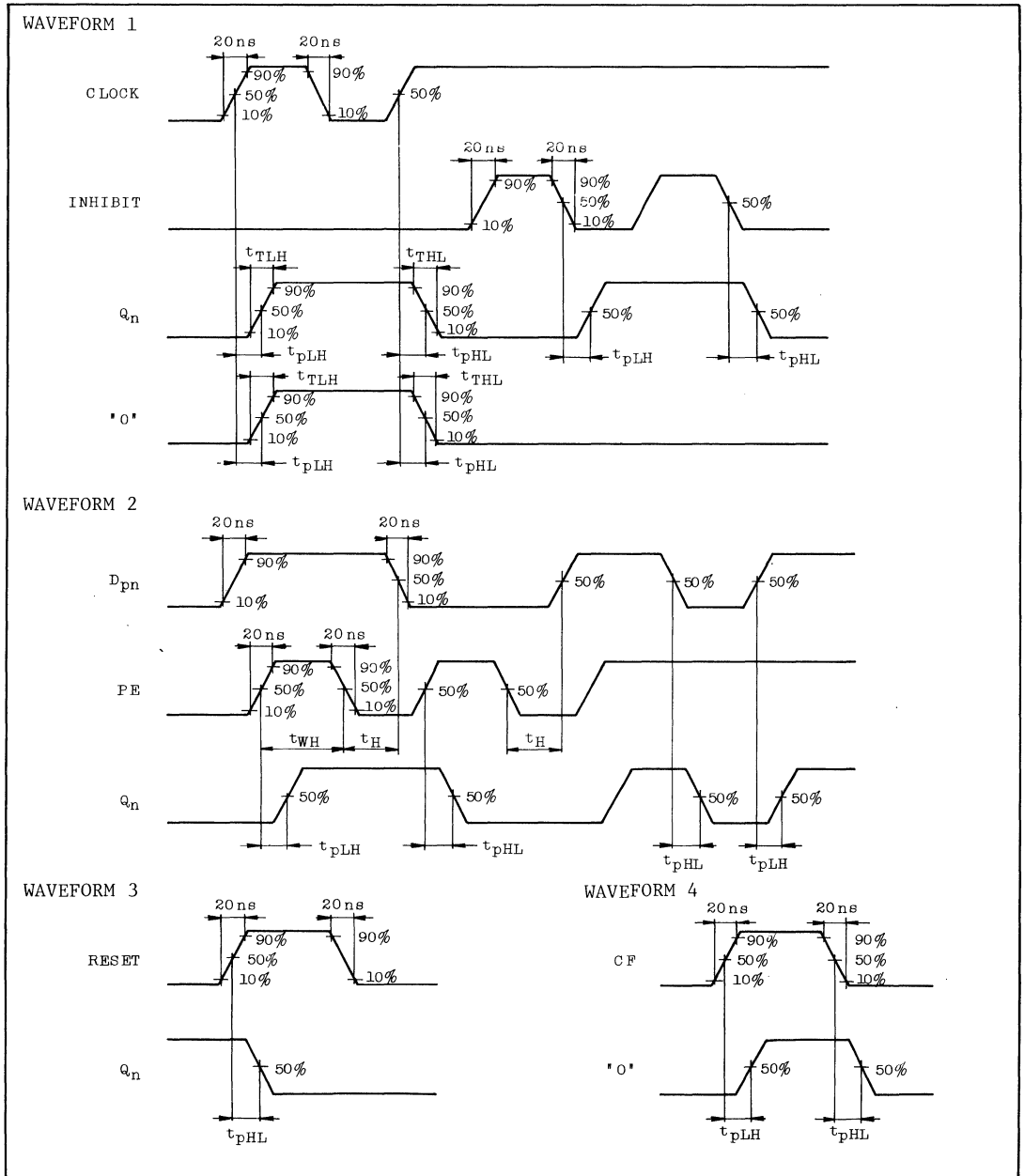
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK, INHIBIT - Q _n)	t _{pLH} t _{pHL}		5	-	450	1100	ns
			10	-	170	450	
			15	-	120	320	
Propagation Delay Time (CLOCK - "0")	t _{pLH} t _{pHL}		5	-	500	1100	ns
			10	-	190	450	
			15	-	130	320	
Propagation Delay Time (PE - Q _n)	t _{pLH} t _{pHL}		5	-	470	1100	ns
			10	-	190	450	
			15	-	130	320	
Propagation Delay Time (D _{pn} - Q _n)	t _{pLH} t _{pHL}		5	-	280	1100	ns
			10	-	120	450	
			15	-	80	320	
Propagation Delay Time (RESET - Q _n)	t _{pHL}		5	-	430	1100	ns
			10	-	170	450	
			15	-	125	320	
Propagation Delay Time (CF - "0")	t _{pLH} t _{pHL}		5	-	160	480	ns
			10	-	100	260	
			15	-	70	200	

TC4522BP, TC4526BP/BF

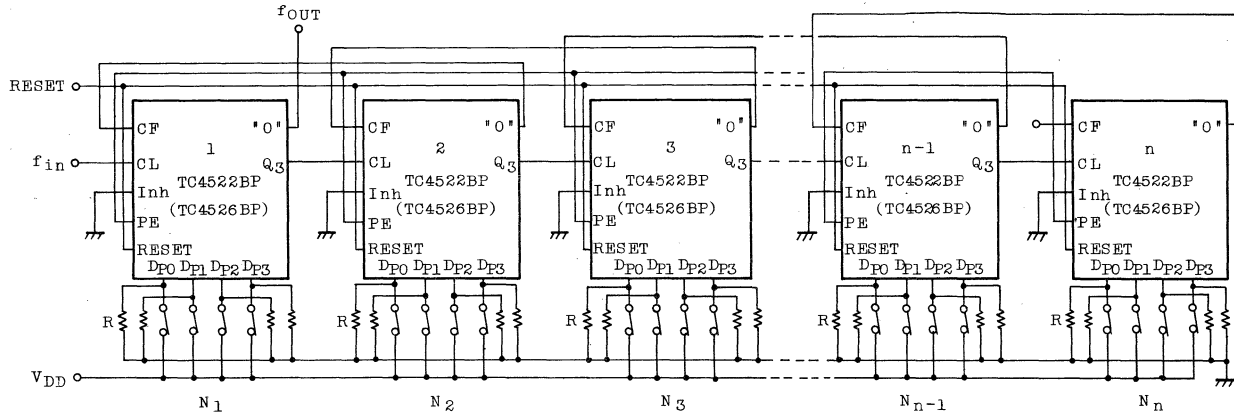
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Max. Clock Frequency	f _{CL}		5	1.0	2	-	MHz
			10	3.0	6	-	
			15	4.0	9	-	
Max. Clock Input Rise/ Fall Time	t _{rCL} t _{fCL}		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Max. Input Rise/ Fall Time (INHIBIT)	t _r t _f		5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Clock Pulse Width	t _W		5	-	250	500	ns
			10	-	85	170	
			15	-	55	110	
Min. Pulse Width (PRESET ENABLE)	t _{WH}		5	-	330	660	ns
			10	-	140	280	
			15	-	100	200	
Min. Pulse Width (RESET)	t _{WH}		5	-	270	540	ns
			10	-	110	250	
			15	-	80	200	
Min. Hold Time (D _{pn} -PE)	t _H		5	-	30	150	ns
			10	-	20	50	
			15	-	15	40	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

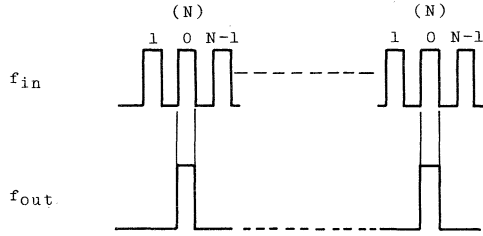


N-STAGE PROGRAMMABLE FREQUENCY DIVIDER



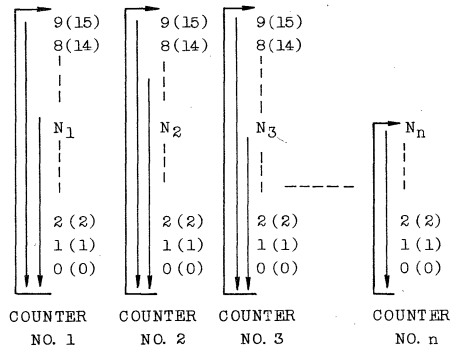
R : 10kΩ ~ 100kΩ

TIMING CHART



$$f_{out} = \frac{f_{in}}{N}, N \neq 0$$

COUNTING CYCLE

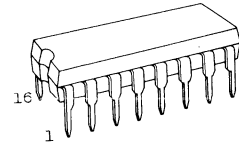


TC4527BP BCD RATE MULTIPLIER

TC4527BP is BCD rate multiplier from which arbitrary number of output pulses determined by BCD inputs (A_{IN} through D_{IN}) can be obtained by supplying ten clock inputs.

For example, setting BCD input to "7" (A = B = C = "H" and D = "L"), if ten counting pulses are applied to CLOCK input, seven pulses are output to OUT (OUT) terminals. Usually, when used alone, ENABLE, STROBE AND CASCADE inputs are kept at "L" level but when used in the cascade connection, refer to the example of applications.

Besides its original purpose of arithmetic circuits, this TC4527BP can be utilized for digital filters, frequency synthesizers and programmable pulse generators.

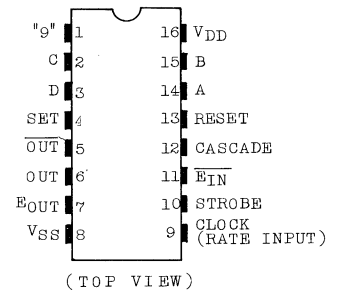


DIP16 (3D16A-P)

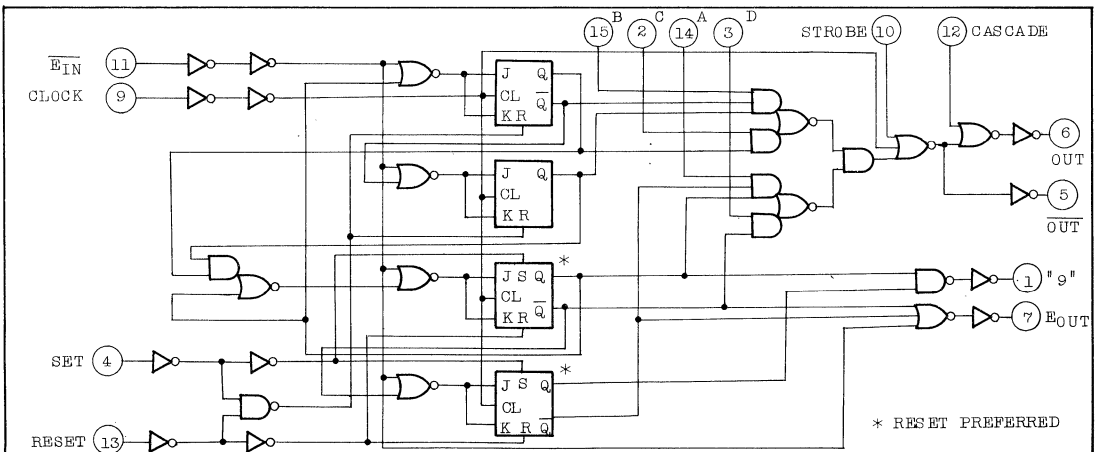
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	PD	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



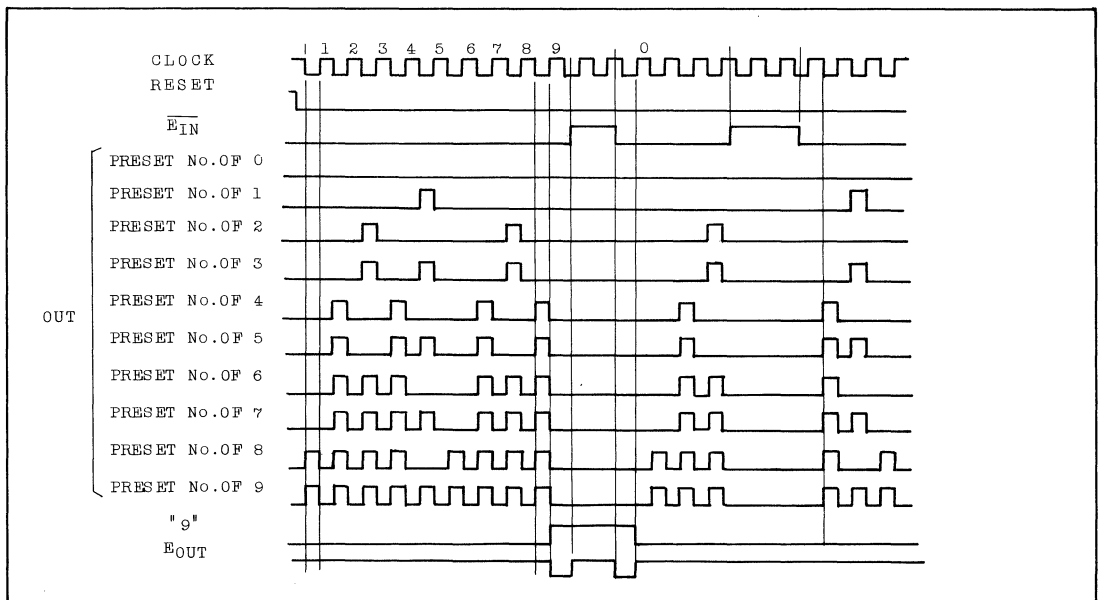
TC4527BP

TRUTH TABLE

INPUTS										OUTPUTS			
D	C	B	A	No. OF CLOCK PULSES	$\overline{E_{IN}}$	STROBE	CASCADE	RESET	SET	OUT	$\overline{O_{UT}}$	"9"	E_{OUT}
L	L	L	L	10	L	L	L	L	L	L	H	1	1
L	L	L	H	10	L	L	L	L	L	L	1	1	1
L	L	H	L	10	L	L	L	L	L	L	2	2	1
L	L	H	H	10	L	L	L	L	L	L	3	3	1
L	H	L	L	10	L	L	L	L	L	L	4	4	1
L	H	L	H	10	L	L	L	L	L	L	5	5	1
L	H	H	L	10	L	L	L	L	L	L	6	6	1
L	H	H	H	10	L	L	L	L	L	L	7	7	1
H	L	L	L	10	L	L	L	L	L	L	8	8	1
H	L	L	H	10	L	L	L	L	L	L	9	9	1
H	L	H	L	10	L	L	L	L	L	L	8	8	1
H	L	H	H	10	L	L	L	L	L	L	9	9	1
H	H	L	L	10	L	L	L	L	L	L	8	8	1
H	H	L	H	10	L	L	L	L	L	L	9	9	1
H	H	H	L	10	L	L	L	L	L	L	8	8	1
H	H	H	H	10	L	L	L	L	L	L	9	9	1
*	*	*	*	10	H	L	L	L	L	L	▲	▲	H
*	*	*	*	10	L	H	L	L	L	L	L	H	1
*	*	*	*	10	L	L	H	L	L	L	H	▲	1
H	*	*	*	10	L	L	L	H	L	L	10	10	L
L	*	*	*	10	L	L	L	H	L	L	H	L	H
*	*	*	*	10	L	L	L	L	H	L	H	H	L

* DON'T CARE ▲ UNDETERMINED 1~10 : NO OF PULSES

TIMING CHART



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

TC4527BP

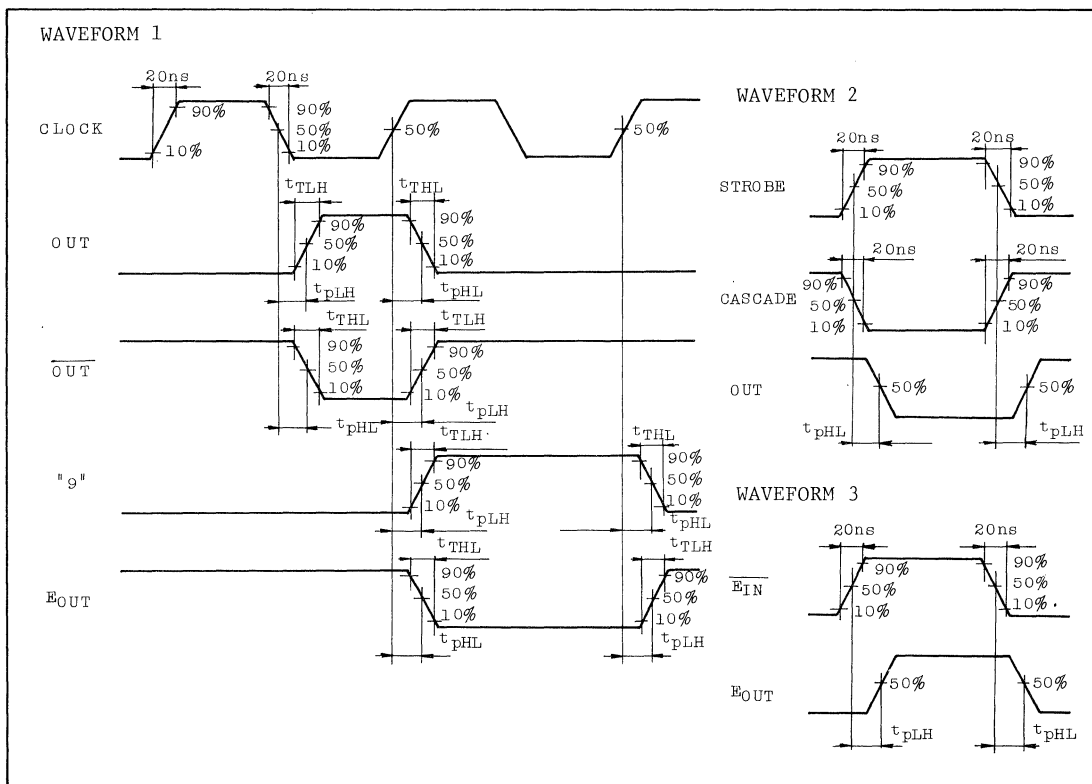
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD	MIN.	TYP.	MAX.	UNITS
			(V)				
Output Transition Time (Low to High)	t_{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t_{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (CLOCK - OUT)	t_{pLH} t_{pHL}		5	-	230	460	
			10	-	95	190	
			15	-	70	140	
Propagation Delay Time (CLOCK - $\overline{\text{OUT}}$)	t_{pLH} t_{pHL}		5	-	190	380	
			10	-	80	160	
			15	-	60	120	
Propagation Delay Time (CLOCK - E_{OUT})	t_{pLH} t_{pHL}		5	-	340	680	
			10	-	140	280	
			15	-	100	200	
Propagation Delay Time (CLOCK - "9")	t_{pLH} t_{pHL}		5	-	260	600	
			10	-	150	300	
			15	-	100	200	
Propagation Delay Time (STROBE - OUT)	t_{pLH} t_{pHL}		5	-	150	300	
			10	-	65	150	
			15	-	55	120	
Propagation Delay Time (CASCADE - OUT)	t_{pLH} t_{pHL}		5	-	95	190	
			10	-	45	90	
			15	-	30	70	
Propagation Delay Time (SET, RESET - OUT)	t_{pLH} t_{pHL}		5	-	320	660	
			10	-	130	300	
			15	-	100	220	
Propagation Delay Time ($\overline{E_{\text{IN}}}$ - E_{OUT})	t_{pLH} t_{pHL}		5	-	140	280	
			10	-	60	120	
			15	-	50	100	
Max. Clock Frequency	f_{CL}		5	1.0	2	-	MHz
			10	2.5	6	-	
			15	3.5	8	-	
Max. Clock Input Rise Time Max. Clock Input Fall Time	$t_{r\text{CL}}$ $t_{f\text{CL}}$		5	20	-	-	μs
			10	15	-	-	
			15	15	-	-	
Min. Clock Pulse Width	t_w		5	-	250	500	ns
			10	-	85	170	
			15	-	60	100	
Min. Pulse Width (SET, RESET)	t_{WH}		5	-	110	220	
			10	-	45	90	
			15	-	35	70	

DYNAMIC ELECTRICAL CHARACTERISTICS (Continued)

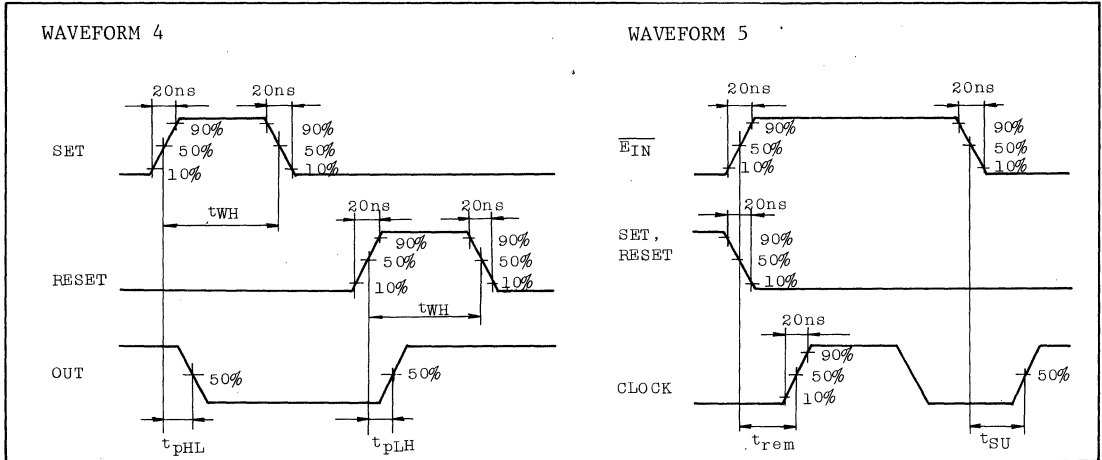
CHARACTERISTIC	SYMBOL	TEST CONDITION	$V_{CC}(V)$	MIN.	TYP.	MAX.	UNITS
Min. Set-up Time ($\overline{E_{IN}}$ - CLOCK)	t_{SU}		5	-	160	320	ns
			10	-	60	120	
			15	-	50	100	
Min. Removal Time ($\overline{E_{IN}}$ - CLOCK)	t_{rem}		5	-	120	240	
			10	-	45	130	
			15	-	25	110	
Min. Removal Time (SET - CLOCK)	t_{rem}		5	-	-50	0	
			10	-	-20	0	
			15	-	-10	0	
Min. Removal Time (RESET - CLOCK)	t_{rem}		5	-	-35	60	
			10	-	-15	40	
			15	-	-10	30	
Input Capacitance	C_{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

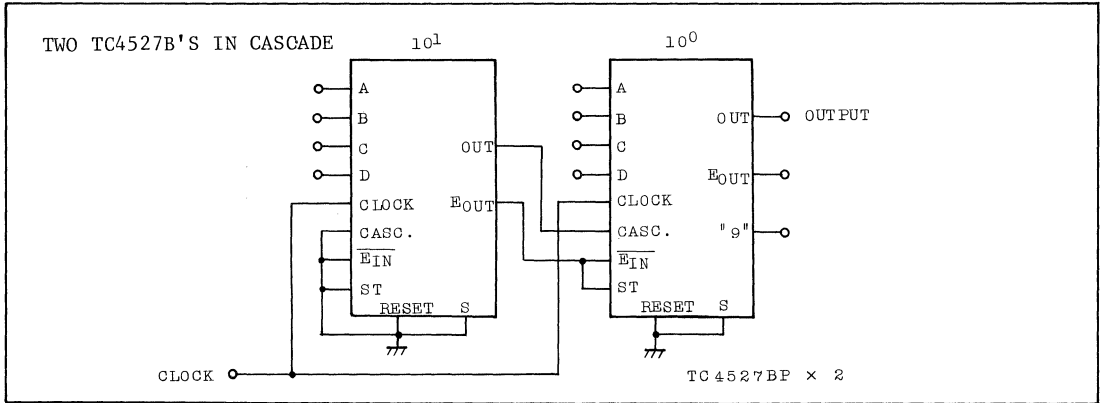


TC4527BP

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

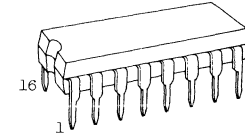


APPLICATION CIRCUIT

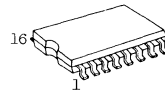


TC4528BP/TC4528BF DUAL MONOSTABLE MULTIVIBRATOR

TC4528BP/BF contains two circuits of monostable multivibrators with the capabilities of retrigger operation and reset operation in one chip. The trigger operation can be achieved either by rising edge or falling edge if one of two inputs A and B are selected. As the pulse width of mono-stable multivibrator output is determined by the time constant of external resistor (R_x) and external capacitor (C_x), wide range of output pulse width can be obtained. The asynchronous reset operation from outside can be achieved by setting CD input to "L" level, and this CD input can be also applied for inhibiting the trigger operation and for shortening the time period from turning the power on the time when TC4528B becomes able to perform the mono-stable operation.



DIP16 (3D16A-P)

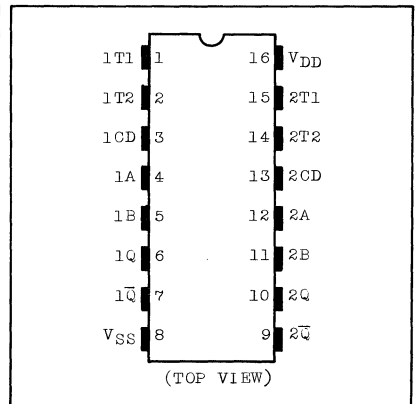


MFP16 (F16GC-P)

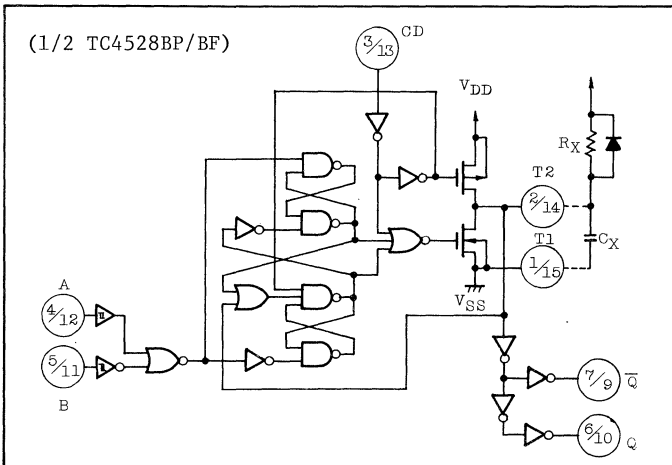
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP)/180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



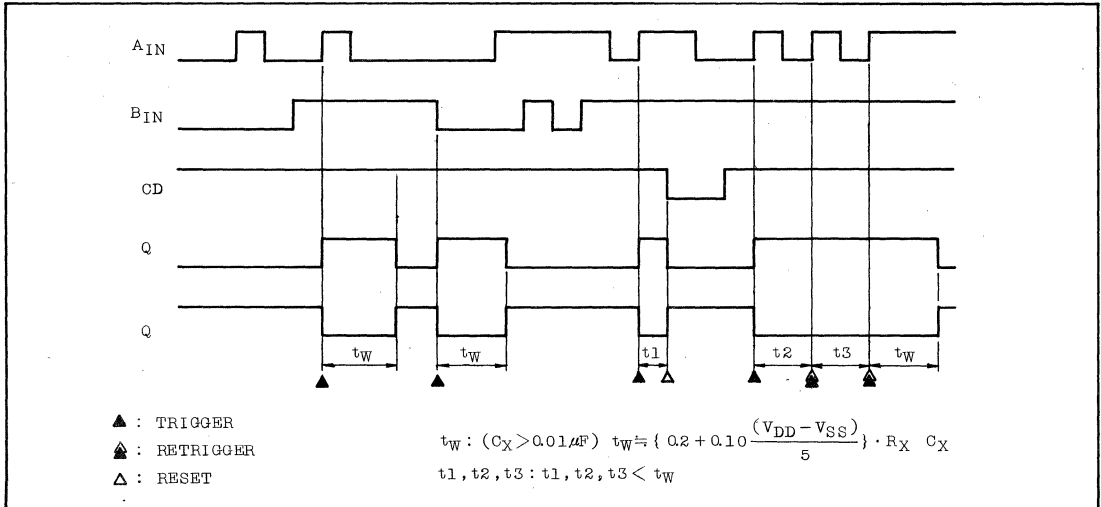
TRUTH TABLE

INPUT		CD	OUTPUT		NOTE
A	B		Q	Q-bar	
	H	H			OUTPUT PULSE
	L	H	L	H	INHIBIT
H		H	L	H	INHIBIT
L		H			OUTPUT PULSE
*	*	L	L	H	INHIBIT

* Don't Care

TC4528BP/BF

TIMING CHART



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
External Resistance	R _X	5	-	1000	kΩ
External Capacitance	C _X	No Limits			μF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			5	0.61	-	0.51	1.2	-	0.42	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	
			10	1.5	-	1.3	3.2	-	1.1	-	
			15	4.0	-	3.4	12.0	-	2.8	-	
			5	0.61	-	0.51	1.2	-	0.42	-	

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

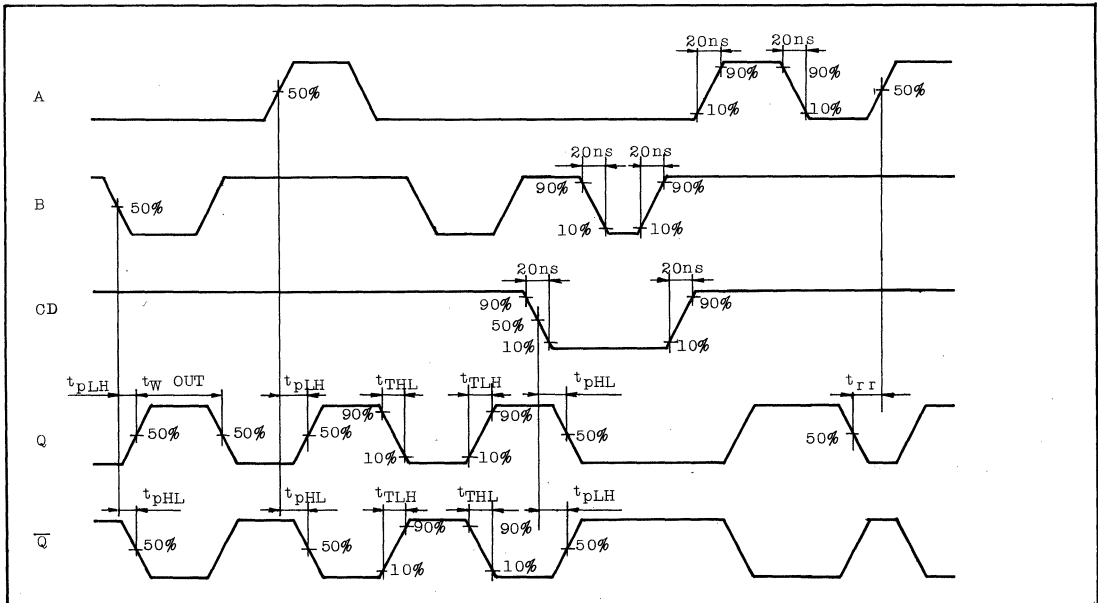
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (A, B - Q, Q̄)	t _{pLH}	R _X =5kΩ C _X =15pF	5	-	230	650	μs
			10	-	110	240	
			15	-	80	180	
	t _{pHL}	R _X =10kΩ C _X =1000pF	5	-	440	-	
			10	-	220	-	
			15	-	160	-	
t _{pHL}	R _X =10kΩ C _X =10000pF	5	-	2.2	5		
		10	-	1.1	3		
		15	-	0.9	2		
Propagation Delay Time (CD - Q, Q̄)	t _{pLH} t _{pHL}	R _X =5kΩ C _X =15pF	5	-	150	600	ns
			10	-	70	225	
			15	-	50	170	
Propagation Delay Time (CD - Q, Q̄)	t _{pLH}	R _X =10kΩ C _X =1000pF	5	-	260	-	ns
			10	-	130	-	
			15	-	100	-	
	t _{pHL}	R _X =10kΩ C _X =10000pF	5	-	700	-	
			10	-	400	-	
			15	-	320	-	

TC4528BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Continued)

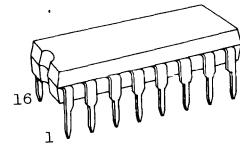
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Min. Input Pulse Width (A, B)	t _{WH} t _{WL}	R _X =5kΩ	5	-	40	150	
		C _X =15pF	10	-	20	75	
			15	-	15	55	
Min. Retrigger Time	t _{rr}	R _X =5kΩ	5	0	-	-	ns
		C _X =15pF	10	0	-	-	
		R _X =10kΩ	5	0	-	-	
		C _X =1000pF	10	0	-	-	
			15	0	-	-	
			15	0	-	-	
Output Pulse Width	t _w OUT	R _X =5kΩ	5	-	190	-	μs
		C _X =15pF	10	-	140	-	
		R _X =10kΩ	5	20	35	45	
		C _X =1000pF	10	35	45	55	
			15	40	50	60	
			15	40	50	60	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4530BP DUAL 5-INPUT MAJORITY LOGIC GATE

The TC4530BP is dual 5-input majority logic gate. Each majority logic gate decides whether or not the input at "H" level is more than that at "L" level. The polarity of decision output Z can be selected by using control input W.

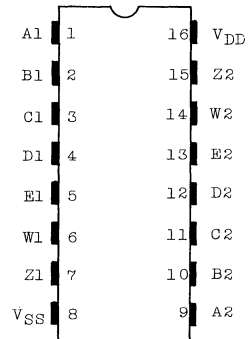


DIP16(3D16A-P)

ABSOLUTE MAXIMUM RATINGS

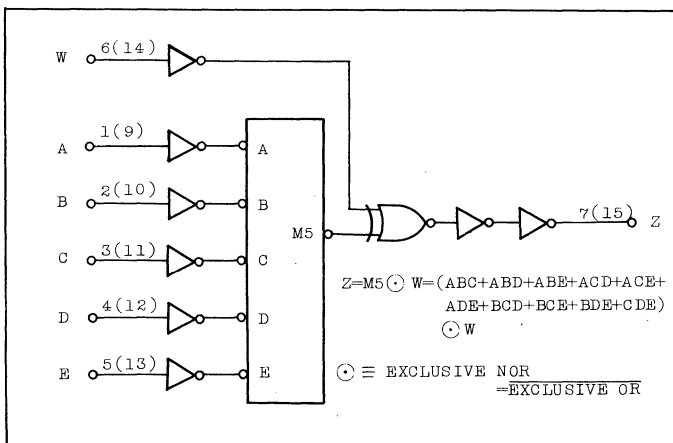
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	PD	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

INPUTS					OUTPUT	
A	B	C	D	E	W	Z
IF ANY THREE OR MORE OF A, B, C, D AND E INPUT ARE AT "L".					L	H
IF ANY THREE OR MORE OF A, B, C, D AND E INPUT ARE AT "L".					H	L
IF ANY THREE OR MORE OF A, B, C, D AND E INPUT ARE AT "L".					L	L
IF ANY THREE OR MORE OF A, B, C, D AND E INPUT ARE AT "L".					H	H

TC4530BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

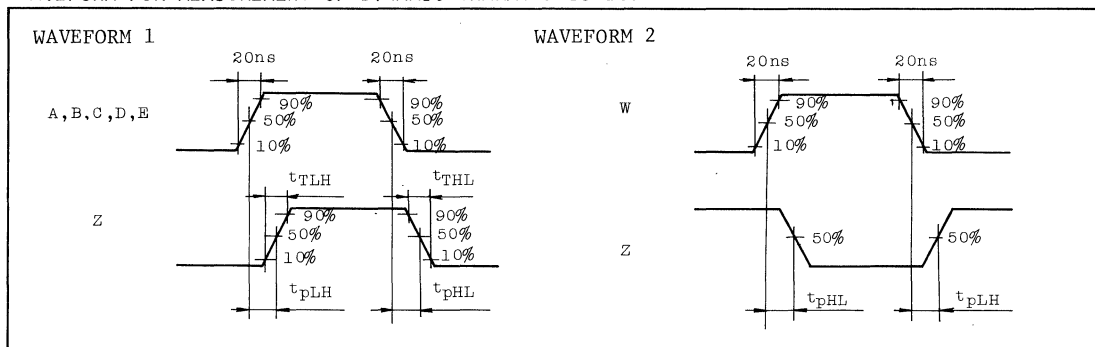
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.001	1	-	7.5	μA	
			10	-	2	-	0.001	2	-	15		
			15	-	4	-	0.002	4	-	30		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
			5 10 15				
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (D - Z)	t _{pLH}		5	-	240	960	
	t _{pHL}		15	-	100	400	
	t _{pHL}		15	-	70	300	
Propagation Delay Time (A, B, C, D, E - Z)	t _{pLH}		5	-	150	640	
	t _{pHL}		10	-	60	300	
	t _{pHL}		15	-	40	210	
Propagation Delay Time (W - Z)	t _{pLH}		5	-	100	575	
	t _{pHL}		10	-	50	265	
	t _{pHL}		15	-	40	190	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4531BP

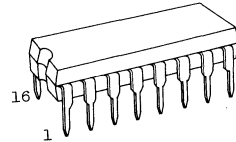
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4531BP 12-BIT PARITY TREE

TC4531BP is 12 bit parity tree consisting of 12 exclusive OR gates.

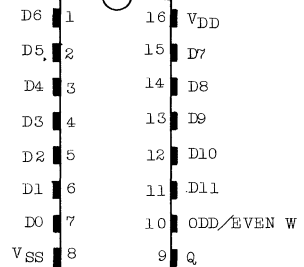
When ODD/EVEN input is set to "L", "H" level is output if the parity of data inputs (D0 through D11) is odd and when ODD/EVEN input is set to "H", "H" level is output if the parity of data inputs is even.

This has wide range of applications such as generating the parity code of n bits data and detecting parity errors.



DIP16 (3D16A-P)

PIN ASSIGNMENT

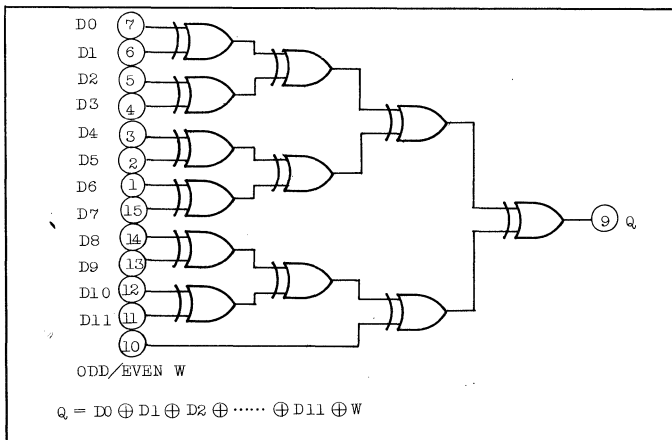


(TOP VIEW)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

LOGIC DIAGRAM



TRUTH TABLE

W	IN							* D·E	OUT Q
	D11	D10	...	D2	D1	D0			
L	L	L	...	L	L	L	0	L	
L	L	L	...	L	L	H	1	H	
L	L	L	...	L	H	L	2	H	
L	L	L	...	L	H	H	3	L	
L	L	L	...	H	L	L	4	H	
L	L	L	...	H	L	H	5	L	
L	L	L	...	H	H	L	6	L	
L	L	L	...	H	H	H	7	H	
:	:	:	⋮	:	:	:	:	:	
H	H	H	...	L	L	L	8184	L	
H	H	H	...	L	L	H	8185	H	
H	H	H	...	L	H	L	8186	H	
H	H	H	...	L	H	H	8187	L	
H	H	H	...	H	L	L	8188	H	
H	H	H	...	H	L	H	8189	L	
H	H	H	...	H	H	L	8190	L	
H	H	H	...	H	H	H	8191	H	

* D · E = DECIMAL EQUIVALENT

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	
			15	4.0	-	3.4	15.0	-	2.8	-	
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA
			10	-	10	-	0.010	10	-	300	
			15	-	20	-	0.015	20	-	600	

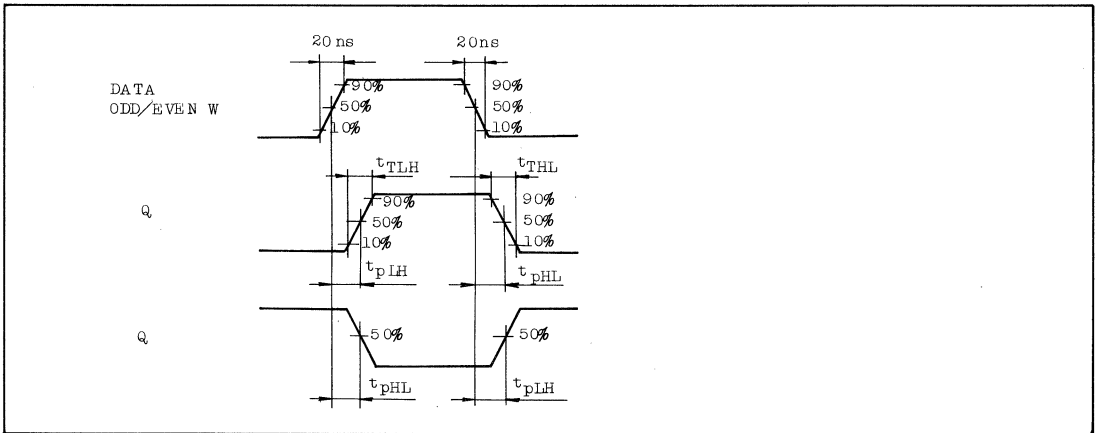
* All valid input combinations.

TC4531BP

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t_{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t_{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (DATA - Q)	t_{pLH}		5	-	320	1320	
			10	-	120	525	
	t_{pHL}		15	-	80	360	
Propagation Delay Time (ODD/EVEN W - Q)	t_{pLH}		5	-	210	750	
			10	-	80	300	
	t_{pHL}		15	-	60	210	
Input Capacitance	C_{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

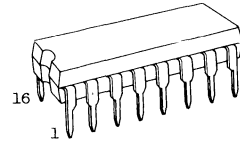


TC4532BP 8-BIT PRIORITY ENCODER

TC4532BP is eight bit encoder which detects "H" level of the highest order among eight input signals and outputs the corresponding signal position in binary code.

The inputs are eight input signals of D0 through D7 and E_{IN} , and when E_{IN} is set to "L" level, the encode operation is inhibited making all the outputs at "L" level.

The encoded output appears on three signal lines Q0 through Q2 in binary. E_{OUT} and G_S are the outputs to indicate the operational mode of encoder and used when the number of bits is to be increased by cascade connection.

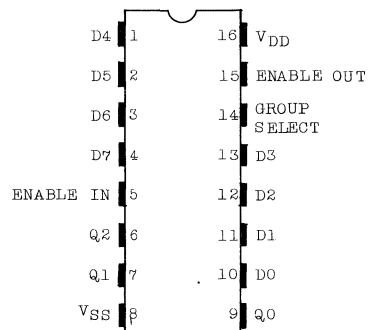


DIP16 (3D16A-P)

ABSOLUTE MAXIMUM RATINGS

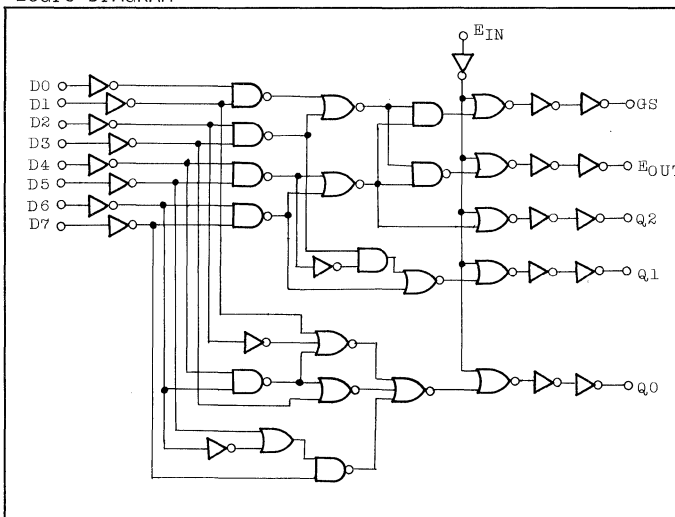
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Input Voltage	V_{IN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Output Voltage	V_{OUT}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

E_{IN}	INPUT								OUTPUT				
	D7	D6	D5	D4	D3	D2	D1	D0	G_S	Q2	Q1	Q0	E_{OUT}
L	*	*	*	*	*	*	*	*	L	L	L	L	L
H	L	L	L	L	L	L	L	L	L	L	L	L	H
H	H	*	*	*	*	*	*	*	H	H	H	H	L
H	L	H	*	*	*	*	*	*	H	H	H	L	L
H	L	L	H	*	*	*	*	*	H	H	L	L	L
H	L	L	L	H	*	*	*	*	H	H	L	L	L
H	L	L	L	L	H	*	*	*	H	L	H	H	L
H	L	L	L	L	L	H	*	*	H	L	H	L	L
H	L	L	L	L	L	L	H	*	H	L	L	H	L
H	L	L	L	L	L	L	L	H	H	L	L	L	L

* Don't Care

TC4532BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

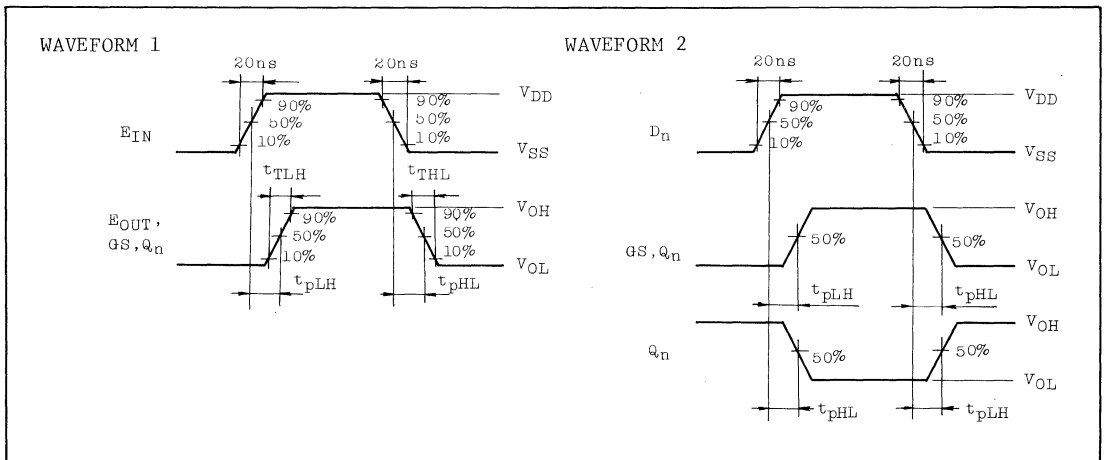
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (E _{IN} - E _{OUT})	t _{pLH} t _{pHL}		5	-	140	280	
			10	-	60	120	
			15	-	45	90	
Propagation Delay Time (E _{IN} - GS)	t _{pLH} t _{pHL}		5	-	150	300	
			10	-	65	130	
			15	-	50	100	
Propagation Delay Time (E _{IN} - Q _n)	t _{pLH} t _{pHL}		5	-	150	340	
			10	-	60	170	
			15	-	45	125	
Propagation Delay Time (D _n - Q _n)	t _{pLH} t _{pHL}		5	-	270	540	
			10	-	90	220	
			15	-	65	160	
Propagation Delay Time (D _n - GS)	t _{pLH} t _{pHL}		5	-	200	400	
			10	-	90	180	
			15	-	70	140	
Input Capacitance	C _{IN}			-	5	7.5	pF

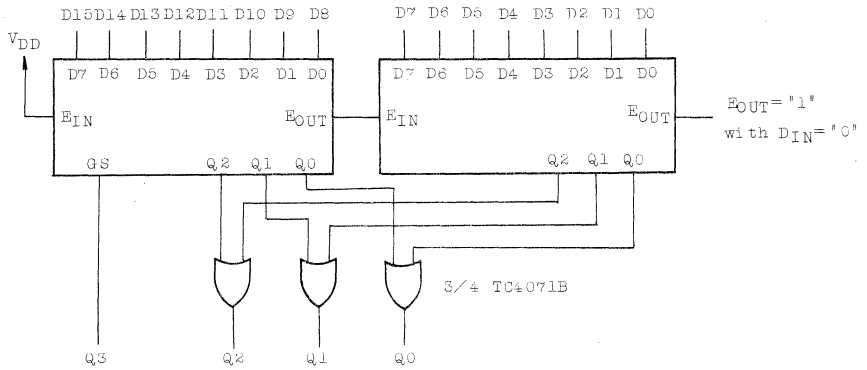
WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4532BP

APPLICATION CIRCUIT

Two TC4532B's Cascaded for 4-Bit Output



TC4538BP/TC4538BF DUAL PRECISION RETRIGGERABLE/RESETTABLE MONOSTABLE MULTIVIBRATOR

The TC4538BP/BF is the retriggerable/resettable monostable multivibrator and the trigger operation can be made at either the leading or trailing edge by 2 inputs of A and B. Since the output monostable pulse width is decided by time constant of the external resistor (R_X) and the external capacitor (C_X), it becomes possible to set a broad range of output pulse widths.

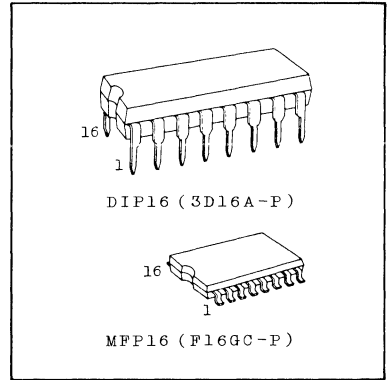
Further, since the pin connection and function are compatible with the TC4528B, the substitution is possible.

FEATURE:

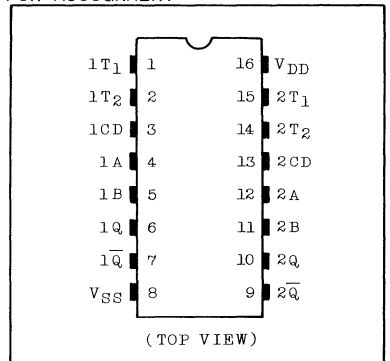
- $t_{wOUT} = 10ms \pm 5%$ (at $R_X = 100k\Omega$, $C_X = 0.1\mu F$, $V_{DD} = 10V$)

ABSOLUTE MAXIMUM RATINGS

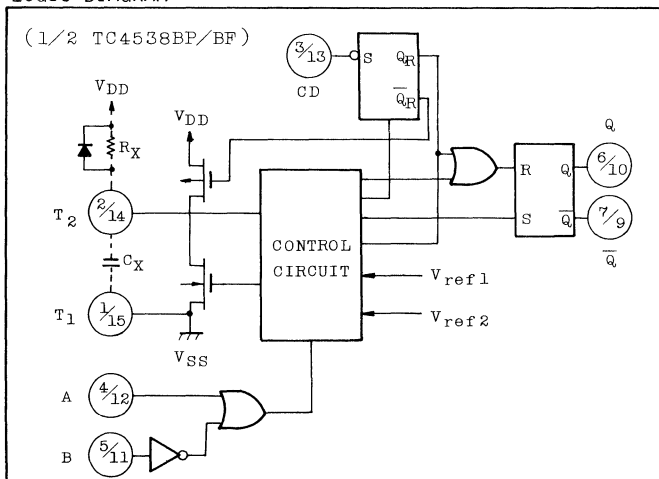
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Input Voltage	V_{IN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Output Voltage	V_{OUT}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	PD	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10sec$	



PIN ASSIGNMENT



LOGIC DIAGRAM



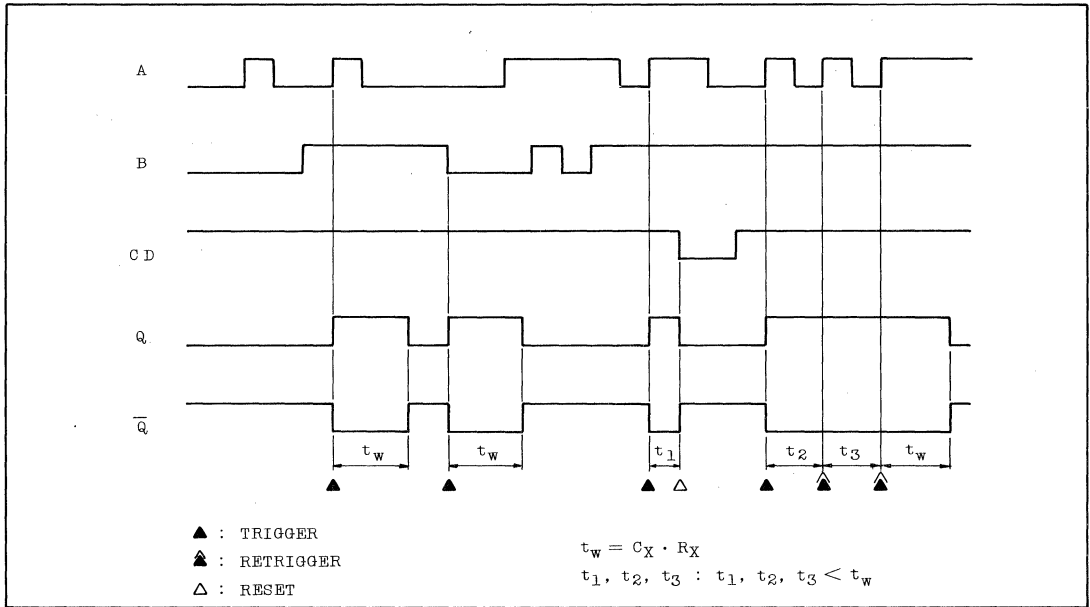
TRUTH TABLE

INPUT		OUTPUT		NOTE
A	B	Q	\bar{Q}	
	H	H		OUTPUT ENABLE
	L	H	H	INHIBIT
H		H	L	INHIBIT
L		H		OUTPUT ENABLE
*	*	L	L	INHIBIT

* Don't Care

TC4538BP/BF

TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
External Resistance	R_X	5	-	1000	k Ω
External Capacitance	C_X	No Limits			μF

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM- EOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output High Current	I _{OH}	V _{OH} =4.6V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
		V _{OH} =2.5V	5	-2.5	-	-2.1	-4.0	-	-1.7	-		
		V _{OH} =9.5V	10	-1.5	-	-1.3	-2.2	-	-1.1	-		
		V _{OH} =13.5V	15	-4.0	-	-3.4	-9.0	-	-2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

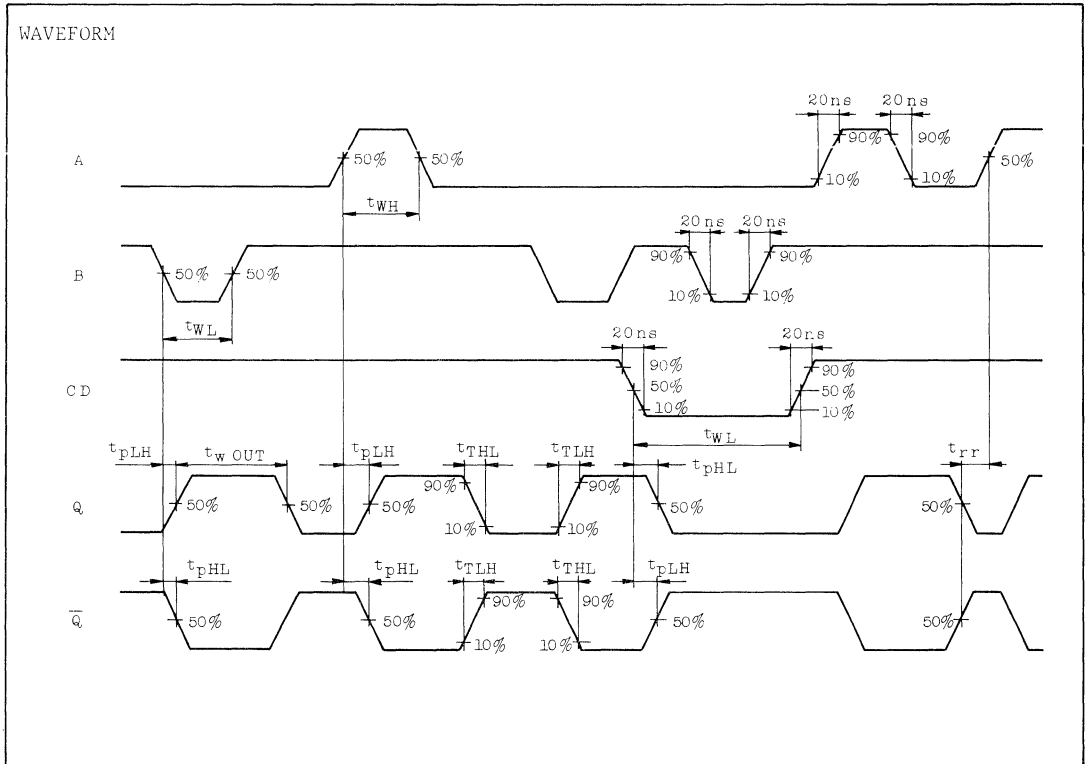
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	

TC4538BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A,B - Q,Q)	t _{pLH} t _{pHL}		5	-	380	760	ns
			10	-	150	300	
			15	-	100	220	
Propagation Delay Time (CD - Q,Q)	t _{pLH} t _{pHL}		5	-	280	560	ns
			10	-	110	250	
			15	-	75	190	
Min. Input Pulse Width (A, B)	t _{WH} t _{WL}		5	-	60	120	ns
			10	-	30	60	
			15	-	25	50	
Min. Pulse Width (CD)	t _{WL}		5	-	95	190	ns
			10	-	45	90	
			15	-	35	70	
Min. Retrigger Time	t _{rr}		5	-	0	-	ns
			10	-	0	-	
			15	-	0	-	
Output Pulse Width	t _w OUT	R _X =100kΩ C _X =0.002μF	5	-	206	-	μs
			10	-	204	-	
			15	-	205	-	
		R _X =100kΩ C _X =0.1μF	5	9.3	9.95	10.4	ms
			10	9.5	10	10.5	
			15	9.55	10.05	10.65	
		R _X =100kΩ C _X =10μF	5	-	0.98	-	s
			10	-	1.00	-	
			15	-	1.01	-	
Pulse Width Match between circuits in the same package	Δt _w OUT	$\frac{t_w(Q2) - t_w(Q1)}{t_w(Q1)} \times 100$	5	-	±1	-	%
			10	-	±1	-	
			15	-	±1	-	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4539BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

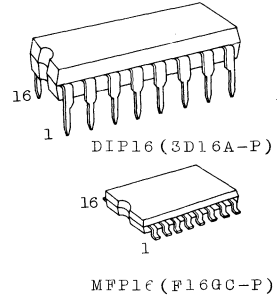
TC4539BP/TC4539BF DUAL 4-CHANNEL DATA SELECTOR/MULTIPLEXER

TC4539BP/BF contains two circuits of data selectors which select data according to common address inputs A and B.

Four channel data X0 through X3 are selected to be output Z according to inputs A and B and four channel data Y0 through Y3 are selected by the same A and B to generate output W.

When input St (ST') is set at "H", the output becomes "L" regardless other inputs.

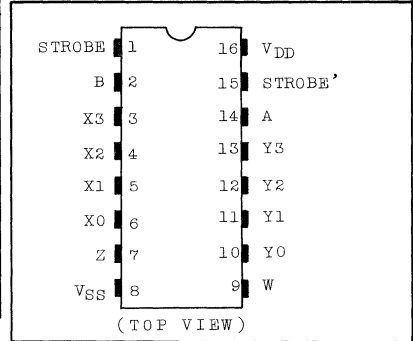
This can be widely applied in composition of signals, parallel to serial conversion and selection of signals.



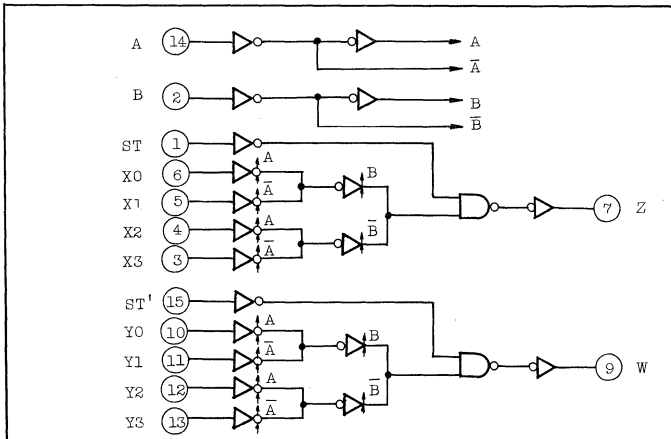
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

A	B	ST ST'	X0 Y0	X1 Y1	X2 Y2	X3 Y3	Z W
*	*	H	*	*	*	*	L
L	L	L	L	*	*	*	L
L	L	L	H	*	*	*	H
H	L	L	*	L	*	*	L
H	L	L	*	H	*	*	H
L	H	L	*	*	L	*	L
L	H	L	*	*	H	*	H
H	H	L	*	*	*	L	L
H	H	L	*	*	*	H	H

* : DON'T CARE

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
				V _{IN} =V _{SS} , V _{DD}								
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
				V _{IN} =V _{SS} , V _{DD}								
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
				|I _{OUT}| < 1μA								
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	5.5	3.0	-	3.0		
			15	-	4.0	-	8.25	4.0	-	4.0		
				|I _{OUT}| < 1μA								
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.001	5	-	150	μA	
			10	-	10	-	0.002	10	-	300		
			15	-	20	-	0.004	20	-	600		

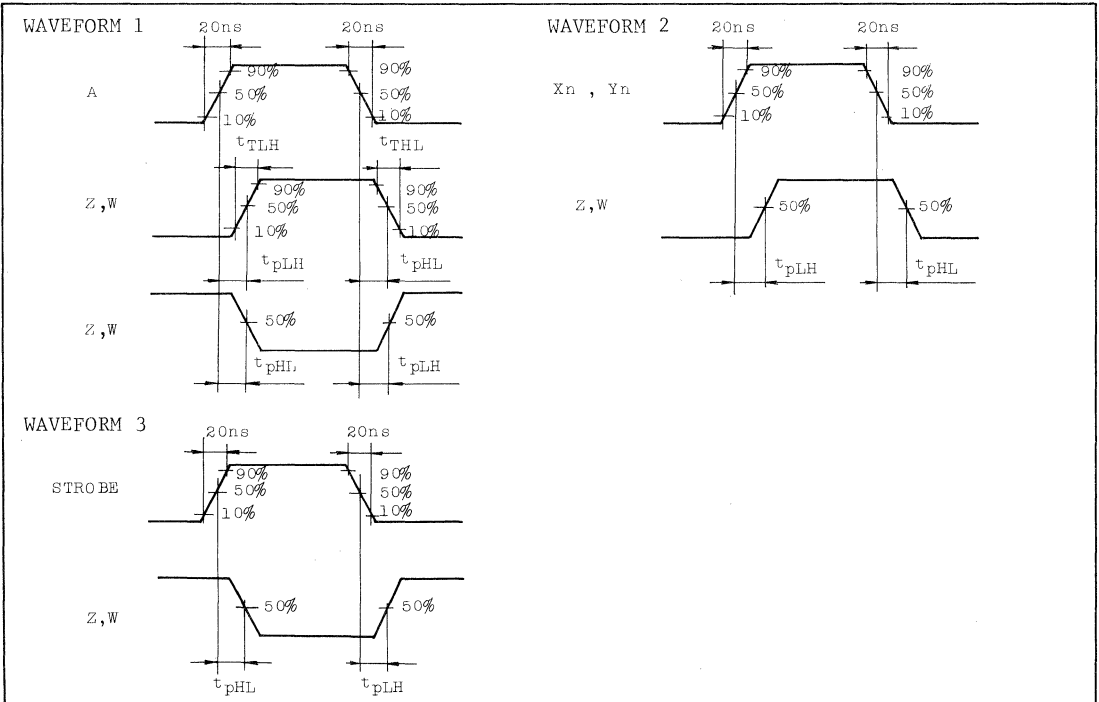
* All valid input combinations.

TC4539BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A - Z, W)	t _{pLH} t _{pHL}		5	-	150	450	
			10	-	60	220	
			15	-	40	170	
Propagation Delay Time (Xn, Yn - Z, W)	t _{pLH} t _{pHL}		5	-	130	420	
			10	-	60	180	
			15	-	40	140	
Propagation Delay Time (STROBE - Z, W)	t _{pLH} t _{pHL}		5	-	85	290	
			10	-	40	150	
			15	-	30	120	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



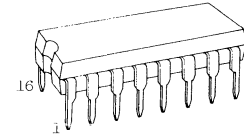
TC4543BP/TC4543BF BCD-TO-SEVEN SEGMENT LATCH/DECODER/DRIVER (For liquid Crystals)

TC4543BP/BF is 7 segment latch/decoder/driver which can directly drive field effect type liquid crystal display element (FEM type) and equipped with BLANKING input, PHASE input and LATCH DISABLE input.

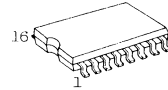
If erroneous BCD code is input, and when BI is "H", all the outputs are blanked.

When FEM type liquid crystal is driven, common pulse should be applied to the back plane of display element and the PHASE input of TC4543BP/BF.

When LED display element is to be driven, drivers should be added to the outputs.



DIP16(3D16A-P)

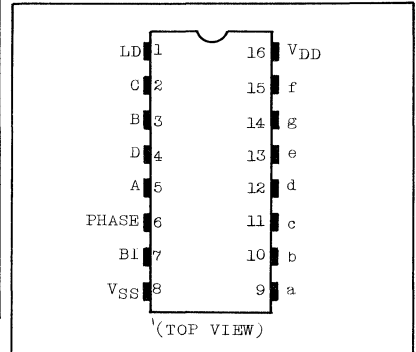


MFP16(F16GC-P)

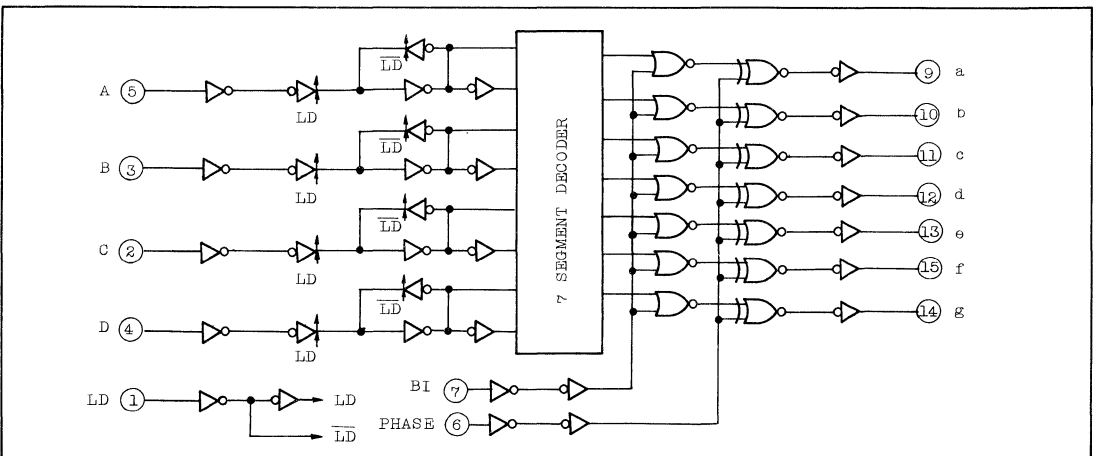
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{VSS} - 0.5 ~ V _{VSS} + 20	V
Input Voltage	V _{IN}	V _{VSS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{VSS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



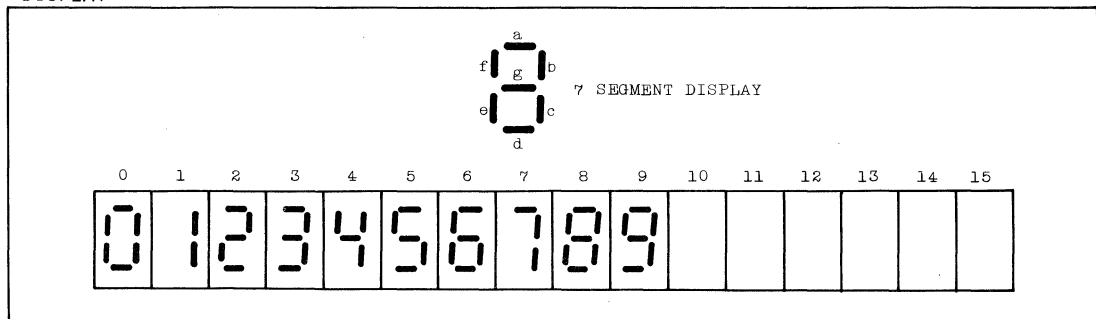
TC4543BP/BF

TRUTH TABLE

INPUTS							OUTPUTS							DISPLAY	NOTE
LD	BI	PHASE	A	B	C	D	a	b	c	d	e	f	g		
*	H	H	*	*	*	*	H	H	H	H	H	H	H	BLANK	
*	H	L	*	*	*	*	L	L	L	L	L	L	L	BLANK	
L	L	H	*	*	*	*	LATCH								
L	L	L	*	*	*	*	LATCH								
H	L	H	L	L	L	L	L	L	L	L	L	L	L	0	
H	L	H	H	L	L	L	H	L	L	L	H	H	H	1	
H	L	H	L	H	L	L	L	L	H	L	L	H	L	2	
H	L	H	H	H	L	L	L	L	L	L	H	H	L	3	
H	L	H	L	L	H	L	H	L	L	H	H	L	L	4	
H	L	H	H	L	H	L	L	H	L	L	H	L	L	5	
H	L	H	L	H	H	L	L	H	L	L	L	L	L	6	
H	L	H	H	H	L	L	L	L	L	H	H	H	H	7	
H	L	H	L	L	L	H	L	L	L	L	L	L	L	8	
H	L	H	H	L	L	H	L	L	L	L	H	L	L	9	
H	L	H	L	H	L	H	H	H	H	H	H	H	H	BLANK	
H	L	H	H	H	L	H	H	H	H	H	H	H	H	BLANK	
H	L	H	L	L	H	H	H	H	H	H	H	H	H	BLANK	
H	L	H	H	L	H	H	H	H	H	H	H	H	H	BLANK	
H	L	H	H	H	H	H	H	H	H	H	H	H	H	BLANK	
H	L	H	H	H	H	H	H	H	H	H	H	H	H	BLANK	
H	L	L	L	L	L	L	H	H	H	H	H	H	L	0	
H	L	L	H	L	L	L	L	H	H	L	L	L	L	1	
H	L	L	L	H	L	L	L	H	H	L	H	L	H	2	
H	L	L	H	H	L	L	H	H	L	H	L	L	H	3	
H	L	L	L	L	H	L	L	H	H	L	L	H	H	4	
H	L	L	H	L	H	L	H	L	H	H	L	H	H	5	
H	L	L	L	H	H	L	H	L	H	H	H	H	H	6	
H	L	L	H	H	H	L	H	H	H	L	L	L	L	7	
H	L	L	L	L	L	H	H	H	H	H	H	H	H	8	
H	L	L	L	L	L	H	H	H	H	H	H	H	H	9	
H	L	L	L	H	L	H	L	L	L	L	L	L	L	BLANK	
H	L	L	H	H	L	H	L	L	L	L	L	L	L	BLANK	
H	L	L	L	L	H	H	L	L	L	L	L	L	L	BLANK	
H	L	L	L	H	H	H	L	L	L	L	L	L	L	BLANK	
H	L	L	L	H	H	H	L	L	L	L	L	L	L	BLANK	

* : DON'T CARE

DISPLAY



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
			5	0.61	-	0.51	1.2	-	0.42	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.2	-	0.42	-	mA	
			10	1.5	-	1.3	3.2	-	1.1	-		
			15	4.0	-	3.4	12.0	-	2.8	-		
			5	3.5	-	3.5	2.75	-	3.5	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			5	-	0.1	-	10 ⁻⁵	0.1	-	1.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"H" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

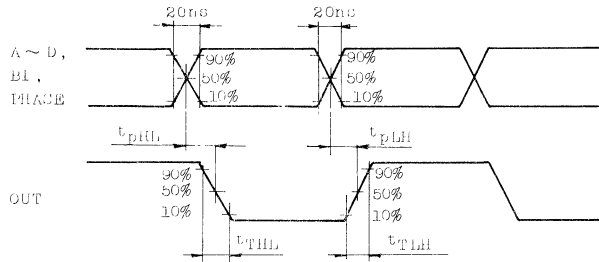
TC4543BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

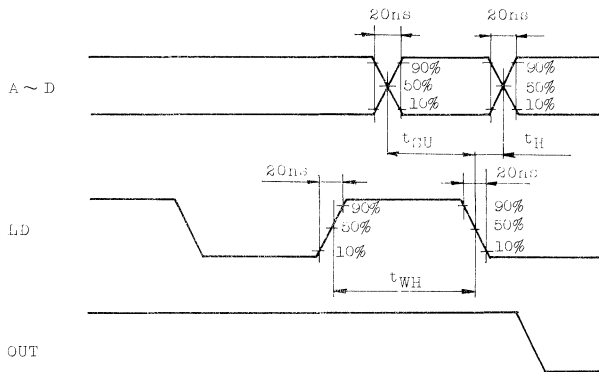
CHARACTERISTICS	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	70	200	ns
			10	-	35	100	
			15	-	30	80	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	35	100	
			15	-	30	80	
Propagation Delay Time (A ~ D - OUT)	t _{pLH} t _{pHL}		5	-	280	1000	
			10	-	140	400	
			15	-	100	300	
Propagation Delay Time (BI - OUT)	t _{pLH} t _{pHL}		5	-	140	500	
			10	-	70	200	
			15	-	55	150	
Propagation Delay Time (LD - OUT)	t _{pLH} t _{pHL}		5	-	300	1000	
			10	-	140	400	
			15	-	100	300	
Propagation Delay Time (PHASE - OUT)	t _{pLH} t _{pHL}		5	-	170	550	
			10	-	85	220	
			15	-	65	180	
Min. Pulse Width (LD)	t _{WH}		5	-	30	250	
			10	-	25	100	
			15	-	20	80	
Min. Set-up Time (LD - A ~ D)	t _{SU}		5	-	20	60	
			10	-	10	20	
			15	-	5	10	
Min. Hold Time (LD - A ~ D)	t _H		5	-	0	25	
			10	-	0	20	
			15	-	0	20	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

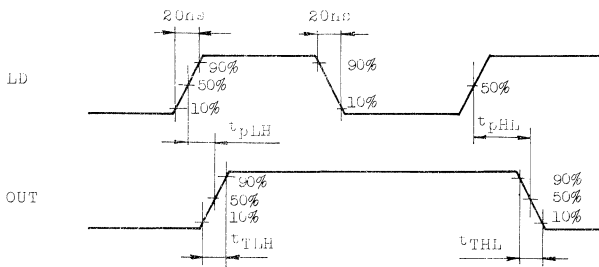
WAVEFORM 1



WAVEFORM 2



WAVEFORM 3



TC4555BP, TC4556BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

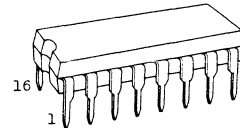
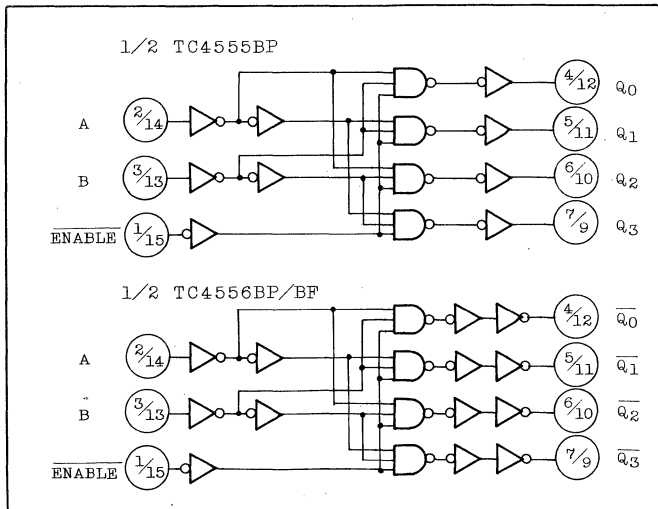
TC4555BP DUAL BINARY TO 1-OF-4 DECODER/DEMULTIPLEXER (Active High Outputs)
TC4556BP/TC4556BF DUAL BINARY TO 1-OF-4 DECODER/DEMULTIPLEXER (Active Low Outputs)

TC4555BP and TC4556BP/BF contain two circuits of decoders/multiplexers.
When $\overline{\text{ENABLE}} = \text{"L"}$, arbitrary one of four outputs is selected by two binary inputs A and B.
The selected output is "H" for TC4555BP and "L" for TC4556BP/BF.
When $\overline{\text{ENABLE}}$ is set to "H", the selection is inhibited making all the output at "L" for TC4555BP and "H" for TC4556BP/BF.

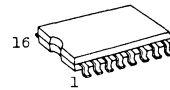
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	PD	300(DIP)/180(MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM



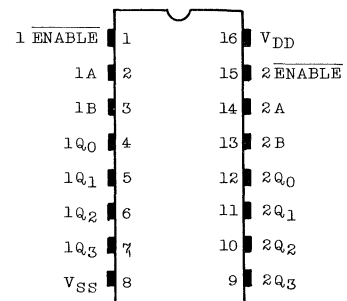
DIP16 (3D16A-P)



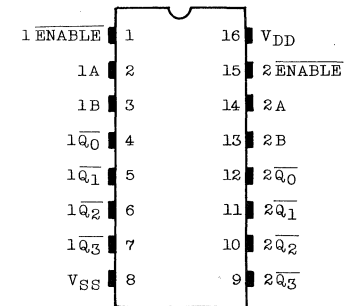
MFP16 (F16GC-P)

PIN ASSIGNMENT

TC4555BP



TC4556BP/BF



(TOP VIEW)

TRUTH TABLE

INPUTS			OUTPUTS TC4555BP				OUTPUTS TC4556BP/BF				*: Don't Care
\bar{E}	B	A	Q3	Q2	Q1	Q0	\bar{Q}_3	\bar{Q}_2	\bar{Q}_1	\bar{Q}_0	
L	L	L	L	L	L	H	H	H	H	L	
L	L	H	L	L	H	\bar{L}	H	H	\bar{L}	H	
L	H	L	L	H	L	L	H	L	H	H	
L	H	H	H	L	L	L	L	H	H	H	
H	*	*	L	L	L	L	H	H	H	H	

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I_{OH}	$V_{IN}=V_{SS}, V_{DD}$	$V_{OH}=4.6V$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			$V_{OH}=2.5V$	5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			$V_{OH}=9.5V$	10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			$V_{OH}=13.5V$	15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I_{OL}	$V_{IN}=V_{SS}, V_{DD}$	$V_{OL}=0.4V$	5	0.61	-	0.51	1.5	-	0.42	-	mA
			$V_{OL}=0.5V$	10	1.5	-	1.3	3.8	-	1.1	-	
			$V_{OL}=1.5V$	15	4.0	-	3.4	15.0	-	2.8	-	
Input High Voltage	V_{IH}$	|I_{OUT}| < 1\mu A$	$V_{OUT}=0.5V, 4.5V$	5	3.5	-	3.5	2.75	-	3.5	-	V
			$V_{OUT}=1.0V, 9.0V$	10	7.0	-	7.0	5.5	-	7.0	-	
			$V_{OUT}=1.5V, 13.5V$	15	11.0	-	11.0	8.25	-	11.0	-	

TC4555BP, TC4556BP/BF

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

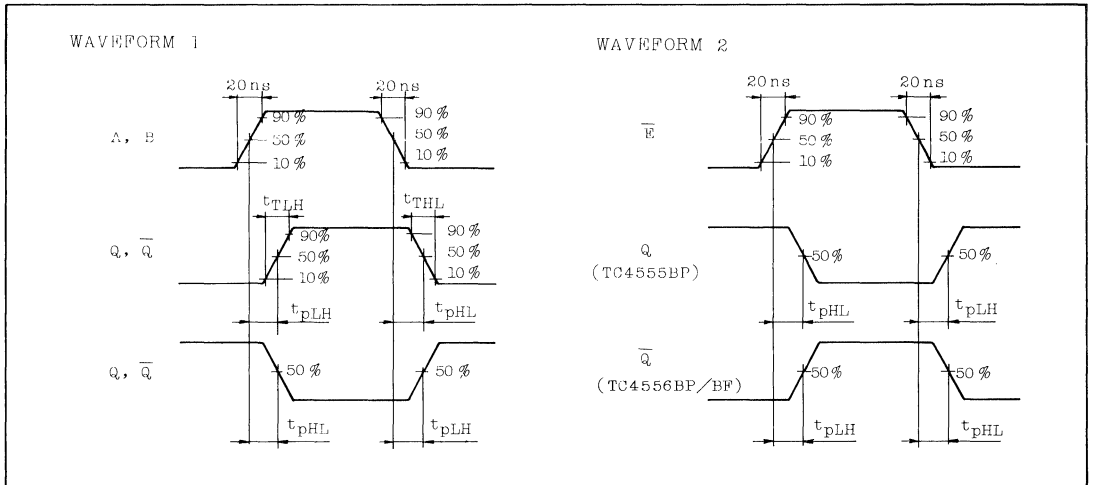
CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0	
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0	
		|I _{OUT}| < 1μA									
Input Current	"H" Level	I _{IH} V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL} V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	4.0	-	0.002	4.0	-	30	μA
			10	-	8.0	-	0.004	8.0	-	60	
			15	-	16.0	-	0.008	16.0	-	120	

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A, B - Q, Q̄)	t _{pLH} t _{pHL}		5	-	140	440	ns
			10	-	65	190	
			15	-	50	140	
Propagation Delay Time (E - Q, Q̄)	t _{pLH} t _{pHL}		5	-	110	400	ns
			10	-	45	170	
			15	-	40	130	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

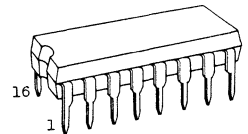


TC4560BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4560BP NBCD ADDER

TC4560BP is NBCD (natural BCD) adder which adds two binary coded decimal numbers (BCD code). The sum of BCD inputs applied to four data input lines (A₁ through A₄) and another set of four data input lines (B₁ through B₄) and carry input C_{IN} from the lower order digit is output to S₁ through S₄ in the same BCD code. When the sum is 10 or larger, "H" level is output to carry output C_{OUT}. When the sum is smaller than 10, C_{OUT} is kept at "L" level. By connecting with TC4561BP (9's complementer), the add/subtract circuit can be easily obtained.

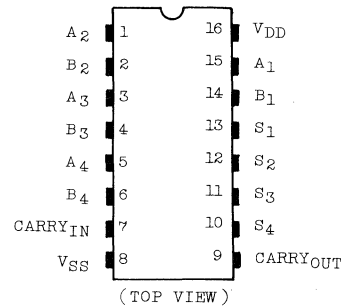


DIP 16 (3D16A-P)

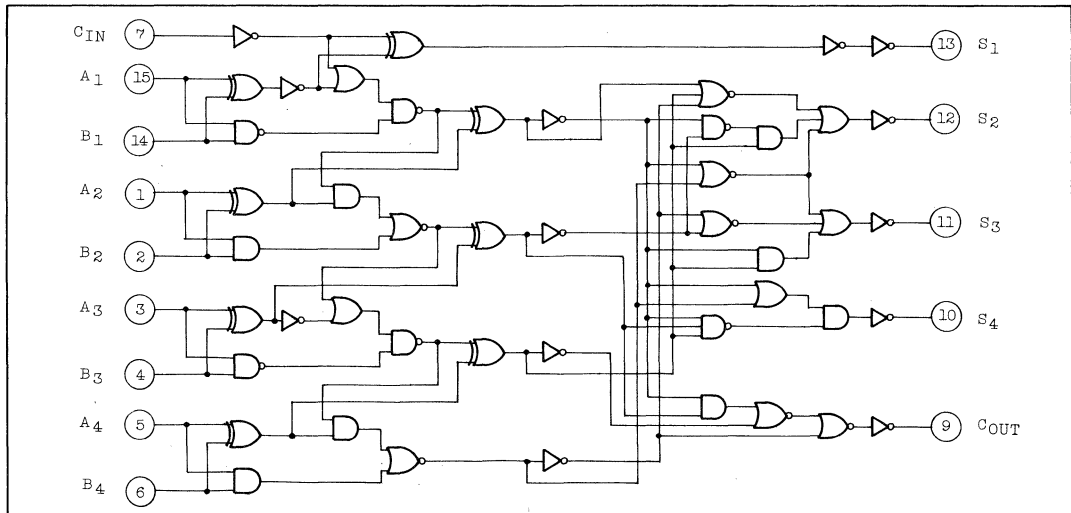
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40~85	°C
Storage Temperature Range	T _{stg}	-65~150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

INPUTS									OUTPUTS				
A ₄	A ₃	A ₂	A ₁	B ₄	B ₃	B ₂	B ₁	C _{IN}	S ₄	S ₃	S ₂	S ₁	C _{OUT}
L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	L	L	L	L	H	L	L	L	H	L
L	H	L	H	L	L	H	L	L	L	H	H	H	L
L	H	L	L	L	L	H	H	H	H	L	L	L	L
L	H	H	L	L	H	L	H	L	L	L	L	H	H
L	L	H	H	H	L	L	L	H	L	L	H	L	H
H	L	L	H	L	H	L	L	L	L	L	H	H	H
L	H	L	H	H	L	L	L	H	L	H	L	L	H
H	L	L	H	H	L	L	H	H	H	L	L	H	H

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
			5	0.61	-	0.51	1.5	-	0.42	-	
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	
			5	0.61	-	0.51	1.5	-	0.42	-	

TC4560BP

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

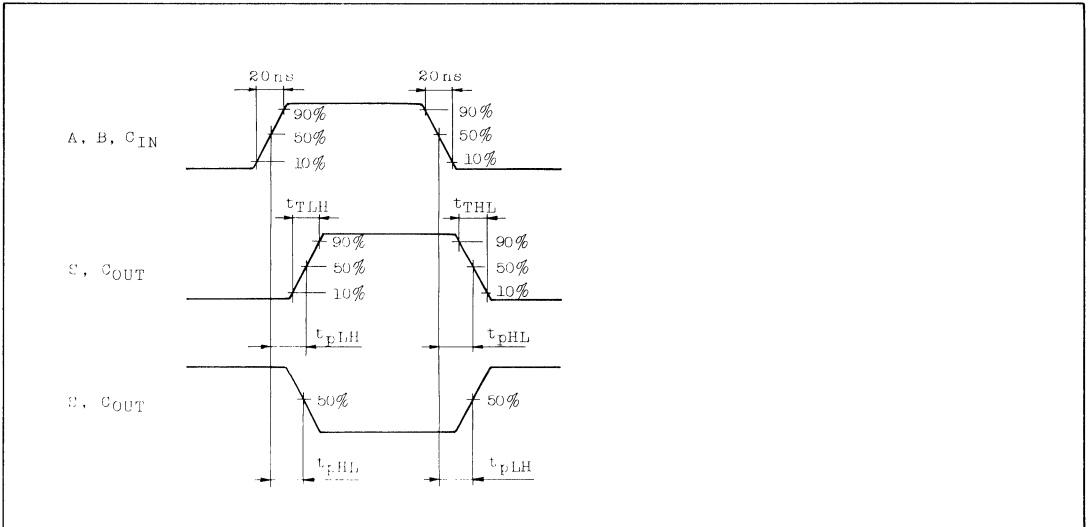
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A, B - S)	t _{pLH} t _{pHL}		5	-	660	2100	ns
			10	-	250	900	
			15	-	170	675	
Propagation Delay Time (A, B - C _{OUT})	t _{pLH} t _{pHL}		5	-	500	1800	ns
			10	-	190	600	
			15	-	130	450	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VGS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time (C _{IN} - C _{OUT})	t _{pLH}		5	-	430	1500	ns
	t _{pHL}		10	-	160	600	
			15	-	110	450	
Propagation Delay Time (C _{IN} - S)	t _{pLH}		5	-	550	1800	
	t _{pHL}		10	-	230	600	
			15	-	160	450	
Input Capacitance	C _{IN}			-	5	7.5	pF

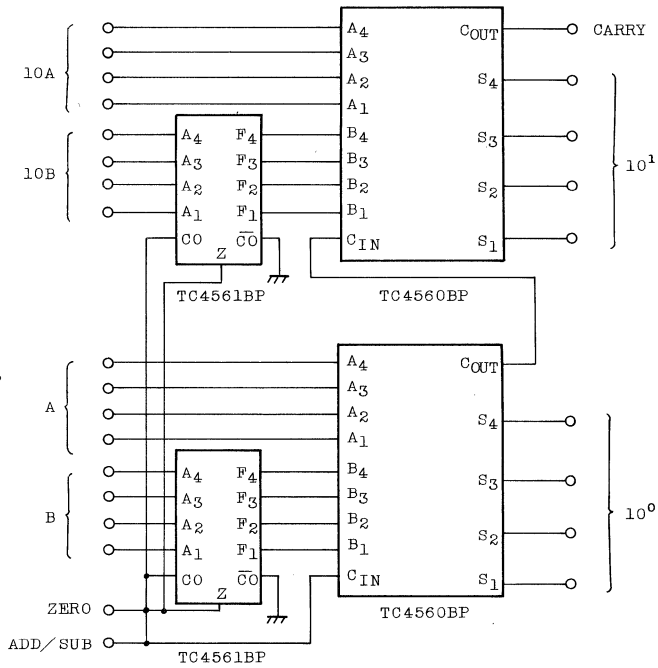
WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4560BP

APPLICATION CIRCUIT

• PARALLEL ADD/SUBTRACT CIRCUIT



FUNCTION TABLE

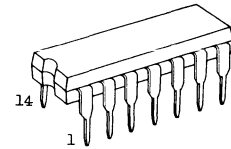
ZERO	ADD/SUB	RESULT
L	L	A + B
L	H	A - B
H	*	A

TC4561BP 9's COMPLEMENTER

TC4561BP is 9's complementer which generates 9's complement of BCD signal.

Keeping Z input at "L", if COMP="H" and $\overline{\text{COMP}}=\text{"L"}$, 9's complement of input BCD code (A1 through A4) is obtained at outputs F1 through F4. (When the input code is 2, the output will be 7.) If COMP input="L" or COMP input="H", the output becomes equal to the input.

If Z="H", outputs F1 through F4 become "L" regardless of other inputs. By connecting with TC4560B, the add/subtract circuit can be easily obtained.

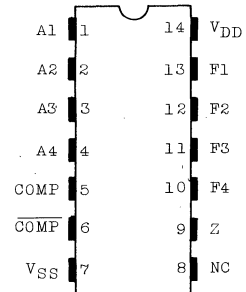


DIP14 (3D14A-P)

ABSOLUTE MAXIMUM RATINGS

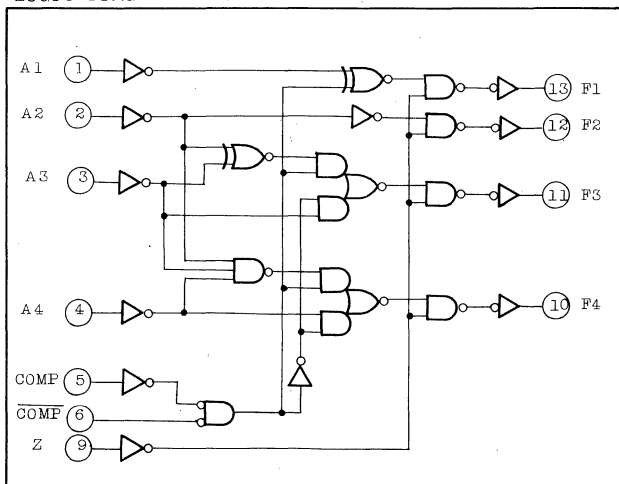
CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



(TOP VIEW)

LOGIC DIAGRAM



TRUTH TABLE

Z	COM	$\overline{\text{COM}}$	F1	F2	F3	F4	MODE
L	L	*					F _n =A _n
L	*	H	A1	A2	A3	A4	F _n =A _n
L	H	L	$\overline{\text{A1}}$	$\overline{\text{A2}}$	$\overline{\text{A2}} \oplus \overline{\text{A3}}$	$\overline{\text{A2}} \cdot \overline{\text{A3}} \cdot \overline{\text{A4}}$	COMP
H	*	*	L	L	L	L	ZERO

$$\begin{aligned} \text{A2} \oplus \overline{\text{A3}} &\equiv \text{A2} \text{ (EXCLUSIVE - OR) } \overline{\text{A3}} \\ &\equiv \text{A2} \cdot \overline{\text{A3}} + \overline{\text{A2}} \cdot \text{A3} \end{aligned}$$

TC4561BP

TRUTH TABLE (COMPLEMENT MODE: Z, $\overline{\text{COMP}}=\text{"L"}$, $\text{COM}=\text{"H"}$)

DECIMAL INPUT CODE	ILLEGAL BCD INPUT CODE	INPUTS				DECIMAL OUTPUT CODE	OUTPUTS			
		A4	A3	A2	A1		F4	F3	F2	F1
0		L	L	L	L	9	H	L	L	H
1		L	L	L	H	8	H	L	L	L
2		L	L	H	L	7	L	H	H	H
3		L	L	H	H	6	L	H	H	L
4		L	H	L	L	5	L	H	L	H
5		L	H	L	H	4	L	H	L	L
6		L	H	H	L	3	L	L	H	H
7		L	H	H	H	2	L	L	H	L
8		H	L	L	L	1	L	L	L	H
9		H	L	L	H	0	L	L	L	L
	10	H	L	H	L	7	L	H	H	H
	11	H	L	H	H	6	L	H	H	L
	12	H	H	L	L	5	L	H	L	H
	13	H	H	L	H	4	L	H	L	L
	14	H	H	H	L	3	L	L	H	H
	15	H	H	H	H	2	L	L	H	L

* DON'T CARE

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-40°C		25°C			85°C		UNITS
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I_{OH}	$V_{OH}=4.6V$ $V_{OH}=2.5V$ $V_{OH}=9.5V$ $V_{OH}=13.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I_{OL}	$V_{OL}=0.4V$ $V_{OL}=0.5V$ $V_{OL}=1.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	0.61	-	0.51	1.5	-	0.42	-	mA
			10	1.5	-	1.3	3.8	-	1.1	-	
			15	4.0	-	3.4	15.0	-	2.8	-	

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	4.0	-	0.002	4.0	-	30	μA	
			10	-	8.0	-	0.004	8.0	-	60		
			15	-	16.0	-	0.008	16.0	-	120		

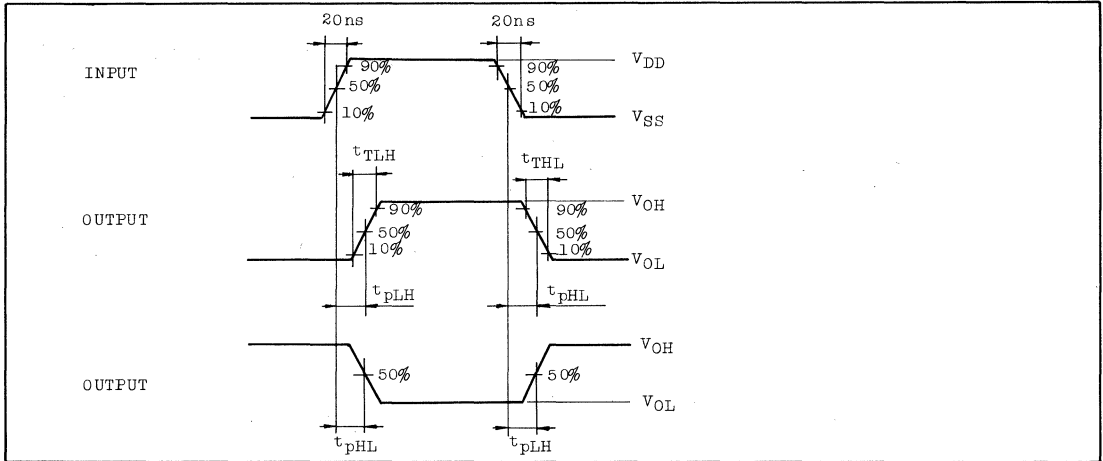
* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A - F)	t _{pLH} t _{pHL}		5	-	220	1000	ns
			10	-	80	400	
			15	-	55	300	
Propagation Delay Time (COMP, COMP - F)	t _{pLH} t _{pHL}		5	-	230	1000	ns
			10	-	85	400	
			15	-	60	300	
Propagation Delay Time (Z - F)	t _{pLH} t _{pHL}		5	-	140	1000	ns
			10	-	50	400	
			15	-	40	300	
Input Capacitance	C _{IN}			-	5	7.5	pF

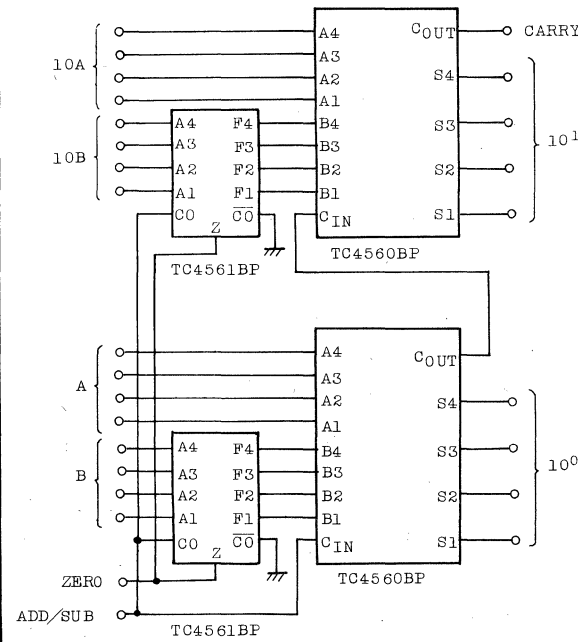
TC4561BP

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



APPLICATION CIRCUIT

• Parallel Add/Subtract Circuit



FUNCTION TABLE

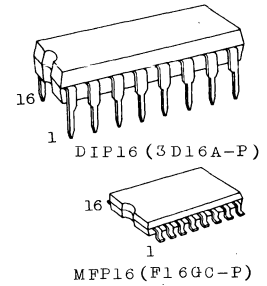
ZERO	ADD/SUB	RESULT
L	L	A + B
L	H	A - B
H	*	A

TC4572BP/TC4572BF HEX GATE

(4 INVERTERS Plus 2-Input NOR Gate Plus 2-Input NAND Gate)

TC4572BP/BF is a multiple gate that contains 4-circuit inverters, 1 circuit 2-input NOR GATE, and 1 circuit 2-input NAND GATE in one package.

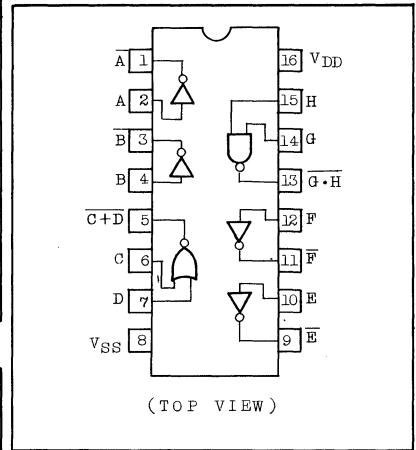
Since each gate is of "B" type equipped with a buffer consisting of 2-stage inverters, it has high noise immunity.



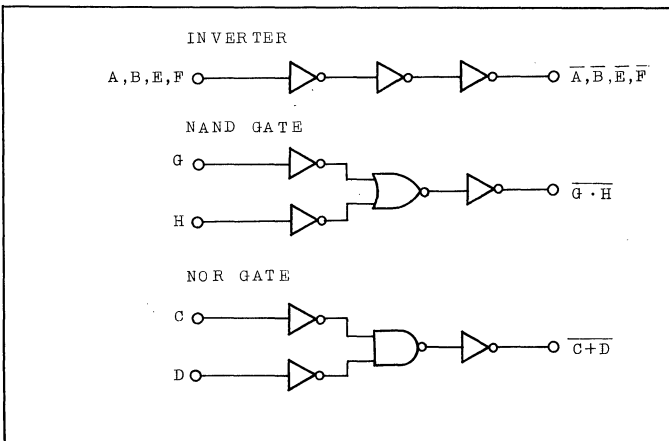
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300 (DIP) / 180 (MFP)	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC4572BP/BF

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

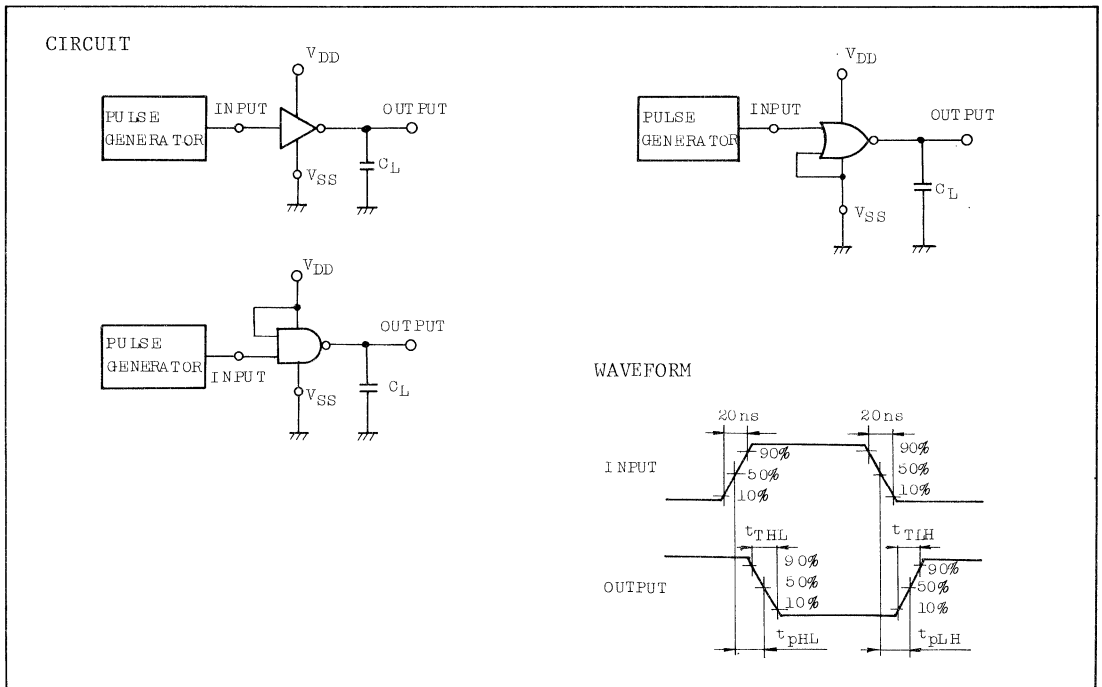
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	0.25	-	0.001	0.25	-	3.8	μA	
			10	-	0.5	-	0.001	0.5	-	7.5		
			15	-	1.0	-	0.002	1.0	-	15		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
			5				
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (INVERTER)	t _{pLH}		5	-	90	200	
			10	-	40	110	
	t _{pHL}		15	-	30	85	
Propagation Delay Time (NAND)	t _{pLH}		5	-	95	200	
			10	-	45	110	
	t _{pHL}		15	-	35	85	
Propagation Delay Time (NOR)	t _{pLH}		5	-	95	200	
			10	-	45	110	
	t _{pHL}		15	-	35	85	
Input Capacitance	C _{IN}			-	5	7.5	pF

CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4583BP

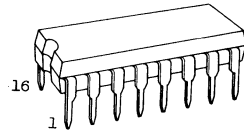
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4583BP DUAL SCHMITT TRIGGER

TC4583BP consists of two independent Schmitt trigger circuits.

By externally connecting resistors between POSITIVE terminal and COMMON terminal and between NEGATIVE terminal and COMMON terminal, hysteresis can be given to two inputs A_{IN} and B_{IN}. Furthermore, the width of hysteresis and the threshold voltage between high level and low level can be varied by varying the resistors. The outputs are available in the forms of positive outputs and inverted three-state outputs from both circuits. Exclusive-OR of both inputs is also output.

This is most suitable for line receivers.

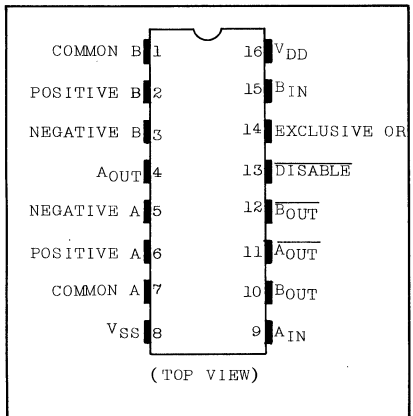


DIP 16 (3D16A-P)

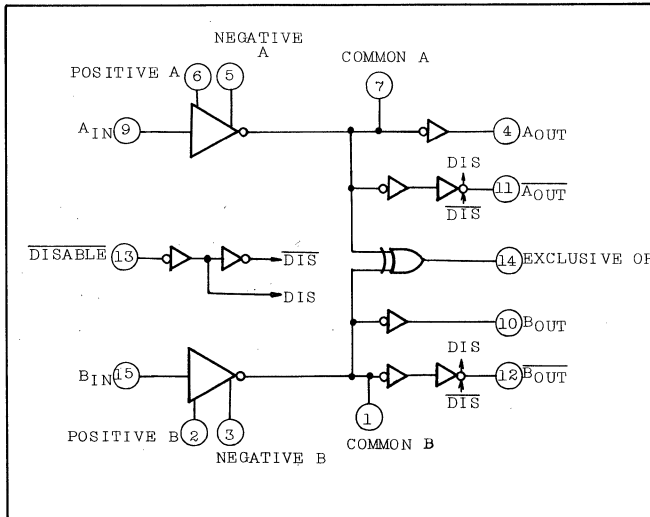
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNITS
DC Supply Voltage	V _{DD}	V _{SS} - 0.5 ~ V _{SS} + 20	V
Input Voltage	V _{IN}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
Output Voltage	V _{OUT}	V _{SS} - 0.5 ~ V _{DD} + 0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C • 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM

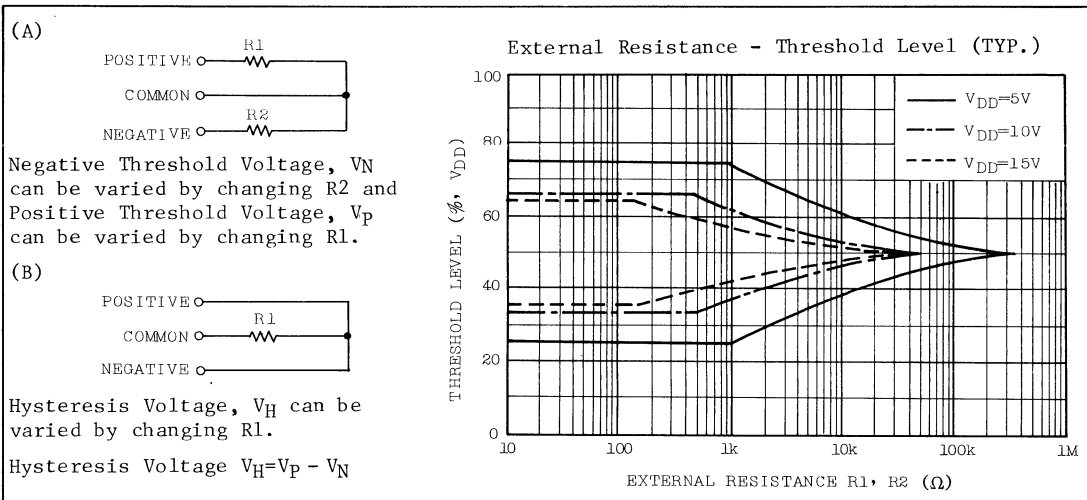


TRUTH TABLE

INPUTS			OUTPUTS				
A	B	DISABLE	A _{OUT}	A _{OUT}	B _{OUT}	B _{OUT}	EX.OR
L	L	L	L	HZ	L	HZ	L
L	L	H	L	H	L	H	L
L	H	L	L	HZ	H	HZ	H
L	H	H	L	H	H	L	H
H	L	L	H	HZ	L	HZ	H
H	L	H	H	L	L	H	H
H	H	L	H	HZ	H	HZ	L
H	H	H	H	L	H	L	L

HZ: HIGH IMPEDANCE

EXTERNAL RESISTER CONNECTION



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
External Resistance	R_1, R_2	No Limits			Ω

STATIC ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I_{OH}	$V_{IN} = V_{SS}, V_{DD}$	$V_{OH} = 4.6V$	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			$V_{OH} = 2.5V$	5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			$V_{OH} = 9.5V$	10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			$V_{OH} = 13.5V$	15	-4.0	-	-3.4	-9.0	-	-2.8	-	
Output Low Current	I_{OL}	$V_{IN} = V_{SS}, V_{DD}$	$V_{OL} = 0.4V$	5	0.61	-	0.51	1.5	-	0.42	-	mA
			$V_{OL} = 0.5V$	10	1.5	-	1.3	3.8	-	1.1	-	
			$V_{OL} = 1.5V$	15	4.0	-	3.4	15.0	-	2.8	-	
			$V_{OL} = 1.5V$	15	4.0	-	3.4	15.0	-	2.8	-	

TC4583BP

STATIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
			|I _{OUT}| < 1μA									
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	5.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
			|I _{OUT}| < 1μA									
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.4	-	10 ⁻⁴	0.4	-	7.5	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.4	-	-10 ⁻⁴	-0.4	-	-7.5	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.002	1	-	3.8	μA	
			10	-	2	-	0.004	2	-	9.5		
			15	-	4	-	0.008	4	-	15		

* All valid input combinations.

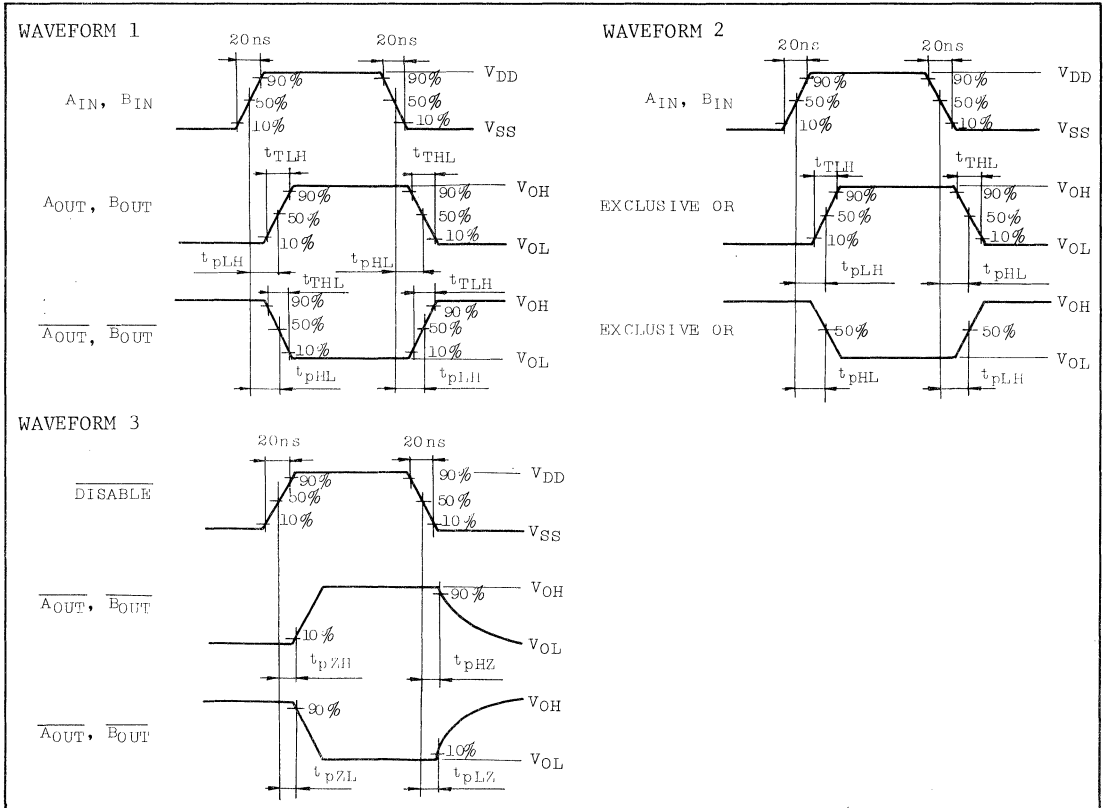
DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (A _{IN} , B _{IN} - A _{OUT} , B _{OUT})	t _{pLH} t _{pHL}		5	-	200	1300	ns
			10	-	80	460	
			15	-	60	300	
Propagation Delay Time (A _{IN} , B _{IN} - $\overline{A_{OUT}}$, $\overline{B_{OUT}}$)	t _{pLH} t _{pHL}		5	-	200	2200	ns
			10	-	80	760	
			15	-	60	520	
Propagation Delay Time (A _{IN} , B _{IN} - EX, OR)	t _{pLH} t _{pHL}		5	-	210	1500	ns
			10	-	80	560	
			15	-	60	340	
3-State Disable Time ($\overline{DISABLE}$ - $\overline{A_{OUT}}$, $\overline{B_{OUT}}$)	t _{pLZ} , t _{pHZ} t _{pZL} , t _{pZH}	R _L =1kΩ	5	-	110	450	ns
			10	-	50	180	
			15	-	35	110	

DYNAMIC ELECTRICAL CHARACTERISTICS (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
Positive Threshold Voltage	V _P	R1, R2=5kΩ	5	-	3.2	-	V
			10	-	5.55	-	
			15	-	8.0	-	
Negative Threshold Voltage	V _N	R1, R2=5kΩ	5	-	1.8	-	V
			10	-	4.45	-	
			15	-	7.0	-	
Hysteresis Voltage	V _H	R1, R2=5kΩ	5	0.5	1.4	3.0	V
			10	0.3	1.1	1.9	
			15	0.2	1.0	1.8	
Threshold Voltage Variation (A - B)	ΔV _T	R1, R2=5kΩ	5	-	0.1	-	V
			10	-	0.15	-	
			15	-	0.2	-	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4584BP/BF

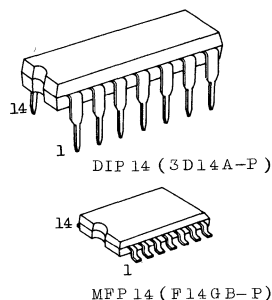
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC4584BP/TC4584BF HEX SCHMITT TRIGGER

The TC4584BP/BF is the 6-circuit inverter having the Schmitt trigger function at the input terminal.

That is, since the circuit threshold level voltages at the leading and trailing edges of input waveform are different (V_P , V_N), the TC4584BP/BF can be used in the broad range application including line receiver, waveform shaping circuit, astable multivibrator, monostable multivibrator, etc. in addition to ordinary inverter.

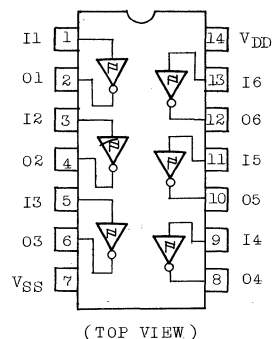
Since the pins are compatible with the TC4069UB, the substitution is also possible.



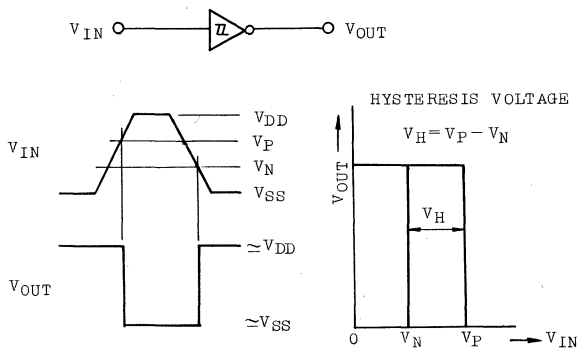
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Input Voltage	V_{IN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Output Voltage	V_{OUT}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	PD	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



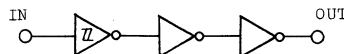
INPUT/OUTPUT VOLTAGE CHARACTERISTIC



* INPUT - OUTPUT VOLTAGE WAVEFORM

* TRANSFER CHARACTERISTICS

LOGIC DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA	
			5	-2.5	-	-2.1	-4.0	-	-1.7	-		
			10	-1.5	-	-1.3	-2.2	-	-1.1	-		
			15	-4.0	-	-3.4	-9.0	-	-2.8	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	0.61	-	0.51	1.5	-	0.42	-	mA	
			10	1.5	-	1.3	3.8	-	1.1	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
			15	4.0	-	3.4	15.0	-	2.8	-		
Positive Trigger Threshold Voltage	V _P	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V	5	2.05	3.75	2.15	3.0	3.75	2.15	3.85	V	
			10	4.8	7.6	4.9	6.4	7.6	4.9	7.7		
			15	7.8	11.6	7.9	9.9	11.6	7.9	11.7		
Negative Trigger Threshold Voltage	V _N	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V	5	1.25	2.95	1.25	2.3	2.85	1.15	2.85	V	
			10	2.4	5.2	2.4	3.8	5.1	2.3	5.1		
			15	3.4	7.2	3.4	5.2	7.1	3.3	7.1		
Hysteresis Voltage	V _H		5	0.10	1.25	0.25	0.65	1.25	0.25	1.40	V	
			10	1.8	3.5	1.9	2.6	3.5	1.9	3.6		
			15	3.7	5.6	3.8	4.7	5.6	3.8	5.7		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1	-	0.001	1	-	7.5	μA	
			10	-	2	-	0.002	2	-	15		
			15	-	4	-	0.004	4	-	30		

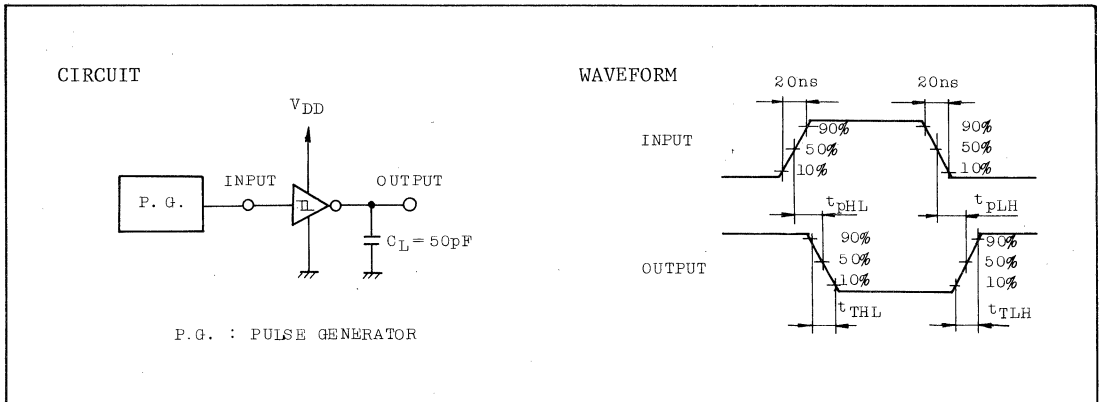
* All valid input combinations.

TC4584BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD(V)	MIN.	TYP.	MAX.	UNITS
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time	t _{pLH}		5	-	170	340	
	t _{pHL}		10	-	80	160	
			15	-	60	120	
Input Capacitance	C _{IN}			-	5	7.5	pF

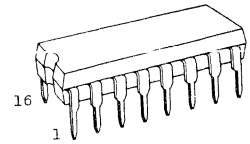
CIRCUIT AND WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC4585BP 4-BIT MAGNITUDE COMPARATOR

TC4585BP is weighted comparator which compares the magnitudes of input data of four bits A₀ through A₃ and another input data of four bits B₀ through B₃. If TC4585BP is used, signal of larger, smaller or equal is obtained at one of three output lines depending on the cascade inputs (A>B)_{IN}, (A=B)_{IN} and (A<B)_{IN}.

It is easy to fabricate the magnitude comparators of 4 × n bits with cascade connection of n number of TC4585BP.

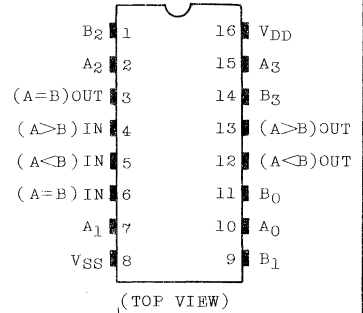


DIP 16 (3D16A-P)

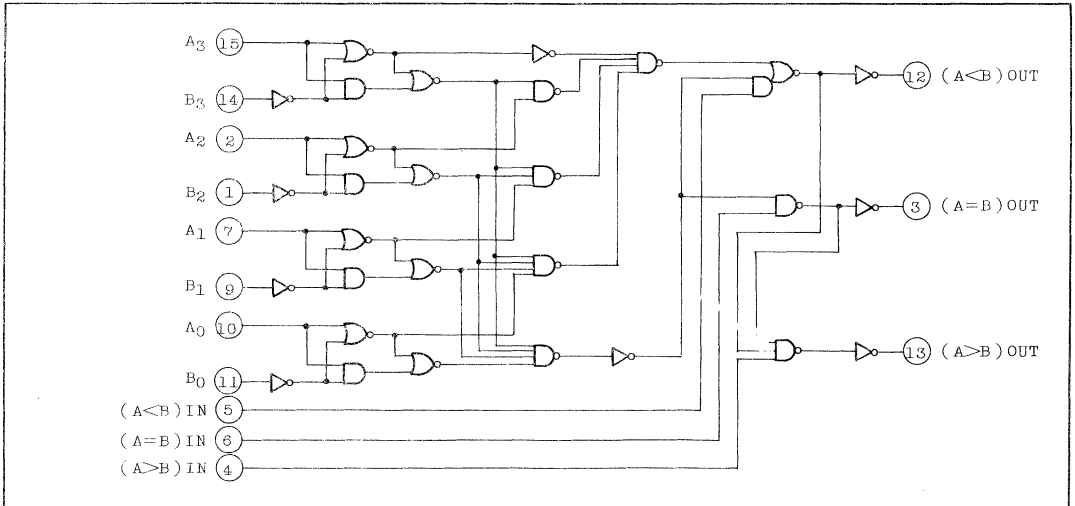
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _A	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC4585BP

TRUTH TABLE

INPUTS							OUTPUTS			* Don't care
COMPARING				CASCADING						
A3, B3	A2, B2	A1, B1	A0, B0	A < B	A = B	A > B	A < B	A = B	A > B	
A3 > B3	*	*	*	*	*	H	L	L	H	
A3 = B3	A2 > B2	*	*	*	*	H	L	L	H	
A3 = B3	A2 = B2	A1 > B1	*	*	*	H	L	L	H	
A3 = B3	A2 = B2	A1 = B1	A0 > B0	*	*	H	L	L	H	
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H	L	L	H	
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	*	L	H	L	
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	*	H	L	L	
A3 = B3	A2 = B2	A1 = B1	A0 < B0	*	*	*	H	L	L	
A3 = B3	A2 = B2	A1 < B1	*	*	*	*	H	L	L	
A3 = B3	A2 < B2	*	*	*	*	*	H	L	L	
A3 < B3	*	*	*	*	*	*	H	L	L	

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
			5	-2.5	-	-2.1	-4.0	-	-1.7	-	
			10	-1.5	-	-1.3	-2.2	-	-1.1	-	
			15	-4.0	-	-3.4	-9.0	-	-2.8	-	

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output Low Current	I _{OL}	V _{OL} =0.4V	5	0.61	-	0.51	1.5	-	0.42	-	mA	
		V _{OL} =0.5V	10	1.5	-	1.3	3.8	-	1.1	-		
		V _{OL} =1.5V	15	4.0	-	3.4	15.0	-	2.8	-		
		V _{IN} =V _{SS} , V _{DD}										
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V	5	3.5	-	3.5	2.75	-	3.5	-	V	
		V _{OUT} =1.0V, 9.0V	10	7.0	-	7.0	5.5	-	7.0	-		
		V _{OUT} =1.5V, 13.5V	15	11.0	-	11.0	8.25	-	11.0	-		
		|I _{OUT}| < 1μA										
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V	5	-	1.5	-	2.25	1.5	-	1.5	V	
		V _{OUT} =1.0V, 9.0V	10	-	3.0	-	4.5	3.0	-	3.0		
		V _{OUT} =1.5V, 13.5V	15	-	4.0	-	6.75	4.0	-	4.0		
		|I _{OUT}| < 1μA										
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.1	-	10 ⁻⁵	-0.1	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.1	-	-10 ⁻⁵	-0.1	-	-1.0	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	5	-	0.005	5	-	150	μA	
			10	-	10	-	0.010	10	-	300		
			15	-	20	-	0.015	20	-	600		

* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

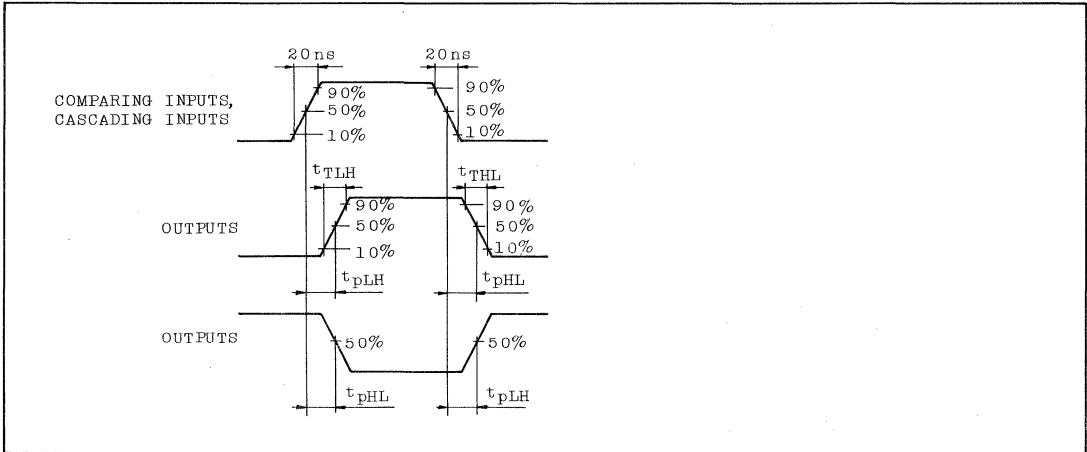
CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Output Transition Time (High to Low)	t _{THL}		5	-	80	200	ns
			10	-	50	100	
			15	-	40	80	
Propagation Delay Time (COMPARING INPUTS - OUTPUTS)	t _{pLH} t _{pHL}		5	-	340	680	ns
			10	-	140	280	
			15	-	100	200	

TC4585BP

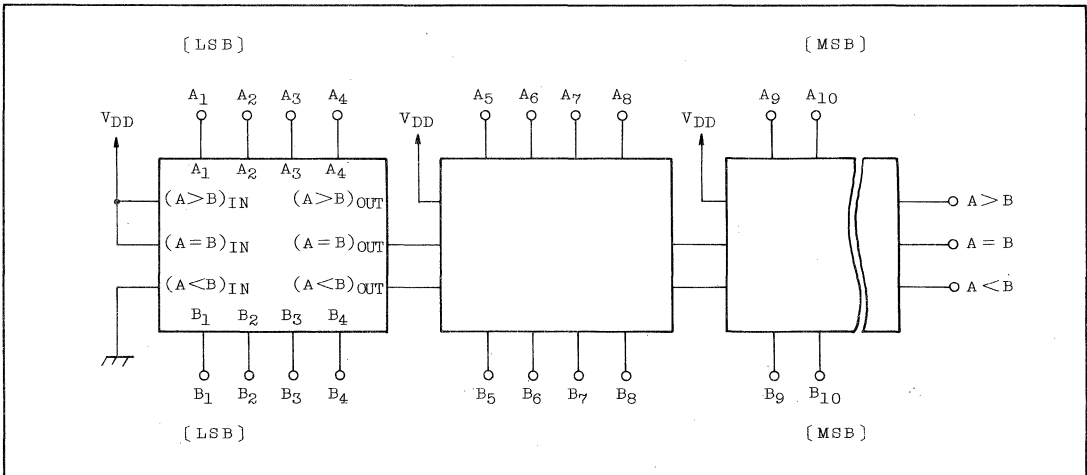
DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD (V)	MIN.	TYP.	MAX.	UNIT
			5				
Propagation Delay Time (CASCADING INPUTS - OUTPUTS)	t _{pLH}		5	-	280	560	ns
	t _{pHL}		10	-	110	220	
			15	-	90	180	
Input Capacitance	C _{IN}			-	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

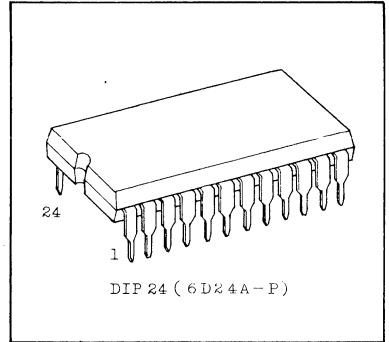


APPLICATION CIRCUIT



TC5001P 4-DIGIT DECADE COUNTER

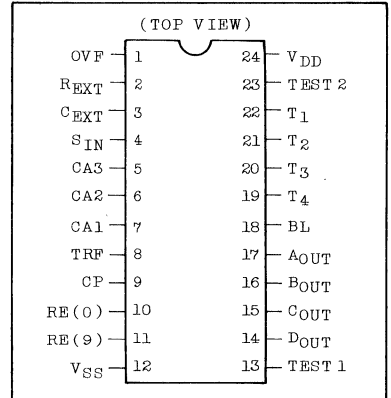
TC5001P is four digit decimal counter containing latches and multiplexer circuits and equipped with the terminals of digit signal outputs for dynamic display, blanking input (for zero suppress operation) and transfer input (latch operation) and transfer input (latch operation). The maximum count of this counter is 9999 and three CARRY terminals are provided for carry operations required in some applications. Refer to TRUTH TABLE, TIMING CHART and OPERATING CONSIDERATION for the operations.



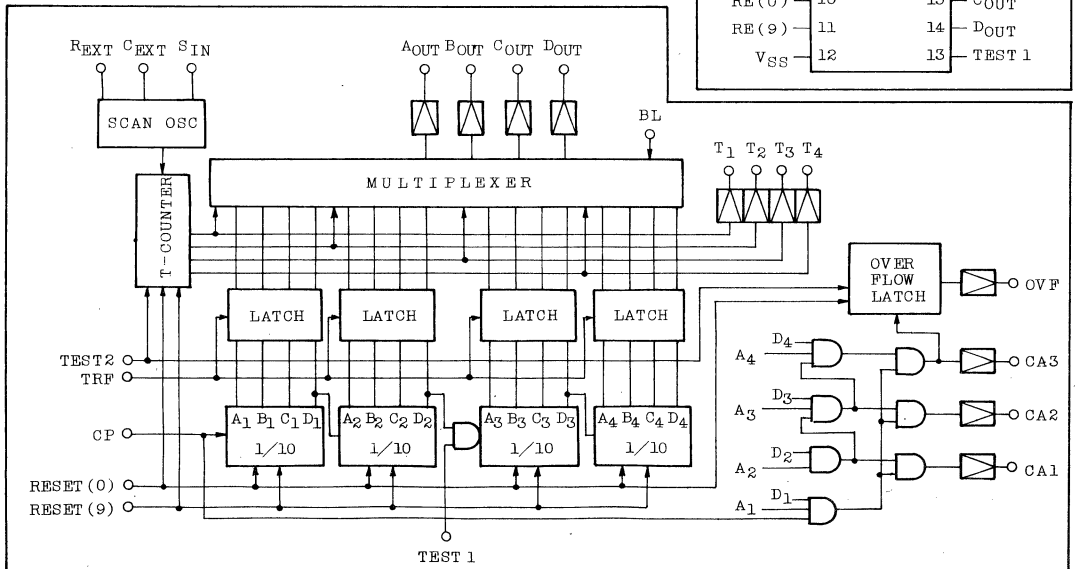
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-55~125	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



BLOCK DIAGRAM



TC5001P

DESCRIPTION OF PIN FUNCTION

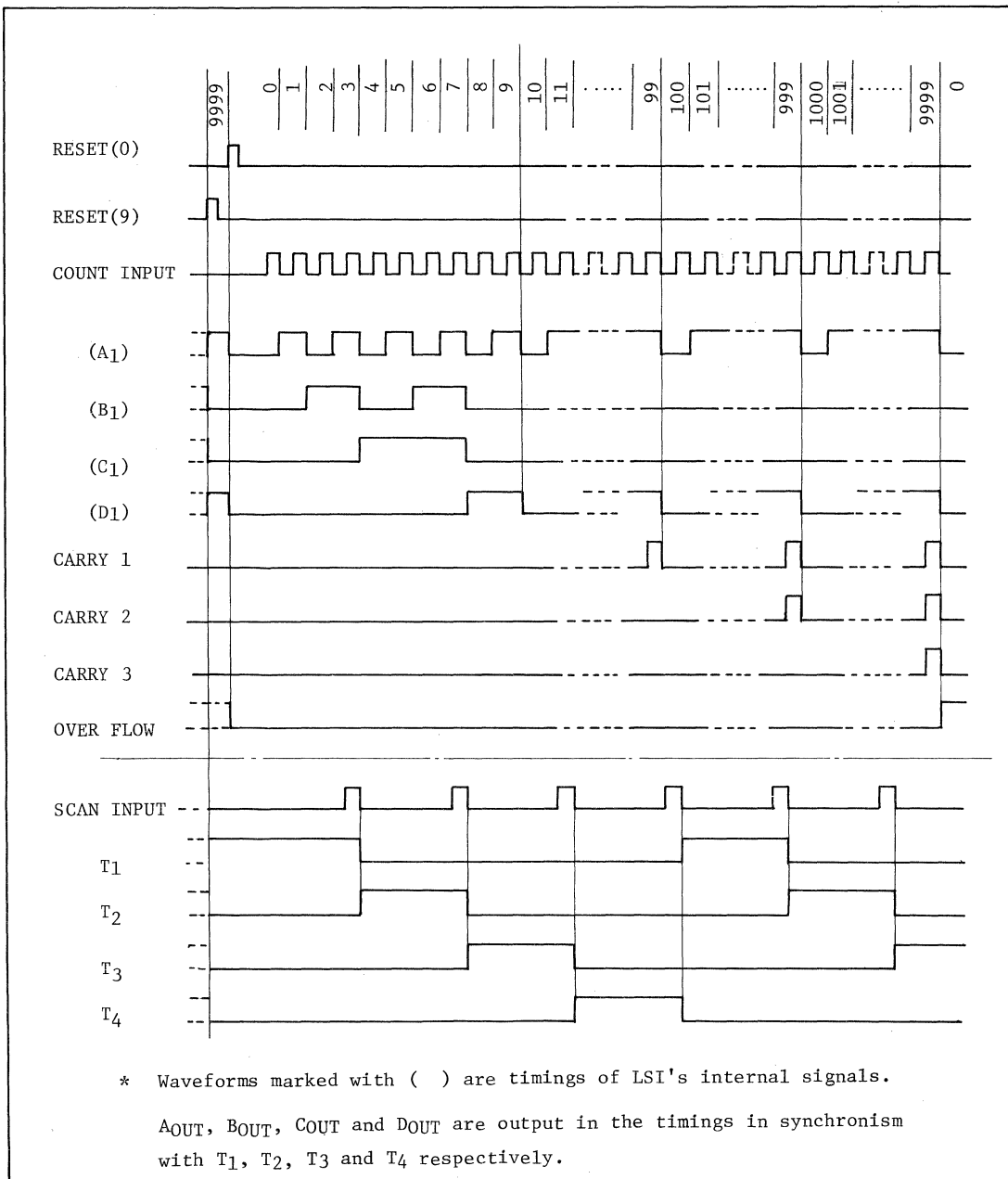
PIN No.	SYMBOL	NAME	FUNCTION						
1	OVF	OVER FLOW	Terminal to detect OVER FLOW condition of the counter which generates "H" level when COUNT is incremented from "9999". Once set to "H", only RESET (0) can clear it to "L".						
2	R _{EXT}	RESISTER EXTERNAL	This is opened when external CLOCK is supplied from S _{IN} . If external CLOCK is not available, CLOCK can be generated by externally connecting a resistor across S _{IN} and R _{EXT} and a capacitor across S _{IN} and C _{EXT} .						
3	C _{EXT}	CAPACITANCE EXTERNAL							
4	S _{IN}	SCAN INPUT	T-COUNTER CLOCK input and T-COUNTER is changed its condition at the falling edge of S _{IN} .						
5	CA3	CARRY-3	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td colspan="2" style="text-align: center;">COUNTER</td> </tr> <tr> <td style="width: 50px;">"9999"</td> <td style="width: 50px;">"x999"</td> </tr> <tr> <td style="width: 50px;">"xx99"</td> <td style="width: 50px;">"H" during CP="H" in COUNT shown at the left, "L" otherwise.</td> </tr> </table>	COUNTER		"9999"	"x999"	"xx99"	"H" during CP="H" in COUNT shown at the left, "L" otherwise.
COUNTER									
"9999"	"x999"								
"xx99"	"H" during CP="H" in COUNT shown at the left, "L" otherwise.								
6	CA2	CARRY-2	CARRY output from n-						
7	CA1	CARRY-1	th digit						
8	TRF	TRANSFER	"H" Decimal COUNTER output is transferred to MULTIPLEXER as it is.						
			"L" COUNTER output at the time of falling edge of TRF is latched.						
9	CP	COUNT INPUT	Lowest order decimal COUNTER CLOCK input and COUNTER is counted by the falling edge of CP.						
10	RE (0)	RESET (0)	"H" Decimal COUNTER output is reset to "0000". This takes precedence over RE (9).						
			"L" If RE (9) = "L", normally counted.						
11	RE (9)	RESET (9)	"H" If RE (0) = "L", COUNTER output is set to "9999".						
			"L" If RE (0) = "L", normally counted.						
12	V _{SS}	V _{SS}	(GND)						

DESCRIPTION OF PIN FUNCTION

PIN No.	SYMBOL	NAME	FUNCTION	
13	TEST ₁	TEST ₁	"H"	If TEST (2) = "H", normally counted.
			"L"	If TEST (2) = "H", only lower order two digits are counted.
14	D _{OUT}	D-OUTPUT	Decimal COUNTER BCD outputs. When T ₁ ="H", the lowest order digit (first digit) is output, when T ₂ = "H", the second digit is output, ... and when T ₄ = "H", the fourth digit is output. During BLANKING all the outputs become "H".	
15	C _{OUT}	C-OUTPUT		
16	B _{OUT}	B-OUTPUT		
17	A _{OUT}	A-OUTPUT		
18	BL	BLANKING	If BL = "H", only all A _{OUT} through D _{OUT} (BCD OUT) become "H".	
19	T ₄	T ₄	Output to indicate the digit position of output signals A _{OUT} through D _{OUT} (BCD OUT) and corresponds in descending order from T ₁ .	
20	T ₃	T ₃		
21	T ₂	T ₂		
22	T ₁	T ₁		
23	TEST ₂	TEST ₂	"H"	Normally counted.
			"L"	Causes T ₁ = "L", T ₂ ~ T ₄ = "H", OVF = "H".
24	V _{DD}	V _{DD}	V _{DD} Power Supply (3~8 volt)	

TC5001P

TIMING CHART



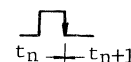
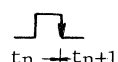
TRUTH TABLE

RESET (0)	RESET (9)	TRANSFER	BLANKING	TEST ₁	TEST ₂	AOUT	BOUT	COUT	DOUT	T ₁	T ₂	T ₃	T ₄	OVER FLOW	
H	*	H	L	*	H	L	L	L	L	H	L	L	L	L	Note-1
L	H	H	L	*	H	H	L	L	H	H	L	L	L	X	Note-1
L	L	H	L	H	H	C	C	C	C	S	S	S	S	X	
L	L	H	L	L	H	C'	C'	C'	C'	S	S	S	S	X	
*	*	L	L	*	*	LA	LA	LA	LA	X	X	X	X	X	
*	*	*	H	*	*	H	H	H	H	X	X	X	X	X	
*	*	*	*	*	L	X	X	X	X	L	H	H	H	H	

- * Don't Care
- X Not defined
- C Count operation (all digits)
- C' Count operation (only lower order two digits)
- LA Latch operation
- S Scan operation

Note 1. SCAN INPUT = "L"

- o All the inputs/outputs (except COUNT INPUT and SCAN INPUT) are activated by "H" level.

- o COUNT INPUT  SCAN INPUT 

- o When used, TEST₁ = "H" and TEST₂ = "H" should be satisfied.

OPERATING CONSIDERATION

1. RESET Operation

- (1) When the level of RESET (0) terminal is set to "H", BCD output of COUNTER is set to "0". The four digit display becomes 0000.
- (2) When the level of RESET (9) terminal is set to "H", BCD output of COUNTER is set to "9". The four digit display becomes 9999.
- (3) When both of RESET (0) terminal and RESET (9) terminal are "H", RESET (0) terminal takes precedence.

2. SCAN Operation

- (1) SCAN signal for dynamic display applied to SCAN INPUT terminal controls the multiplexer circuit and transfers four digit information in the latches to BCD outputs one digit at a time in sequence.

OPERATING CONSIDERATION

- (2) Arbitrary digit can be made real time output (completely static) by making SCAN signal DC.
- (3) The digit pulses in synchronism with SCAN signal for dynamic display appear at the digit output terminals (T₁, T₂, T₃ and T₄). The digit output terminals (T₁, T₂, T₃ and T₄) are used for the digit selection circuit and for arbitrary digit zero suppress.
- (4) The digit pulse is activated by the falling edge of SCAN INPUT signal.
- (5) SCAN signal is supplied from the internal oscillator as shown in Fig. 1 or from the external one as shown in Fig. 2.

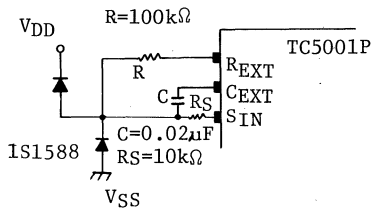


Fig. 1

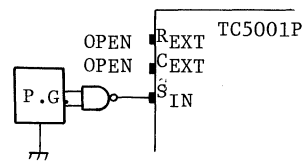


Fig. 2

$$f_{\text{SCAN}} = \frac{1}{2.2CR} \text{ [Hz]}$$

3. Latch Operation

- (1) When the level of TRANSFER terminal is "H", COUNTER information is transferred to the latches.
- (2) When the level of TRANSFER terminal is charged from "H" to "L", the information transferred from COUNTER is latched.

4. Count Operation

- (1) Set input terminals TEST₁, TEST₂ and TRANSFER to "H" and BLANKING terminal to "L".
- (2) COUNTER is set by applying "H" level to RESET (0) or RESET (9) terminal and two RESET terminals are returned to "L".

OPERATING CONSIDERATION

- (3) When the count pulse is applied to COUNT INPUT terminal, COUNTER performs its COUNT operation at the falling edge of count pulse.
- (4) The maximum count is 9999 and if 9999 is exceeded, "H" level appears at OVER FLOW terminal. Removal of OVER FLOW signal can be achieved by applying "H" to RESET (0) terminal.
- (5) The carry signals from 100's and 1000's digits appear at output terminals CARRY₁, CARRY₂ and CARRY₃.
- (6) When TEST₁ terminal is "L", only lower order two digits of COUNTER are counted.

5. BLANKING Operation

When BLANKING terminal is set to "H", all the BCD outputs of COUNTER become "H" and this signal is used to achieve the zero suppress operation.

TC5001P

RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	8	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp.	Topr	-30	-	85	°C
External Resistance	R _{EXT}	10	100	1000	kΩ
External Capacitance	C _{EXT}	10 ⁻⁴	0.02	1.0	μF

ELECTRICAL CHARACTERISTICS (VSS=0V)

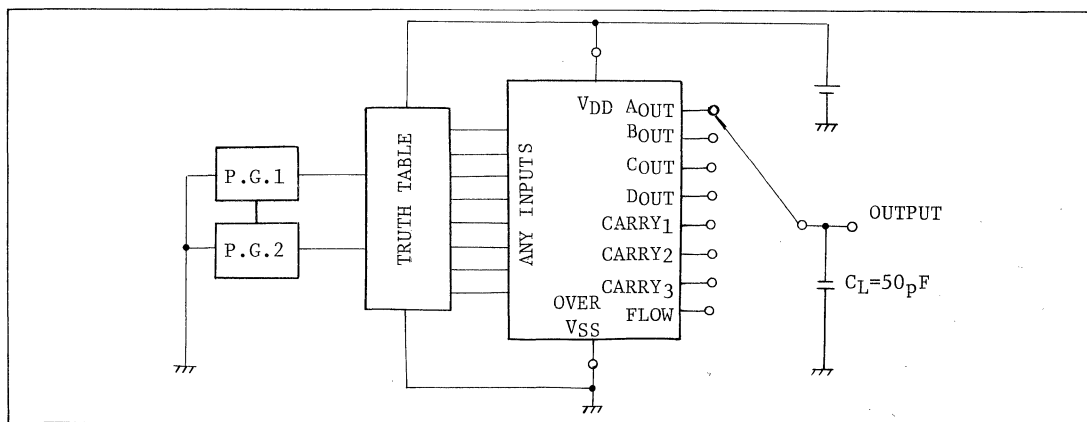
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-30°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	|I _O UT| < 1μA V _{IN} =V _{DD} ,V _{SS}	5	4.95	-	4.95	-	-	4.95	-	V	
Low Level Output Voltage	V _{OL}	|I _O UT| < 1μA V _{IN} =V _{DD} ,V _{SS}	5	-	0.05	-	-	0.05	-	0.05		
High Level Output Current	A _{OUT} ,B _{OUT} C _{OUT} ,D _{OUT}	I _{OH}	V _{OH} = 2.5V V _{IN} =V _{DD} ,V _{SS}	5	-1.2	-	-1.0	-	-0.75	-	mA	
	CARRY1,2,3 OVER FLOW T1,T2,T3, T4	I _{OH}		5	-1.2	-	-1.0	-	-0.75	-		
	R _{EXT} C _{EXT}	I _{OH}		5	-0.3	-	-0.25	-	-0.2	-		
Low Level Output Current	A _{OUT} ,B _{OUT} C _{OUT} ,D _{OUT}	I _{OL}	V _{OL} = 0.4V V _{IN} =V _{DD} ,V _{SS}	5	2.4	-	2.0	-	1.6	-	mA	
	CARRY1,2,3 OVER FLOW T1,T2,T3, T4	I _{OL}		5	0.52	-	0.44	-	0.36	-		
	R _{EXT} C _{EXT}	I _{OL}		5	0.28	-	0.24	-	0.2	-		
Input Voltage	"H" Level	V _{IH}	V _{OUT} =0.1V,4.9V	5	3.8	-	3.8	2.75	-	3.8	-	V
	"L" Level	V _{IL}	|I _O UT| < 1μA	5	-	1.2	-	2.25	1.2	-	1.2	
Input Current	"H" Level	I _{IH}	V _{IH} = 8V	8	-	0.2	-	-	0.2	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} = 0V	8	-	-0.2	-	-	-0.2	-	-1.0	
Quiescent Current Consumption	I _{DD}	V _{IN} =V _{DD} ,V _{SS} *	8	-	50	-	-	50	-	500	μA	

* All valid input combinations

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL = 50pF)

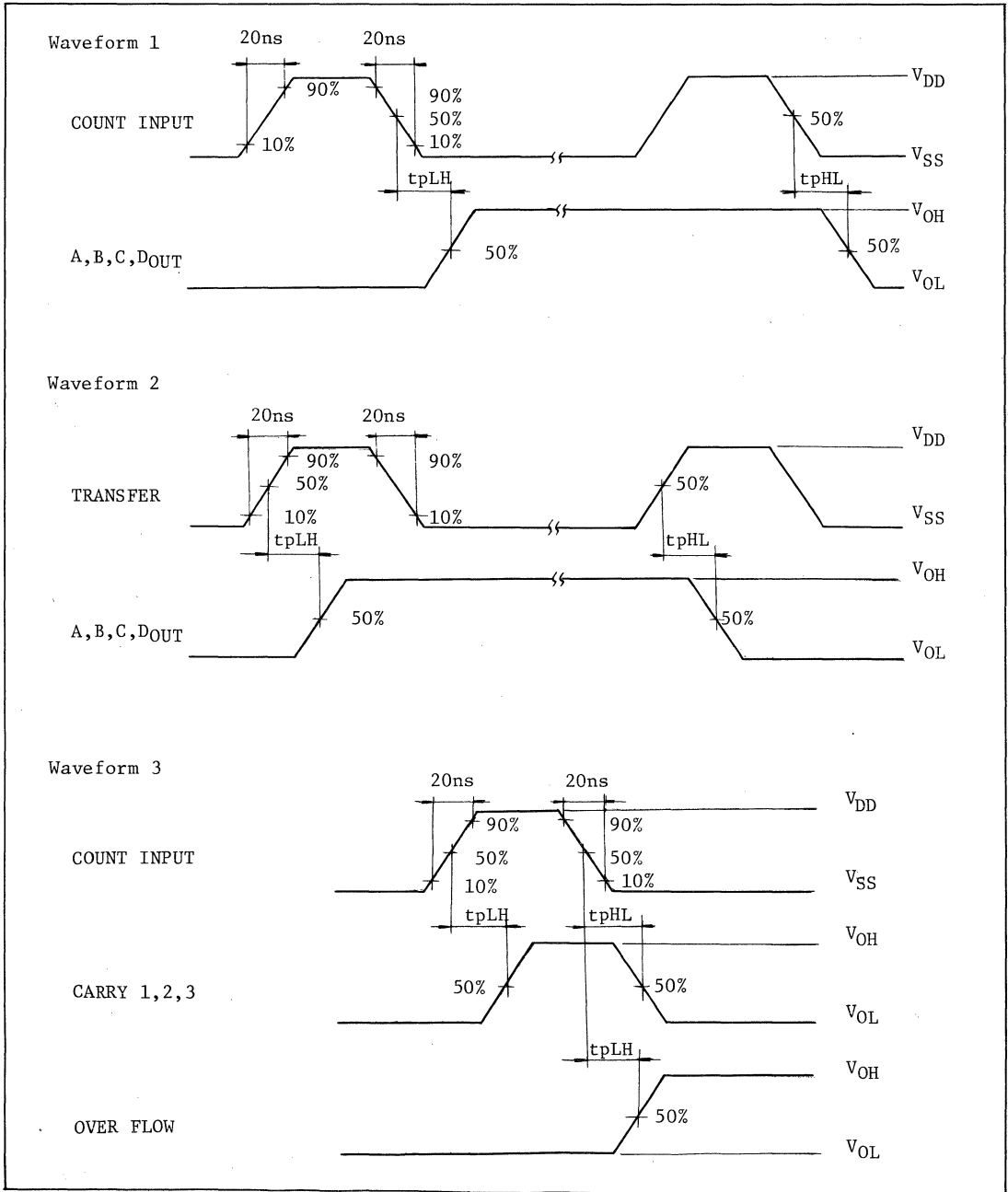
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
(LOW-HIGH) Propagation Delay Time	t _{pLH}	COUNT INPUT – A, B, C, D, OUT (Waveform 1)	5	-	600	1000	ns
(HIGH-LOW) Propagation Delay Time	t _{pHL}		5	-	600	1000	
(LOW-HIGH) Propagation Delay Time	t _{pLH}	TRANSFER – A, B, C, D, OUT (Waveform 2)	5	-	400	1000	
(HIGH-LOW) Propagation Delay Time	t _{pHL}		5	-	400	1000	
(LOW-HIGH) Propagation Delay Time	t _{pLH}	COUNT INPUT – CARRY _{1,2,3} – OVER FLOW (Waveform 3)	5	-	400	1000	
(HIGH-LOW) Propagation Delay Time	t _{pHL}		5	-	400	1000	
Max. Clock Rise Time	t _{rCL} , t _{fCL}		5	20	-	-	μs
Min. Clear Pulse Width	t _{w(RE)}	RESET(0), (9)	5	-	-	1000	ns
Min. Transfer Pulse Width	t _{w(TR)}	TRANSFER	5	-	-	1000	
Input Capacity	9, 10, 11, 18 PIN	C _{IN}		-	5	7.5	pF
	4, 13, 23 PIN	C _{IN}		-	7	10	
	8 PIN	C _{IN}		-	9	15	
Max. Clock Frequency	f _{CL}		5	0.5	2.0	-	MHz

SWITCHING TIME TEST CIRCUIT



TC5001P

SWITCHING TIME TEST WAVEFORMS

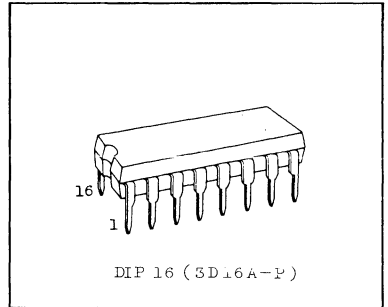


TC5002BP, TC5022BP BCD TO 7-SEGMENT DECODER/DRIVER

TC5002BP and TC5022BP are decoders to convert BCD code input to the driving signal for 7-segment display element and equipped with NPN transistors as the output buffers enabling direct driving of common cathode type LED.

When BI input is set at "H" level, all the segment outputs are turned "OFF" (not illumination) regardless of other inputs.

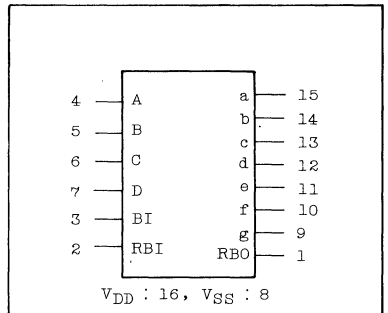
RBI input is to turn the output "OFF" and RBO input is to generate "H" level output only for "0" code input and these are used for leading zero suppress when connected in cascade.



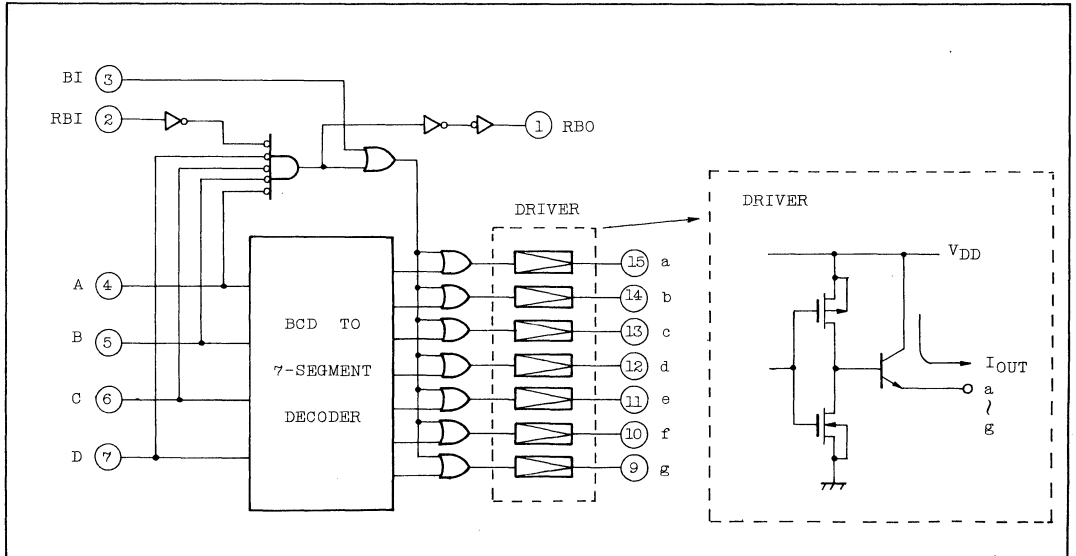
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10sec$	

PIN ASSIGNMENT



LOGIC DIAGRAM



TC5002BP, TC5022BP

TRUTH TABLE

(TC5002BP)

		INPUT				OUTPUT								
BI	RBI	A	B	C	D	a	b	c	d	e	f	g	RBO	NOTE
H	*	*	*	*	*	L	L	L	L	L	L	L	☆	
L	H	L	L	L	L	L	L	L	L	L	L	L	H	
L	L	L	L	L	L	H	H	H	H	H	H	L	L	
L	*	H	L	L	L	L	H	H	L	L	L	L	L	
L	*	L	H	L	L	H	H	L	H	H	L	H	L	
L	*	H	H	L	L	H	H	H	H	L	L	H	L	
L	*	L	L	H	L	L	H	H	L	L	H	H	L	
L	*	H	L	H	L	H	L	H	H	L	H	H	L	
L	*	L	H	H	L	L	L	H	H	H	H	H	L	1
L	*	H	H	H	L	H	H	H	L	L	L	L	L	2
L	*	L	L	L	H	H	H	H	H	H	H	H	L	
L	*	H	L	L	H	H	H	H	L	L	H	H	L	3
L	*	L	H	L	H	H	H	H	H	H	H	L	L	
L	*	H	H	L	H	L	H	H	L	L	L	L	L	
L	*	L	L	H	H	H	H	L	H	H	L	H	L	
L	*	H	L	H	H	H	H	H	L	L	L	H	L	
L	*	L	H	H	H	L	H	H	L	L	H	H	L	
L	*	H	H	H	H	H	L	H	H	L	H	H	L	

NOTE 1 : TC5022BP, \longrightarrow a = "H"

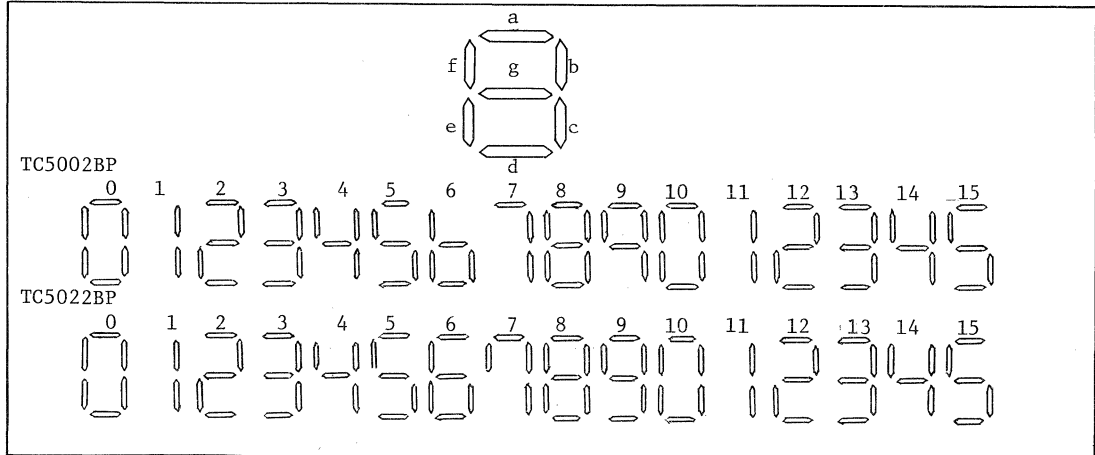
2 : TC5022BP, \longrightarrow f = "H"

3 : TC5022BP, \longrightarrow d = "H"

☆ : Undetermined

* : Don't Care

DISPLAY INDICATE MODE



RECOMMENDED OPERATING CONDITIONS (VSS= 0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VDD	3	-	18	V
Input Voltage	VIN	0	-	VDD	V
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage (RBO)	VOH	|I _{OUT}| < 1μA VIN=VSS, VDD	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low Level Output Voltage (RBO)	VOL	|I _{OUT}| < 1μA VIN=VSS, VDD	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Voltage (a - g)	VOH	|I _{OUT}| < 1μA VIN=VSS, VDD	5	4.0	-	4.0	4.5	-	4.0	-	V
			10	9.0	-	9.0	9.5	-	9.0	-	
			15	14.0	-	14.0	14.5	-	14.0	-	
High Level Output Current (RBO)	IOH	VOH=4.6V VOH=9.5V VOH=13.5V VIN=VSS, VDD	5	-0.2	-	-0.16	-	-0.12	-	mA	
			10	-0.5	-	-0.4	-	-0.3	-		
			15	-1.4	-	-1.2	-	-1.0	-		
Low Level Output Current (RBO)	IOL	VOL=0.4V VOL=0.5V VOL=1.5V VIN=VSS, VDD	5	0.52	-	0.44	-	0.36	-	mA	
			10	1.3	-	1.1	-	0.9	-		
			15	3.6	-	3.0	-	2.4	-		
High Level Output Current (a - g)	IOH	VOH=3.5V VOH=8.5V VOH=13.5V VIN=VSS, VDD	5	-20	-	-20	-	-15	-	mA	
			10	-25	-	-25	-	-20	-		
			15	-30	-	-30	-	-25	-		
High Level Input Voltage	VIH **	VOUT=0.5V, 4.0V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
Low Level Input Voltage	VIL **	VOUT=0.5V, 4.0V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
Disable Current (a - g)	IDL	VOL=0V	18	-	-3.0	-	-10 ⁻⁴	-3.0	-	-30	μA
Input "H" Level Current	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Current Consumption	IDD	VIN=VSS, VDD *	5	-	20	-	0.005	20	-	150	μA
			10	-	40	-	0.010	40	-	300	
			15	-	80	-	0.015	80	-	600	

* All valid input combinations. Outputs open.

** Required pull down register RL = 20 kΩ (a ~ g outputs).

TC5002BP, TC5022BP

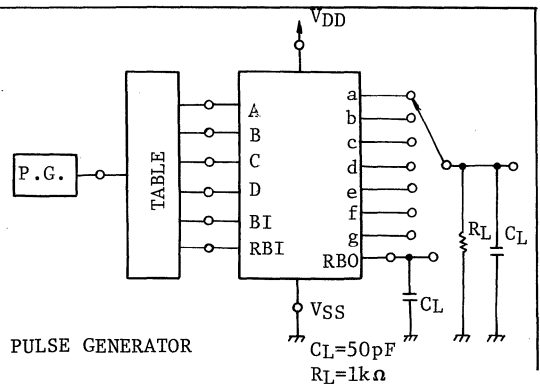
SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50 pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time (SEGMENT OUT)	t _{TLH}	R _L =1 kΩ	5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
Output Rise Time (RBO)	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time (RBO)	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
(LOW-HIGH) Propagation Delay Time (A,B,C,D-SEGMENT OUT)	t _{pLH}	R _L =1 kΩ	5	-	500	1000	ns
			10	-	150	400	
			15	-	120	300	
(HIGH-LOW) Propagation Delay Time (A,B,C,D-SEGMENT OUT)	t _{pHL}	R _L =1 kΩ	5	-	1000	2000	ns
			10	-	450	1000	
			15	-	320	700	
(LOW-HIGH) Propagation Delay Time (A,B,C,D - RBO)	t _{pLH}		5	-	1000	2000	ns
			10	-	370	1000	
			15	-	250	750	
(HIGH-LOW) Propagation Delay Time (A,B,C,D - RBO)	t _{pHL}		5	-	500	1000	ns
			10	-	200	500	
			15	-	140	300	
(LOW-HIGH) Propagation Delay Time (RBI - RBO)	t _{pLH}		5	-	800	1600	ns
			10	-	270	700	
			15	-	190	500	
(HIGH-LOW) Propagation Delay Time (RBI - RBO)	t _{pHL}		5	-	180	700	ns
			10	-	70	350	
			15	-	50	250	
Propagation Delay Time (BI - SEGMENT OUT)	t _{pLH} t _{pHL}	R _L =1 kΩ	5	-	500	1500	ns
			10	-	200	600	
			15	-	150	500	
Input Capacity	C _{IN}				5	7.5	pF

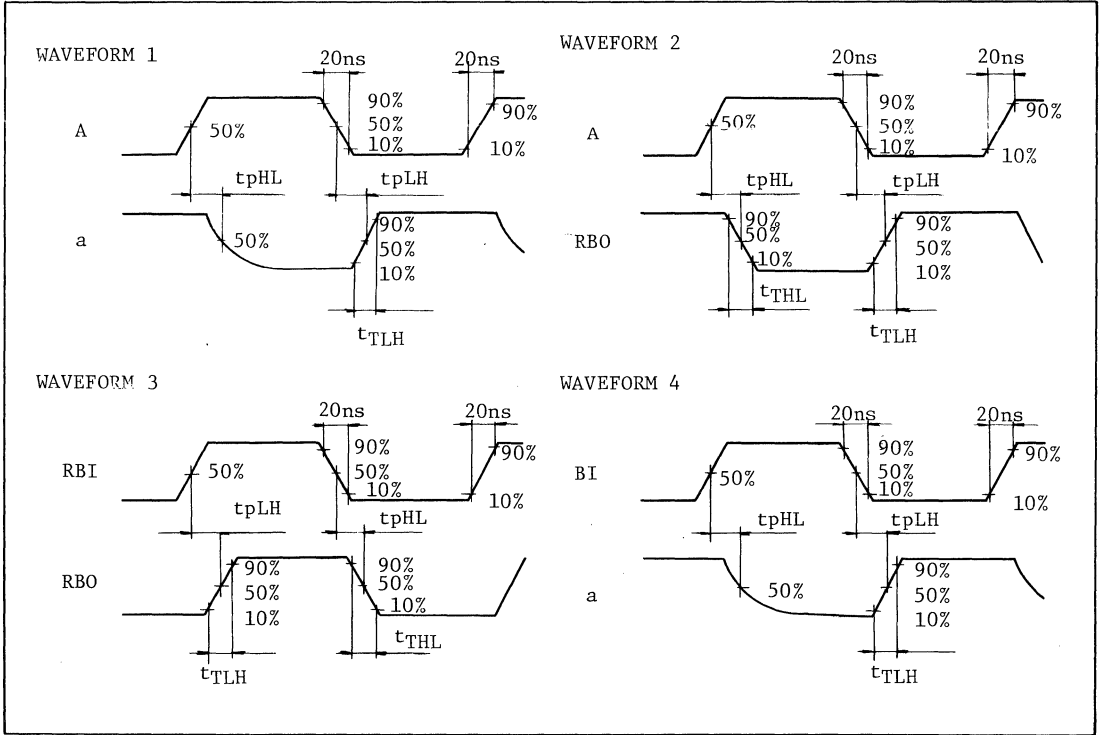
SWITCHING TIME TEST CIRCUIT

TABLE (t_{pLH}, t_{pHL} Test Condition)

TEST	P.G.	"H"	"L"	OUTPUT	Wave-form
A,B,C,D - SEGMENT OUT	A	-	Other Inputs	a	1
A,B,C,D - RBO	A	RBI	Other Inputs	RBO	2
RBI - RBO	RBI	-	Other Inputs	RBO	3
BI - SEGMENT OUT	BI	A,B	Other Inputs	a	4



SWITCHING TIME TEST WAVEFORMS

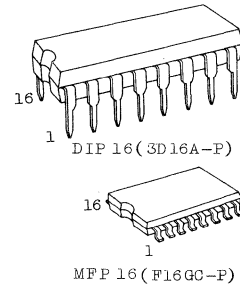


TC5012BP/BF

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5012BP/TC5012BF HEX NON-INVERTING 3-STATE BUFFER

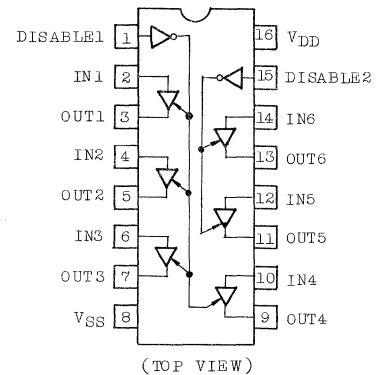
TC5012BP/BF contains six circuits of non-inverting buffers having three state output. Since DISABLE inputs to disable the outputs are provided separately, one common for four circuits and another common for other two circuits, this is suitable for controlling four bit data lines. Large output current enables to directly control one TTL input.



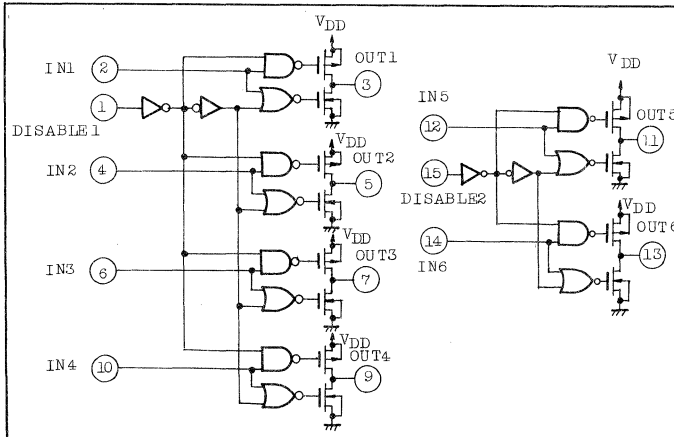
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS} - 0.5 \sim V_{SS} + 20$	V
Input Voltage	V_{IN}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
Output Voltage	V_{OUT}	$V_{SS} - 0.5 \sim V_{DD} + 0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300(DIP)/180(MFP)	mW
Operating Temperature Range	T_A	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10 \text{ sec}$	

PIN ASSIGNMENT



CIRCUIT DIAGRAM



TRUTH TABLE

DISABLE INPUT	INPUT	OUTPUT
L	L	L
L	H	H
H	*	HZ

* : DON'T CARE
HZ : HIGH IMPEDANCE

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNITS	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low-Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Output High Current	I _{OH}	V _{OH} =4.6V V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V V _{IN} =V _{SS} , V _{DD}	5	-	-	-	-	-	-	-	mA	
			5	-1.4	-	-1.25	-	-1.0	-	-		
			10	-1.4	-	-1.25	-	-3.0	-	-		
			15	-4.0	-	-3.75	-	-3.0	-	-		
Output Low Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	3.5	-	3.2	-	2.5	-	-	mA	
			10	6.0	-	5.0	-	3.6	-	-		
			15	26.0	-	24.0	-	18.0	-	-		
			15	26.0	-	24.0	-	18.0	-	-		
Input High Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Input Low Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
3-State Output Leakage Current	"H" Level	I _{DH}	V _{OUT} =18V	18	-	0.5	-	10 ⁻⁴	0.5	-	30	μA
	"L" Level	I _{DL}	V _{OUT} =0V	18	-	-0.5	-	-10 ⁻⁴	-0.5	-	-30	
Quiescent Device Current	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	4.0	-	0.002	4.0	-	30	μA	
			10	-	8.0	-	0.004	8.0	-	60		
			15	-	16.0	-	0.008	16.0	-	120		

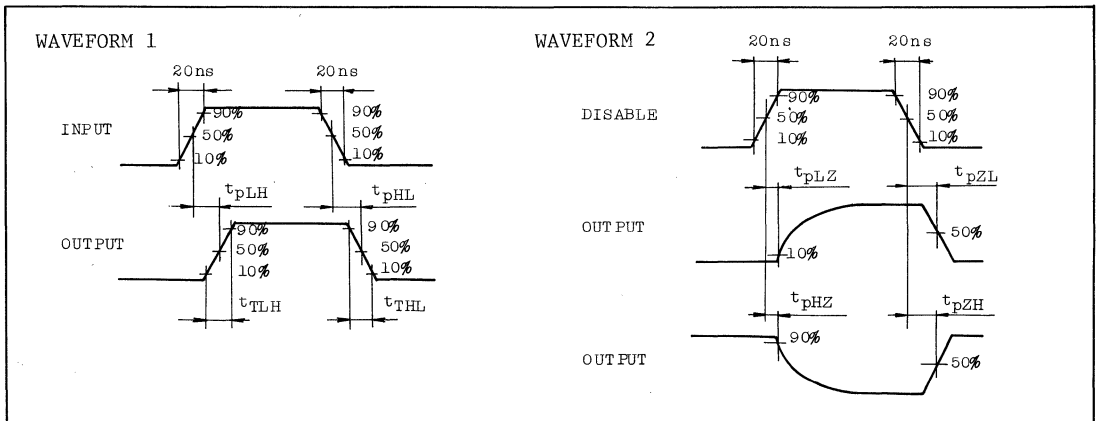
* All valid input combinations.

TC5012BP/BF

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNITS
			5				
Output Transition Time (Low to High)	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	100	
Output Transition Time (High to Low)	t _{THL}		5	-	70	200	
			10	-	40	100	
			15	-	35	80	
Propagation Delay Time (IN - OUT)	t _{pLH}		5	-	320	430	
			10	-	150	220	
			15	-	110	200	
Propagation Delay Time (IN - OUT)	t _{pHL}		5	-	280	380	
			10	-	130	220	
			15	-	100	200	
Three State Disable Time (DISABLE - OUT)	t _{pHZ}	R _L =1kΩ	5	-	320	500	
			10	-	280	450	
			15	-	250	400	
Three State Disable Time (DISABLE - OUT)	t _{pLZ}	R _L =1kΩ	5	-	420	600	
			10	-	320	500	
			15	-	270	450	
Three State Disable Time (DISABLE - OUT)	t _{pZH}	R _L =1kΩ	5	-	280	400	
			10	-	140	200	
			15	-	120	180	
Three State Disable Time (DISABLE - OUT)	t _{pZL}	R _L =1kΩ	5	-	300	450	
			10	-	150	225	
			15	-	130	200	
Input Capacitance	C _{IN}			-	7.5	15	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

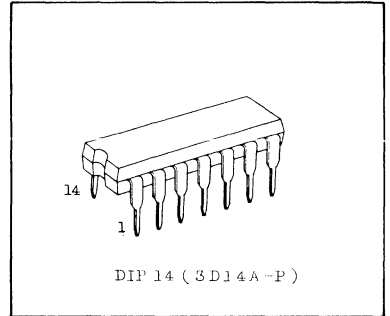


TC5018P 4 BIT BINARY COUNTER WITH CLOCK GENERATOR

TC5018P is four digit binary counter equipped with CR oscillator circuit to automatically generate the clock pulse and RS flip-flop to provide the clock input by mechanical contact points.

The outputs are buffered by N-channel open-drain structure which enables to directly drive two TTL IC's or LED components.

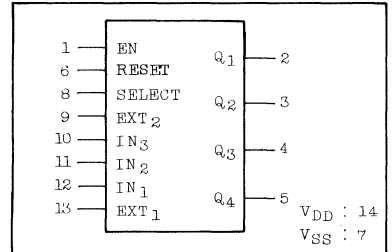
Usually, binary codes are obtained at four output with SELECT input being "H", but if SELECT input is set to "L", scan output which shifts "L" level on Q₁-Q₄ in sequence is obtained. This is suitable for applications such as channel scanner.



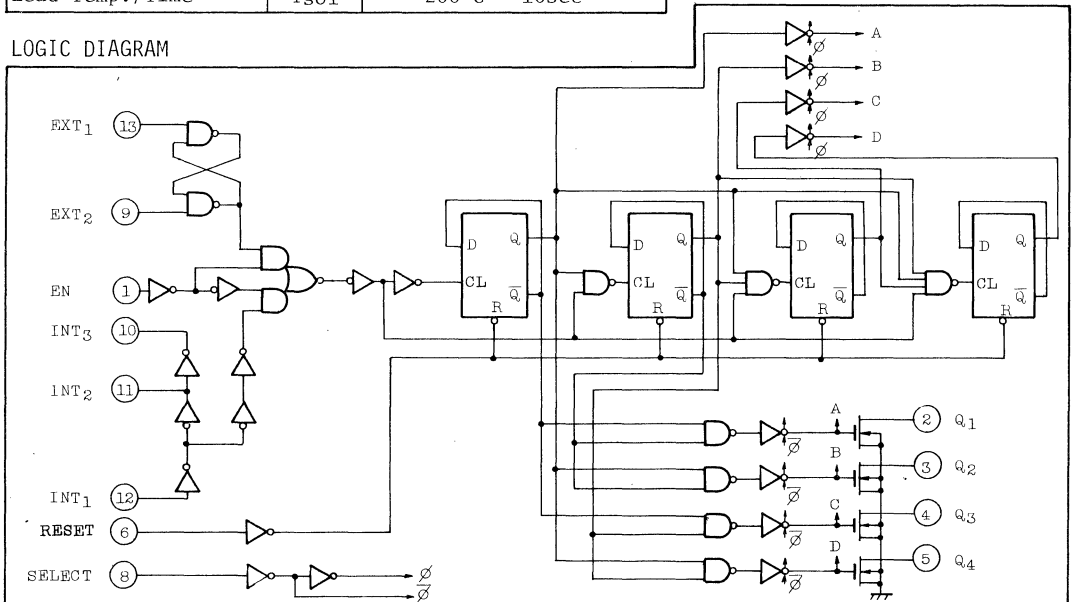
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +14	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65~150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM

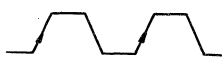


TC5018P

TRUTH TABLE

INPUTS						OUTPUTS			
IN ₁	EXT ₁	EXT ₂	EN	SELECT	RESET	Q ₁	Q ₂	Q ₃	Q ₄
*	$\overline{\text{CL}}$	CL	L	L	L	S	S	S	S
CL	*	*	H	L	L	S	S	S	S
*	$\overline{\text{CL}}$	CL	L	H	L	C	C	C	C
CL	*	*	H	H	L	C	C	C	C
*	*	*	*	L	H	L	H	H	H
*	*	*	*	H	H	L	L	L	L

C ; Count operation
 S ; Scan Operation
 CL ; Clock Pulse
 * ; Don't care
 (Note) Outputs change the state at the rising edge of CLOCK.

CL 

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	12	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp.	T _{opr}	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
Low Level Output Current	I _{OL}	V _{OL} = 0.4V V _{OL} = 0.5V V _{IN} =V _{SS} , V _{DD}	5	4.5	-	4.5	9.0	-	3.2	-	mA	
			10	9.0	-	9.0	20.0	-	6.0	-		
High Level Input Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V △ |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
Low Level Input Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V △ |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
Output Off Leakage Current	I _{DH}	V _{DH} = 12V	12	-	0.5	-	10 ⁻⁴	0.5	-	30	μA	
Input Current	H Level	I _{IH}	V _{IH} = 12V	12	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	L Level	I _{IL}	V _{IL} = 0V	12	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Current Consumption	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	20	-	0.005	20	-	150	μA	
			10	-	40	-	0.010	40	-	300		

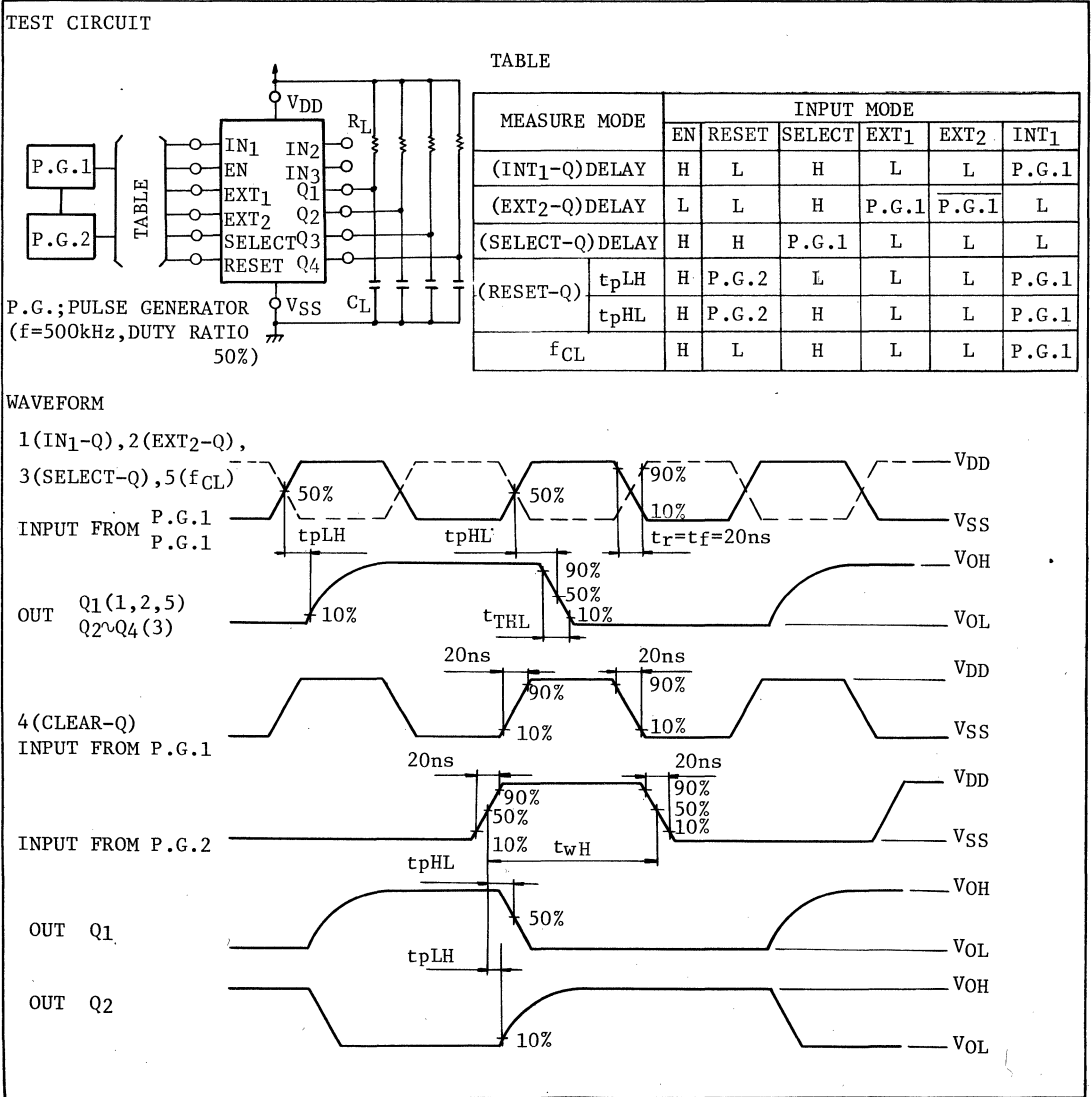
* All valid input combinations
 △ R_L = 10 kΩ

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Fall Time	t _{THL}	R _L = 5kΩ	5	-	-	200	ns
		C _L = 50pF	10	-	-	100	
(LOW-HIGH) Propagation Delay Time (INT ₁ - Q)	tpLH	R _L = 5kΩ	5	-	750	1800	ns
		C _L = 50 pF	10	-	380	900	
(HIGH-LOW) Propagation Delay Time (INT ₁ - Q)	tpHL	R _L = 5kΩ	5	-	500	1500	ns
		C _L = 50pF	10	-	200	600	
(LOW-HIGH) Propagation Delay Time (EXT ₂ - Q)	tpLH	R _L = 5kΩ	5	-	750	1800	ns
		C _L = 50pF	10	-	380	900	
(HIGH-LOW) Propagation Delay Time (EXT ₂ - Q)	tpHL	R _L = 5kΩ	5	-	500	1500	ns
		C _L = 50pF	10	-	200	600	
(LOW-HIGH) Propagation Delay Time (SELECT - Q)	tpLH	R _L = 5kΩ	5	-	380	1000	ns
		C _L = 50pF	10	-	140	500	
(HIGH-LOW) Propagation Delay Time (SELECT - Q)	tpHL	R _L = 5kΩ	5	-	200	600	ns
		C _L = 50pF	10	-	90	300	
(LOW-HIGH) Propagation Delay Time (RESET - Q)	tpLH	R _L = 5kΩ	5	-	550	1500	ns
		C _L = 50pF	10	-	300	900	
(HIGH-LOW) Propagation Delay Time (RESET - Q)	tpHL	R _L = 5kΩ	5	-	400	1500	ns
		C _L = 50pF	10	-	150	900	
Max. Clock Rise Time	t _{rCL}	{ EXT ₁ } , INT ₁	5	1000	-	-	μs
Max. Clock Fall Time	t _{fCL}		10	1000	-	-	
Min. Pulse Width (RESET)	t _{WH}		5	-	-	400	ns
			10	-	-	200	
Max. Clock Frequency	f _{CL}	R _L = 5kΩ	5	1.0	2.0	-	MHz
		C _L = 50pF	10	1.0	2.0	-	
Max. Clock Frequency	f _{CL}	R _L = 1kΩ	5	1.0	2.0	-	MHz
		C _L = 15pF	10	2.0	5.0	-	
Output Off Capacity	C _{OUT}			-		-	pF
Input Capacity	C _{IN}			-	5	7.5	pF

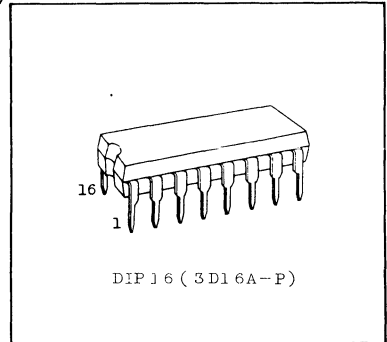
TC5018P

SWITCHING TIME TEST CIRCUIT AND WAVEFORMS



TC5020BP HEX LOW-TO-HIGH VOLTAGE TRANSLATOR (INVERTING)

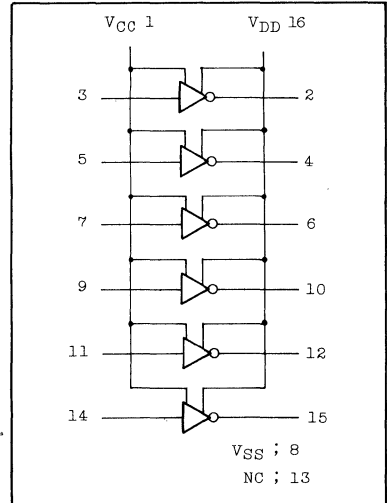
TC5020BP contains six circuits of level converters which convert the signals from low power supply voltage logical systems to the logical signals for high power supply voltage C²MOS systems. This is most suitable for interfacing between TTL, MDTL systems and C²MOS systems, and between two power supply voltage C²MOS systems. Normally, V_{CC} is connected to low voltage power supply and V_{DD} is connected to high voltage power supply, however this can also operate having V_{CC} and V_{DD} common. When the input is "H", some amount of I_{CC} flows because of circuit structure.



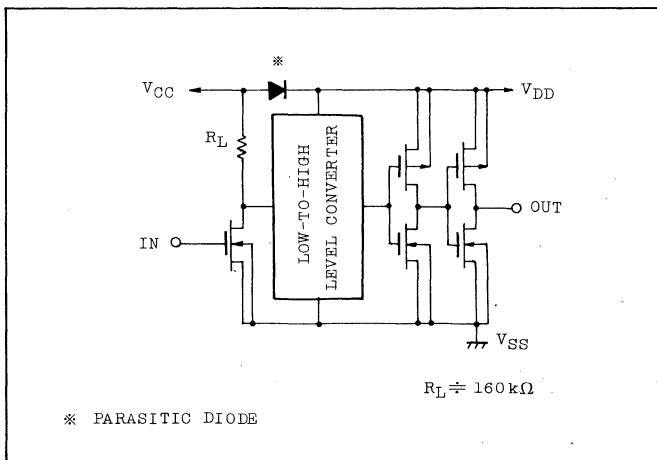
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
	V _{CC}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{CC} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

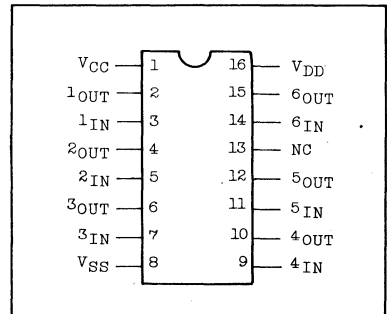
LOGIC DIAGRAM



CIRCUIT DIAGRAM



PIN ASSIGNMENT



TC5020BP

RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply Voltage (1)	V _{CC} V _{DD}	V _{CC} = V _{DD}	3	-	18	V
Supply Voltage (2)	V _{CC}	V _{CC} < V _{DD}	5	-	V _{DD}	V
	V _{DD}		5	-	18	
Input Voltage	V _{IN}		0	-	V _{CC}	V
Operating Temp.	T _{opr}		-40	-	85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V, VCC=VDD)

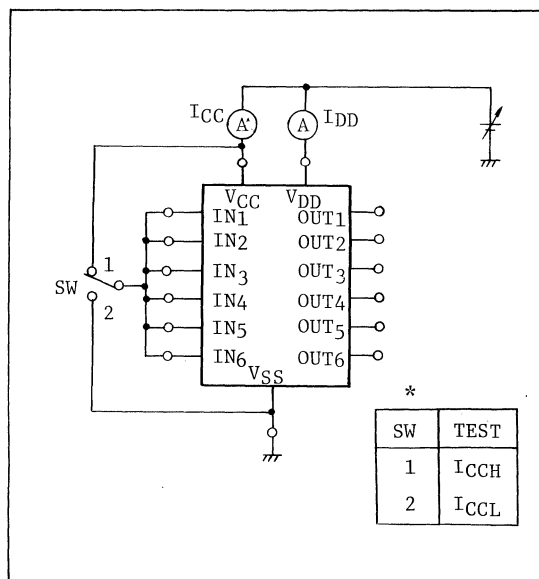
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} = V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} = V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
High Level Output Current	I _{OH}	V _{OH} = 4.6V V _{OH} = 9.5V V _{OH} = 13.5V V _{IN} = V _{SS}	5	-0.2	-	-0.16	-	-	-0.12	-	mA	
			10	-0.5	-	-0.4	-	-	-0.3	-		
			15	-1.4	-	-1.2	-	-	-1.0	-		
Low Level Output Current	I _{OL}	V _{OL} = 0.4V V _{OL} = 0.5V V _{OL} = 1.5V V _{IN} = V _{DD}	5	0.52	-	0.44	-	-	0.36	-	mA	
			10	1.3	-	1.1	-	-	0.9	-		
			15	3.6	-	3.0	-	-	2.4	-		
High Level Input Voltage	V _{IH}	V _{OUT} = 0.5V V _{OUT} = 1.0V V _{OUT} = 1.5V |I _{OUT}| < 1μA	5	4.0	-	4.0	-	-	4.0	-	V	
			10	7.0	-	7.0	-	-	7.0	-		
			15	10.0	-	10.0	-	-	10.0	-		
Low Level Input Voltage	V _{IL}	V _{OUT} = 4.5V V _{OUT} = 9.0V V _{OUT} = 13.5V |I _{OUT}| < 1μA	5	-	1.0	-	-	1.0	-	1.0	V	
			10	-	1.2	-	-	1.2	-	1.2		
			15	-	1.5	-	-	1.5	-	1.5		
Input Current	H Level	I _{IH}	V _{IH} = 18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	L Level	I _{IL}	V _{IL} = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Current Consumption	I _{DD}	V _{IN} = V _{SS} , V _{DD} *	5	-	1.0	-	0.001	1.0	-	7.5	μA	
			10	-	2.0	-	0.001	2.0	-	15.0		
			15	-	4.0	-	0.002	4.0	-	30.0		
Quiescent Current Consumption	I _{CCH}	V _{IN} = V _{DD}	5	-	0.9	-	0.2	0.48	-	0.9	mA	
			10	-	1.6	-	0.4	0.96	-	1.6		
			15	-	2.1	-	0.6	1.5	-	2.1		
Quiescent Current Consumption	I _{CCL}	V _{IN} = V _{SS}	5	-	1.0	-	0.001	1.0	-	7.5	μA	
			10	-	2.0	-	0.001	2.0	-	15.0		
			15	-	4.0	-	0.002	4.0	-	30.0		

* All valid input combinations

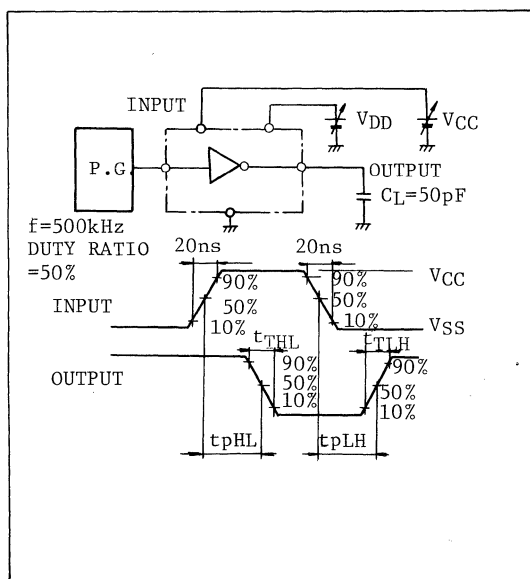
SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	CONDITIONS	VDD (V)		MIN.	TYP.	MAX.	UNIT
			VCC (V)	VDD (V)				
Output Rise Time	t_{rLH}		-	5	-	130	400	ns
			-	10	-	65	200	
			-	15	-	50	160	
Output Fall Time	t_{fHL}		-	5	-	100	200	ns
			-	10	-	50	100	
			-	15	-	40	80	
(LOW-HIGH) Propagation Delay Time	t_{pLH}		5	5	-	780	1600	ns
			10	10	-	330	800	
			15	15	-	230	600	
			5	10	-	750	1600	
			5	15	-	850	1800	
			10	15	-	330	800	
(HIGH-LOW) Propagation Delay Time	t_{pHL}		5	5	-	220	600	ns
			10	10	-	75	300	
			15	15	-	50	200	
			5	10	-	130	300	
			5	15	-	150	400	
			10	15	-	60	200	
Input Capacity	C_{IN}				-	5	7.5	pF

I_{DD}, I_{CC} TEST CIRCUIT



SWITCHING TIME TEST CIRCUIT AND WAVEFORM



TC5023BP

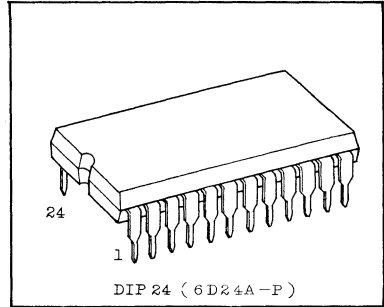
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5023BP 16-LINE DATA SELECTOR/MULTIPLEXER

TC5023BP is data selector which selects one of 16 input signals $X_0 \sim X_{15}$ according to binary address inputs A, B, C and D.

The data input (X_n) which corresponds to the binary address appears inverted on output \bar{Z} .

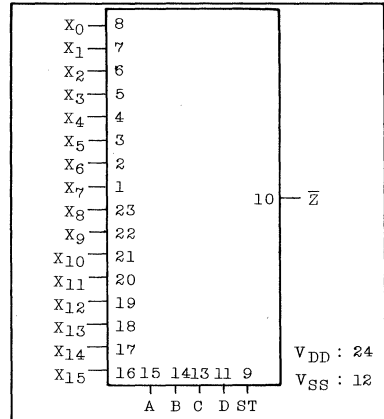
If STROBE input is set to "H", output \bar{Z} becomes "H" regardless of other inputs.



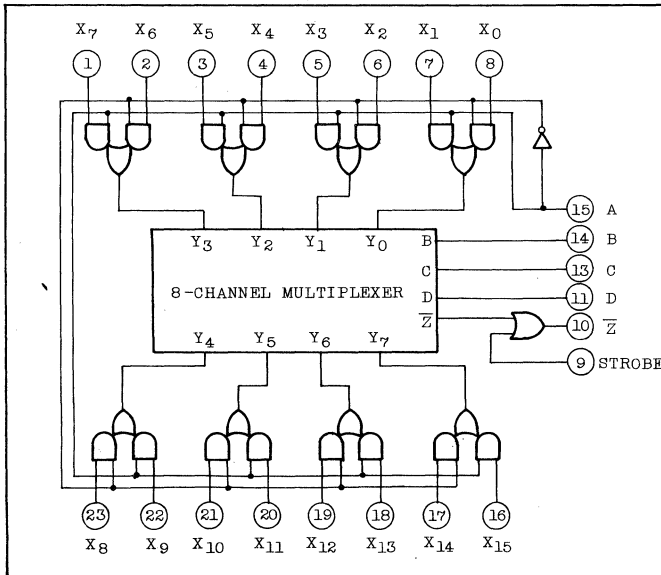
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10\text{sec}$	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

INPUTS					OUTPUT
D	C	B	A	ST	\bar{Z}
*	*	*	*	H	H
L	L	L	L	L	\bar{X}_0
L	L	L	H	L	\bar{X}_1
L	L	H	L	L	\bar{X}_2
L	L	H	H	L	\bar{X}_3
L	H	L	L	L	\bar{X}_4
L	H	L	H	L	\bar{X}_5
L	H	H	L	L	\bar{X}_6
L	H	H	H	L	\bar{X}_7
H	L	L	L	L	\bar{X}_8
H	L	L	H	L	\bar{X}_9
H	L	H	L	L	\bar{X}_{10}
H	L	H	H	L	\bar{X}_{11}
H	H	L	L	L	\bar{X}_{12}
H	H	L	H	L	\bar{X}_{13}
H	H	H	L	L	\bar{X}_{14}
H	H	H	H	L	\bar{X}_{15}

* : Don't Care

RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VDD	3	-	18	V
Input Voltage	VIN	0	-	VDD	V
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	VOH	|IOUT| < 1μA VIN = VSS, VDD	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low Level Output Voltage	VOL	|IOUT| < 1μA VIN = VSS, VDD	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
High Level Output Current	IOH	VOH = 4.6V VOH = 9.5V VOH = 13.5V VIN = VSS, VDD	5	-0.2	-	-0.16	-	-0.12	-	-	mA	
			10	-0.5	-	-0.4	-	-0.3	-	-		
			15	-1.4	-	-1.2	-	-1.0	-	-		
			5	0.52	-	0.44	-	0.36	-	-		
Low Level Output Current	IOL	VOL = 0.4V VOL = 0.5V VOL = 1.5V VIN = VSS, VDD	5	0.52	-	0.44	-	0.36	-	-	mA	
			10	1.3	-	1.1	-	0.9	-	-		
			15	3.6	-	3.0	-	2.4	-	-		
			5	3.5	-	3.5	2.75	-	3.5	-		-
High Level Input Voltage	VIH	VOUT=0.5V, 4.5V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |IOUT| < 1μA	5	7.0	-	7.0	5.5	-	7.0	-	V	
			10	11.0	-	11.0	8.25	-	11.0	-		
			15	-	1.5	-	2.25	1.5	-	1.5		
			5	-	3.0	-	4.5	3.0	-	3.0		
Low Level Input Voltage	VIL	VOUT=0.5V, 4.5V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |IOUT| < 1μA	5	-	4.0	-	6.75	4.0	-	4.0	V	
			10	-	-	-	-	-	-	-		
			15	-	-	-	-	-	-	-		
			18	-	0.3	-	10 ⁻⁵	0.3	-	1.0		
Input Current	High Level	IIH	VIH = 18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	Low Level	IIL	VIL = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	IDD	VIN = VSS, VDD *	5	-	20	-	0.005	20	-	150	μA	
			10	-	40	-	0.010	40	-	300		
			15	-	80	-	0.015	80	-	600		

* All valid input combinations

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

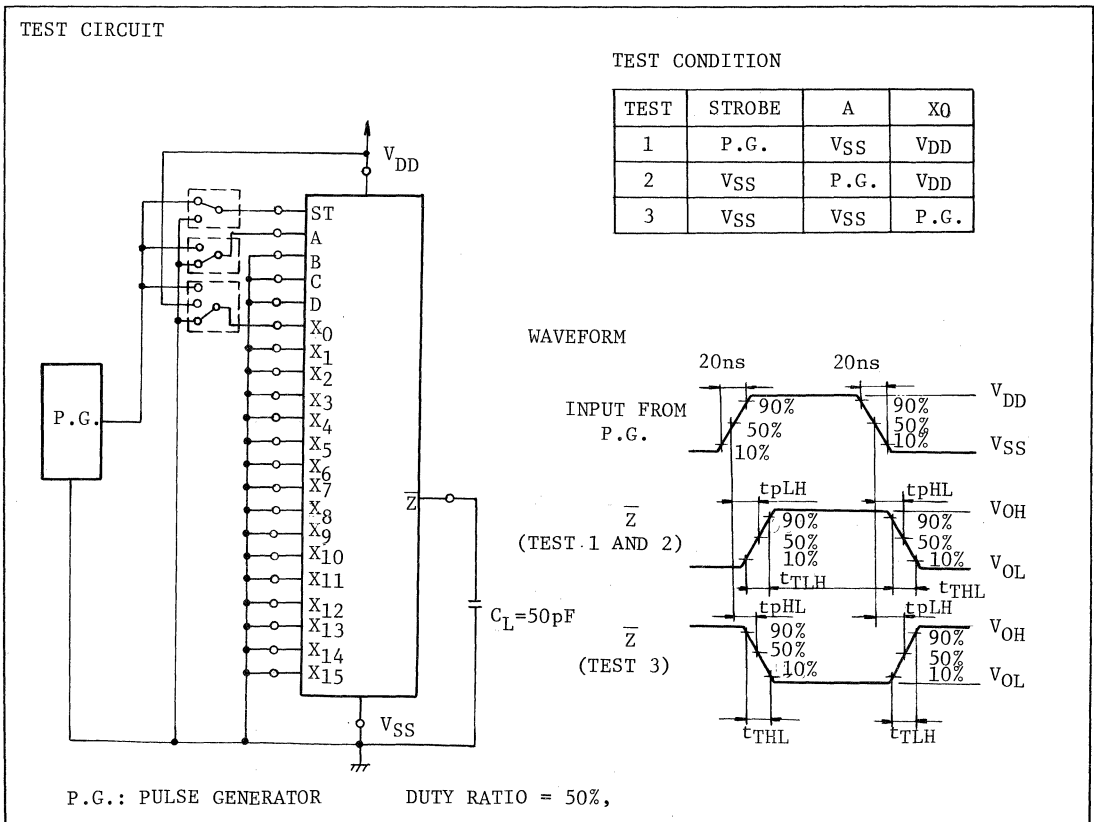
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	tTLH		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	tTHL		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

TC5023BP

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD(V)	MIN.	TYP.	MAX.	UNIT
(LOW-HIGH) Propagation Delay Time (Xn, A, B, C, D - Z)	tpLH		5	-	900	1800	ns
			10	-	370	800	
			15	-	250	550	
(HIGH-LOW) Propagation Delay Time (Xn, A, B, C, D - Z)	tpHL		5	-	650	1400	ns
			10	-	260	600	
			15	-	190	400	
(LOW-HIGH) Propagation Delay Time (STROBE - Z)	tpLH		5	-	280	600	ns
			10	-	130	300	
			15	-	100	250	
(HIGH-LOW) Propagation Delay Time (STROBE - Z)	tpHL		5	-	800	1600	ns
			10	-	340	700	
			15	-	230	500	
Input Capacity	CIN	All Inputs		-	5	7.5	pF

SWITCHING TIME TEST CIRCUIT AND WAVEFORMS

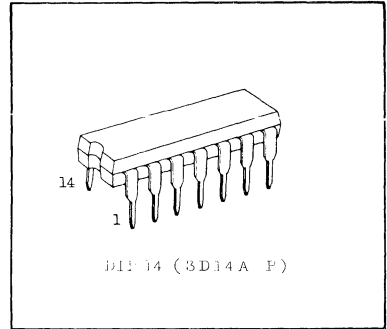


TC5024BP QUAD BUS BUFFER WITH 3-STATE OUTPUT ("H"-DISABLE)
TC5025BP QUAD BUS BUFFER WITH 3-STATE OUTPUT ("L"-DISABLE)

TC5024BP/TC5025BP contain four circuits of buffers having tri-state outputs. As all the buffers are controlled by four independent DISABLE inputs, any buffer outputs can be placed in the high impedance state.

The output becomes high impedance with DIS="H" for TC5024BP and $\overline{\text{DIS}}$ ="L" for TC5025BP.

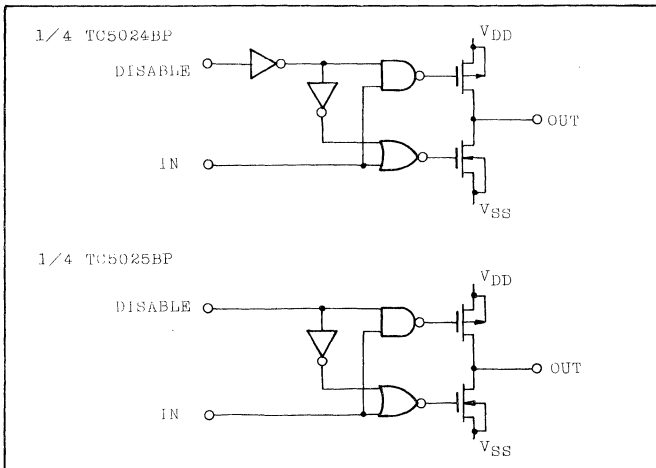
Large output current enables to directly drive one TTL. These can be utilized as interfaces with system bus lines, multiplexers, etc.



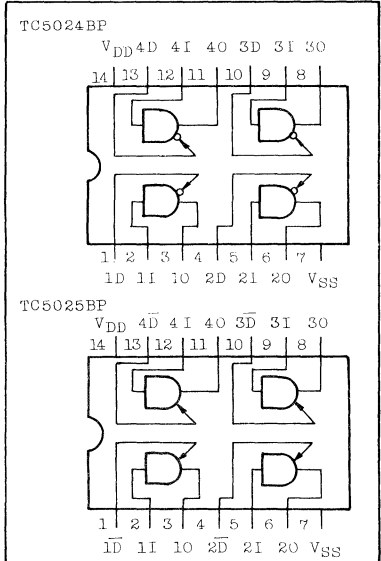
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C . 10sec	

LOGIC DIAGRAM



PIN ASSIGNMENT



TRUTH TABLE

TC5024BP			TC5025BP		
INPUTS		OUTPUT	INPUTS		OUTPUT
IN	DIS	OUT	IN	$\overline{\text{DIS}}$	OUT
L	L	L	L	L	HZ
H	L	H	H	L	HZ
L	H	HZ	L	H	L
H	H	HZ	H	H	H

HZ ; HIGH IMPEDANCE

TC5024BP, TC5025BP

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	3	-	18	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
Operating Temp.	T_{opr}	-40	-	85	$^{\circ}C$

ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-40 $^{\circ}C$		25 $^{\circ}C$			85 $^{\circ}C$		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
High Level Output Current	I_{OH}	$V_{OH} = 2.5V$ $V_{OH} = 9.5V$ $V_{OH} = 13.5V$ $V_{IN} = V_{SS}, V_{DD}$	5	-1.40	-	-1.25	-	-	-1.0	-	mA	
			10	-1.40	-	-1.25	-	-	-1.0	-		
			15	-4.00	-	-3.75	-	-	-3.0	-		
Low Level Output Current	I_{OL}	$V_{OL} = 0.4V$ $V_{OL} = 0.5V$ $V_{OL} = 1.5V$ $V_{IN} = V_{SS}, V_{DD}$	5	3.5	-	3.2	-	-	2.5	-	mA	
			10	6.0	-	5.0	-	-	3.6	-		
			15	26.0	-	24.0	-	-	18.0	-		
High Level Input Voltage (IN, TC5024BP DISABLE)	V_{IH}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Low Level Input Voltage (IN, TC5024BP DISABLE)	V_{IL}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
High Level Input Voltage (TC5025BP DISABLE)	V_{IH}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	4.0	-	4.0	-	-	4.0	-	V	
			10	8.0	-	8.0	-	-	8.0	-		
			15	12.5	-	12.5	-	-	12.5	-		
Low Level Input Voltage (TC5025BP DISABLE)	V_{IL}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $V_{OUT}=1.5V, 13.5V$ $|I_{OUT}| < 1\mu A$	5	-	1.0	-	-	1.0	-	1.0	V	
			10	-	2.0	-	-	2.0	-	2.0		
			15	-	2.5	-	-	2.5	-	2.5		
Input Current	H Level	I_{IH}	$V_{IH} = 18V$	18	-	0.3	-	10^{-5}	0.3	-	1.0	μA
	L Level	I_{IL}	$V_{IL} = 0V$	18	-	-0.3	-	-10^{-5}	-0.3	-	-1.0	
Disable Current	H Level	I_{DH}	$V_{OH} = 18V$	18	-	0.5	-	10^{-4}	0.5	-	30	μA
	L Level	I_{DL}	$V_{OL} = 0V$	18	-	-0.5	-	-10^{-4}	-0.5	-	-30	
Quiescent Current Consumption	I_{DD}	$V_{IN} = V_{SS}, V_{DD}$ *	5	-	4.0	-	0.002	4.0	-	30	μA	
			10	-	8.0	-	0.004	8.0	-	60		
			15	-	16.0	-	0.008	16.0	-	120		

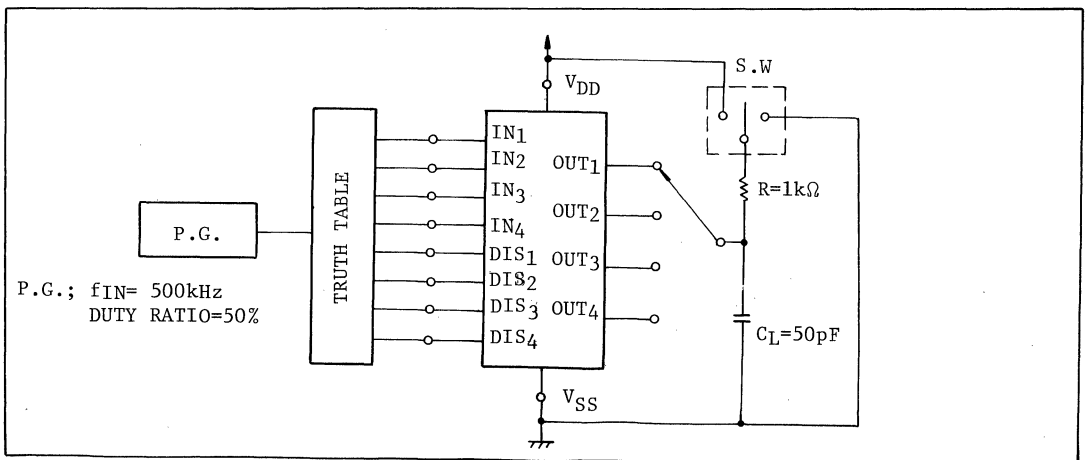
* All valid input combinations

TC5024BP, TC5025BP

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

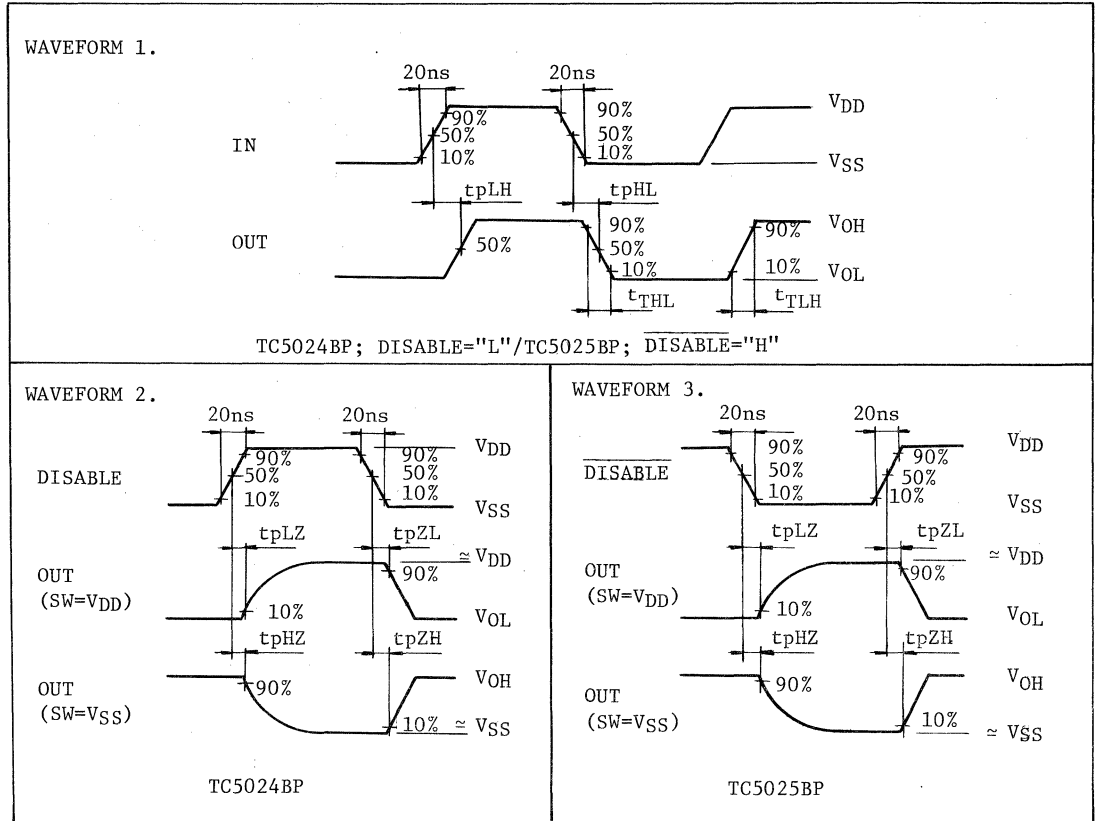
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	TC5024BP			TC5025BP			UNIT
				MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Output Rise Time	t _{TLH}		5	-	130	400	-	130	400	ns
			10	-	65	200	-	65	200	
			15	-	50	160	-	50	160	
Output Fall Time	t _{THL}		5	-	100	200	-	100	200	ns
			10	-	50	100	-	50	100	
			15	-	40	80	-	40	80	
(LOW-HIGH) Propagation Delay Time (IN - OUT)	t _{pLH}		5	-	150	300	-	150	300	ns
			10	-	75	150	-	75	150	
			15	-	60	100	-	60	100	
(HIGH-LOW) Propagation Delay Time (IN - OUT)	t _{pHL}		5	-	180	300	-	180	300	ns
			10	-	75	150	-	75	150	
			15	-	60	100	-	60	100	
Three State Propagation Delay Time	H-HZ	t _{pHZ}	5	-	95	200	-	70	150	ns
			10	-	50	120	-	50	100	
			15	-	40	100	-	40	80	
	L-HZ	t _{pLZ}	5	-	300	600	-	130	200	ns
			10	-	200	400	-	70	150	
	15	-	190	300	-	60	120			
	HZ-H	t _{pZH}	5	-	100	200	-	70	150	ns
			10	-	40	120	-	40	80	
15	-	30	100	-	30	70				
HZ-L	t _{pZL}	5	-	210	600	-	130	200	ns	
		10	-	90	300	-	60	150		
		15	-	60	200	-	40	120		
Input Capacity	C _{IN}			-	5	7.5	-	5	7.5	pF
Output Disable Capacity	C _{OUT}			-	30	-	-	30	-	pF

SWITCHING TIME TEST CIRCUIT



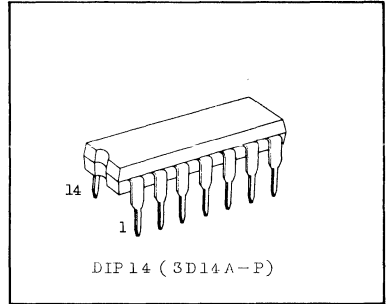
TC5024BP, TC5025BP

SWITCHING TIME TEST WAVEFORMS



TC5026BP DECADE COUNTER

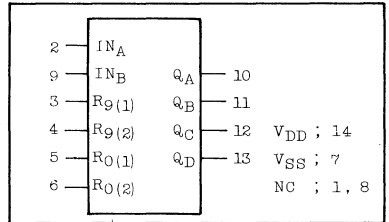
TC5026BP is DECADE UP COUNTER with two reset functions, RESET (9) and RESET (0) and can be used as binary counter, quinary counter or decimal counter. When two inputs of RESET (0) are set to "H", the content of counter is reset to 0 regardless of the clock and when two inputs of RESET (9) are set to "H", it is set to 9. RESET (9) takes precedence over RESET (0). The outputs change their states at the falling edge of count inputs (IN_A and IN_B).



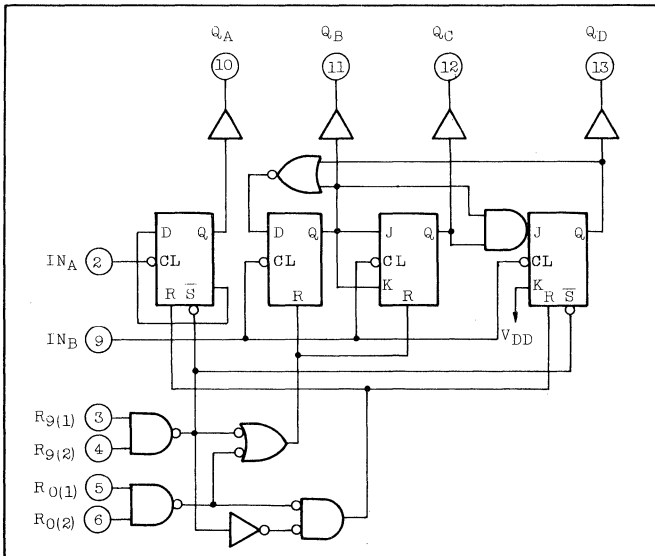
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

RESET / COUNT MODE									
INPUTS						OUTPUTS			
IN _A , IN _B	R ₀ (1)	R ₀ (2)	R ₉ (1)	R ₉ (2)	Q _D	Q _C	Q _B	Q _A	
*	H	H	L	*	L	L	L	L	
*	H	H	*	L	L	L	L	L	
*	*	*	H	H	H	L	L	H	
\bar{L}	*	L	*	L					COUNT
\bar{L}	L	*	L	*					COUNT
\bar{L}	L	*	*	L					COUNT
\bar{L}	*	L	L	*					COUNT

* Don't care

COUNT MODE A

COUNT NO.	Q _D	Q _C	Q _B	Q _A
0	L	L	L	L
1	L	L	H	L
2	L	H	L	L
3	L	H	H	L
4	H	L	L	L

COUNT MODE B

COUNT NO.	Q _D	Q _C	Q _B	Q _A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L

A ; Separate mode.
 B ; IN_B should be connected to Q_A

5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

TC5026BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} = V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} = V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Current	I _{OH}	V _{OH} = 4.6V V _{OH} = 9.5V V _{OH} = 13.5V V _{IN} = V _{SS} , V _{DD}	5	-0.2	-	-0.16	-	-	-0.12	-	mA
			10	-0.5	-	-0.4	-	-	-0.3	-	
			15	-1.4	-	-1.2	-	-	-1.0	-	
			5	0.52	-	0.44	-	-	0.36	-	
Low Level Output Current	I _{OL}	V _{OL} = 0.4V V _{OL} = 0.5V V _{OL} = 1.5V V _{IN} = V _{SS} , V _{DD}	5	0.52	-	0.44	-	-	0.36	-	mA
			10	1.3	-	1.1	-	-	0.9	-	
			15	3.6	-	3.0	-	-	2.4	-	
			5	3.5	-	3.5	2.75	-	3.5	-		V
10	7.0	-	7.0	5.5	-	7.0	-				
15	11.0	-	11.0	8.25	-	11.0	-				
High Level Input Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.0	-	
			5	-	1.5	-	2.25	1.5	-	1.5		V
10	-	3.0	-	4.5	3.0	-	3.0				
15	-	4.0	-	6.75	4.0	-	4.0				
Low Level Input Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
			18	-	0.3	-	10 ⁻⁵	0.3	-	1.0		μA
"L" Level	I _{IL}	V _{IL} = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Current Consumption	I _{DD}	V _{IN} = V _{SS} , V _{DD} *	5	-	20	-	0.005	20	-	150	μA
			10	-	40	-	0.010	40	-	300	
			15	-	80	-	0.015	80	-	600	

* All valid input combinations

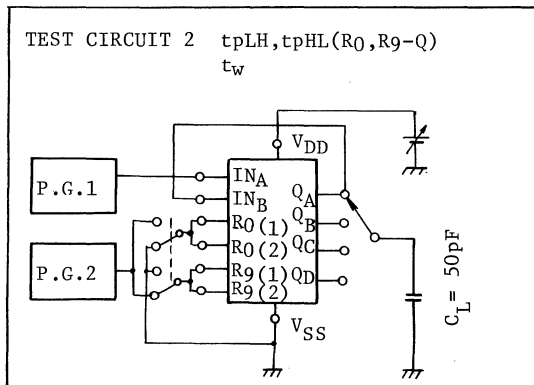
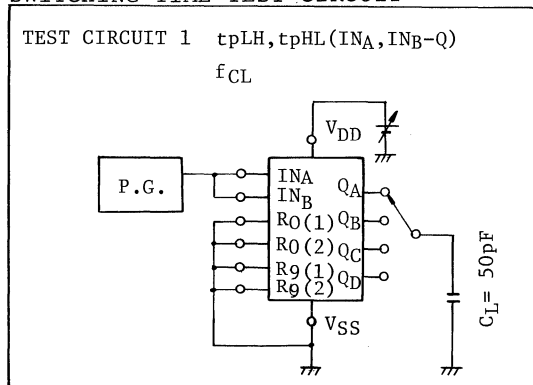
SWITCHING CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD(V)	MIN.	TYP.	MAX.	UNIT
(LOW-HIGH) Propagation Delay Time (INA, INB - Q)	tpLH		5	-	340	750	ns
			10	-	160	350	
			15	-	130	280	
(HIGH-LOW) Propagation Delay Time (INA, INB - Q)	tpHL		5	-	310	650	
			10	-	150	330	
			15	-	120	250	
(LOW-HIGH) Propagation Delay Time (R(0), R(9) - Q)	tpLH		5	-	350	700	ns
			10	-	150	300	
			15	-	120	250	
(HIGH-LOW) Propagation Delay Time (R(0), R(9) - Q)	tpHL		5	-	350	700	
			10	-	150	300	
			15	-	120	250	
Max. Clock Rise Time	t _{rCL}		5	20	-		μs
Max. Clock Fall Time	t _{fCL}		10	2.5	-		
			15	1.0	-		
Max. Clock Frequency (INA, INB)	t _{CL}		5	0.8	1.2	-	MHz
			10	1.5	2.5	-	
			15	2.0	3.2	-	
Min. Reset Pulse Width	t _w (RESET)		5	-	250	500	ns
			10	-	100	200	
			15	-	75	150	
Input Capacity	C _{IN}			-	5	7.5	pF

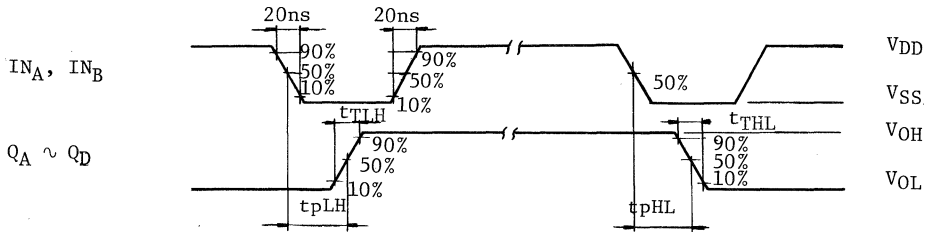
SWITCHING TIME TEST CIRCUIT



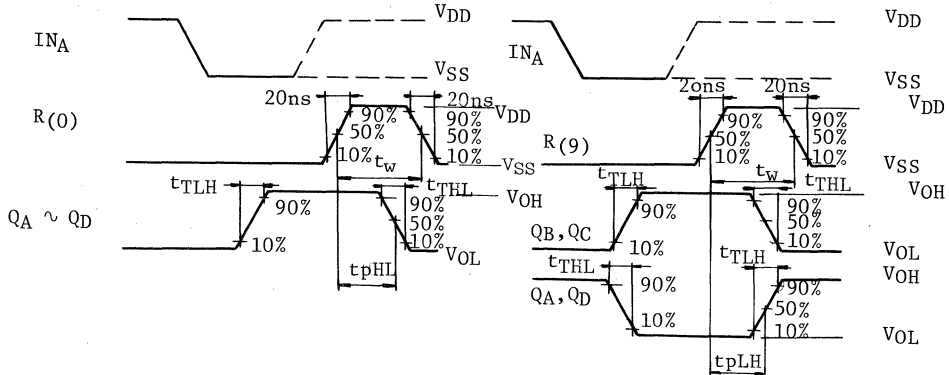
TC5026BP

SWITCHING TIME TEST WAVEFORMS

WAVEFORM 1. t_{pLH} , t_{pHL} ($IN_A, IN_B - Q$), f_{CL}



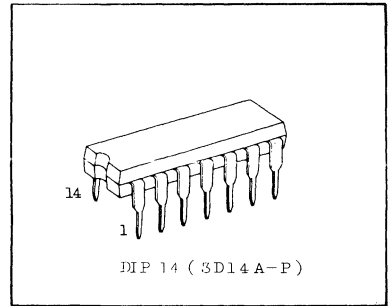
WAVEFORM 2. t_{pLH} , t_{pHL} [$R(0), R(9) - Q$], t_w



TC5027BP BINARY COUNTER

TC5027BP is four bit binary up counter with the reset function and since the clock for the first stage is independent from the clock for the second through the fourth stages, this can be used as binary, octal or hexadecimal counter/divider.

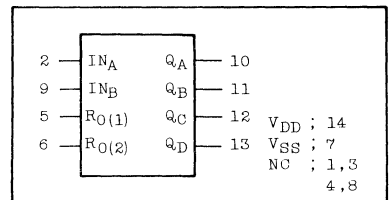
When two inputs of RESET(0) are set to "H", the content of counter is reset to 0 regardless of the clock. The outputs change their states at the falling edge of count inputs (IN_A, IN_B).



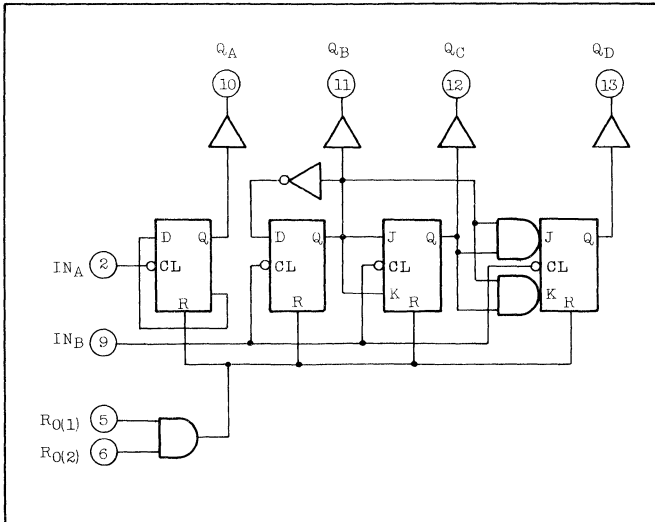
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _d	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



LOGIC DIAGRAM



TRUTH TABLE

RESET / COUNT MODE								
INPUTS			OUTPUT					
IN _A , IN _B	R ₀ (1)	R ₀ (2)	Q _D	Q _C	Q _B	Q _A		
*	H	H	L	L	L	L		
\overline{L}	L	*	COUNT					
\overline{L}	*	L	COUNT					
* Don't care								
COUNT MODE A				COUNT MODE B				
COUNT NO.	OUTPUTS			COUNT NO.	OUTPUTS			
	Q _D	Q _C	Q _B		Q _D	Q _C	Q _B	Q _A
0	L	L	L	0	L	L	L	L
1	L	L	H	1	L	L	L	H
2	L	H	L	2	L	L	H	L
3	L	H	H	3	L	L	H	H
4	H	L	L	4	L	H	L	L
5	H	L	H	5	L	H	L	H
6	H	H	L	6	L	H	H	L
7	H	H	H	7	L	H	H	H
				8	H	L	L	L
				9	H	L	L	H
				10	H	L	H	L
				11	H	L	H	H
				12	H	H	L	L
				13	H	H	L	H
				14	H	H	H	L
				15	H	H	H	H

A ; Separate mode.
B ; IN_B should be connected to Q_A.

TC5027BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp.	T _{opr}	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} = V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} = V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
High Level Output Current	I _{OH}	V _{OH} = 4.6V V _{OH} = 9.5V V _{OH} = 13.5V V _{IN} = V _{SS} , V _{DD}	5	-0.2	-	-0.16	-	-	-0.12	-	mA	
			10	-0.5	-	-0.4	-	-	-0.3	-		
			15	-1.4	-	-1.2	-	-	-1.0	-		
Low Level Output Current	I _{OL}	V _{OL} = 0.4V V _{OL} = 0.5V V _{OL} = 1.5V V _{IN} = V _{SS} , V _{DD}	5	0.52	-	0.44	-	-	0.36	-	mA	
			10	1.3	-	1.1	-	-	0.9	-		
			15	3.6	-	3.0	-	-	2.4	-		
High Level Input Voltage	V _{IH}	V _{OUT} = 0.5V, 4.5V V _{OUT} = 1.0V, 9.0V V _{OUT} = 1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Low Level Input Voltage	V _{IL}	V _{OUT} = 0.5V, 4.5V V _{OUT} = 1.0V, 9.0V V _{OUT} = 1.5V, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} = 18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	I _{DD}	V _{IN} = V _{SS} , V _{DD} *	5	-	20	-	0.005	20	-	150	μA	
			10	-	40	-	0.010	40	-	300		
			15	-	80	-	0.015	80	-	600		

*All valid input combinations

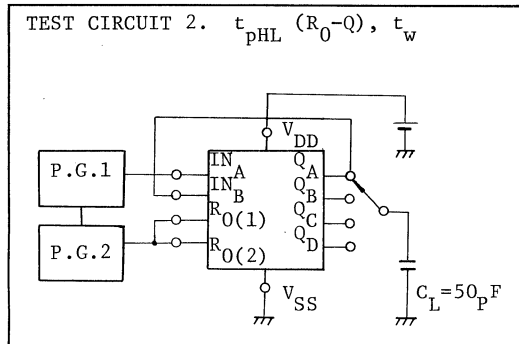
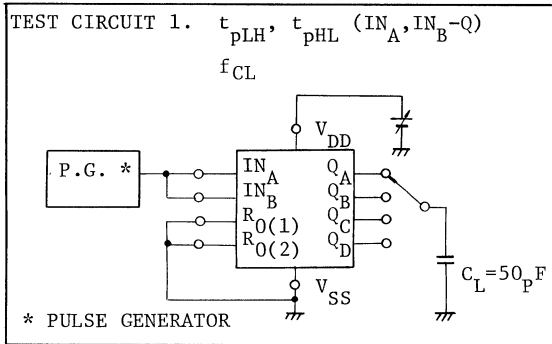
SWITCHING CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

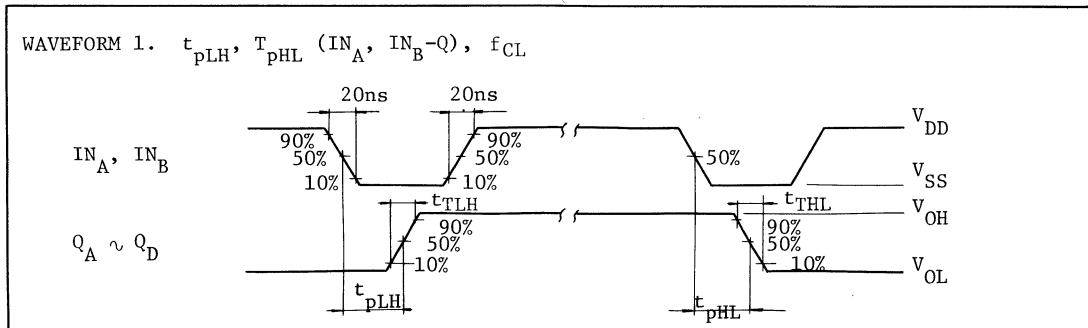
SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50 pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD}	MIN.	TYP.	MAX.	UNIT
(Low-High) Propagation Delay Time (IN _A , IN _B - Q)	t _{pLH}		5	-	340	750	
			10	-	160	350	
			15	-	130	280	
(High-Low) Propagation Delay Time (IN _A , IN _B - Q)	t _{pHL}		5	-	310	650	ns
			10	-	150	330	
			15	-	120	250	
(High-Low) Propagation Delay Time (R ₀ - Q)	t _{pHL}		5	-	250	700	ns
			10	-	120	300	
			15	-	100	250	
Max. Clock Rise Time	t _{rCL}		5	20	-	-	μs
			10	2.5	-	-	
Max. Clock Fall Time	t _{fCL}		5	1.0	-	-	μs
			10	1.0	-	-	
Max. Clock Frequency (IN _A , IN _B)	f _{CL}		5	0.8	1.2	-	MHz
			10	1.5	2.5	-	
			15	2.0	3.2	-	
Min. Reset Pulse Width	t _w (RESET)		5	-	250	500	ns
			10	-	110	200	
			15	-	80	150	
Input Capacitance	C _{IN}		-	5	-	pF	

SWITCHING TIME TEST CIRCUITS

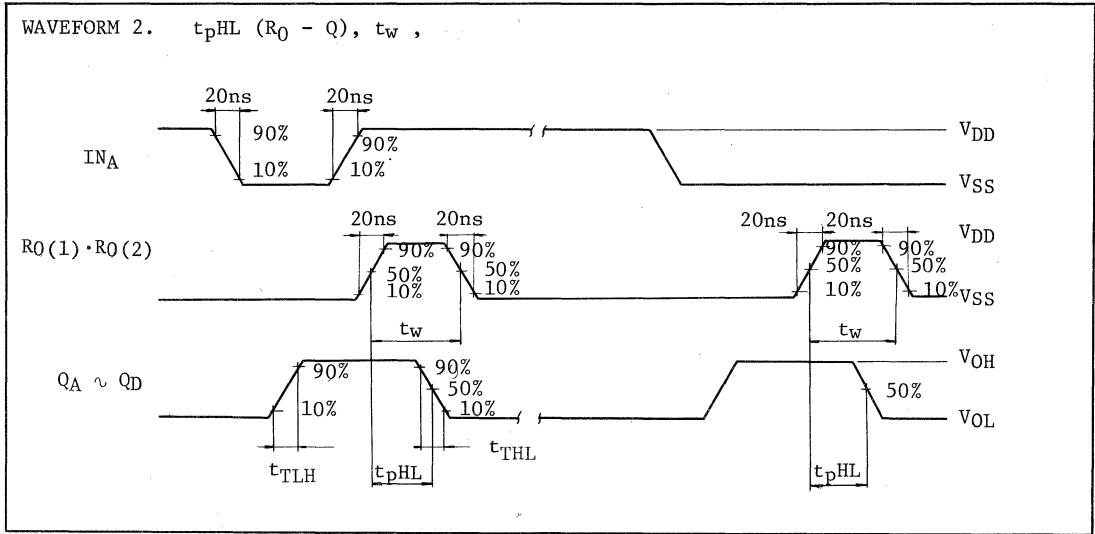


SWITCHING TIME TEST WAVEFORMS



TC5027BP

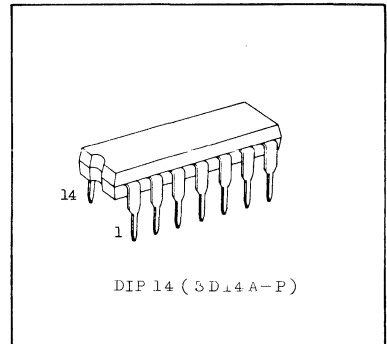
SWITCHING TIME TEST WAVEFORMS



TC5029BP QUAD 2-INPUT NAND GATE WITH N-CHANNEL OPEN DRAIN OUTPUT

TC5029BP contains four circuits of 2 input NAND gates having its respective outputs of N-channel open drain structure.

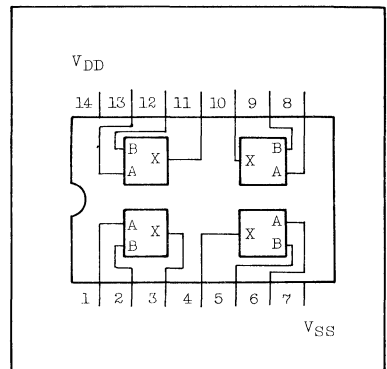
Since the drain voltage of output transistors are guaranteed up to 26 volts, these can be used for wide range of applications such as level shifters and drivers, and the wired OR arrangement is also easily obtained. Please utilize these for level shifters for P-channel MOS, controlling analog switches of positive/negative power supplies, etc.



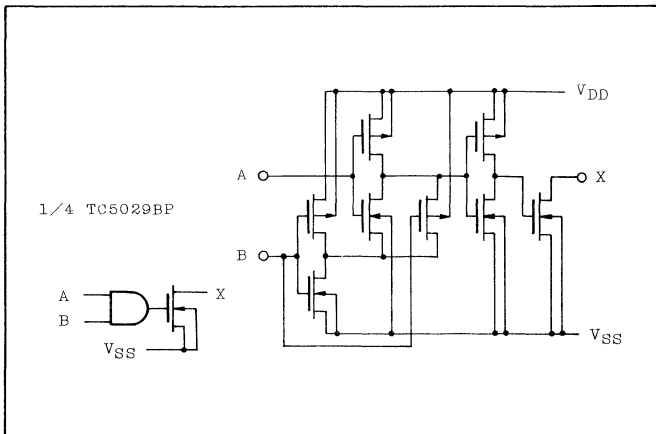
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{SS}+26$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}C$
Lead Temp./Time	T_{sol}	$260^{\circ}C \cdot 10sec$	

PIN ASSIGNMENT



CIRCUIT DIAGRAM



TRUTH TABLE

INPUTS		OUTPUT
B	A	X
L	L	HZ
L	H	HZ
H	L	HZ
H	H	L

HZ ; HIGH IMPEDANCE

TC5029BP

RECOMMENDED OPERATION CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Output Voltage	V _{OUT}	0	-	24	V
Operating Temperature	T _{opr}	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Low Level Output Voltage	V _{OL}	I _{OUT} <1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} , V _{DD}	5	3.2	-	3.2	-	-	2.5	-	mA	
			10	5.0	-	5.0	-	-	3.6	-		
			15	24.0	-	24.0	-	-	18.0	-		
High Level Input Voltage **	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V I _{OUT} <1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Low Level Input Voltage **	V _{IL}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V I _{OUT} <1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Output off Leakage Current	I _{DH}	V _{OH} =24V	-	-	0.5	-	10 ⁻³	0.5	-	50	μA	
Input Current	High Level	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	Low Level	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Current Consumption	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	1.0	-	0.001	1.0	-	7.5	μA	
			10	-	2.0	-	0.001	2.0	-	15		
			15	-	4.0	-	0.002	4.0	-	30		

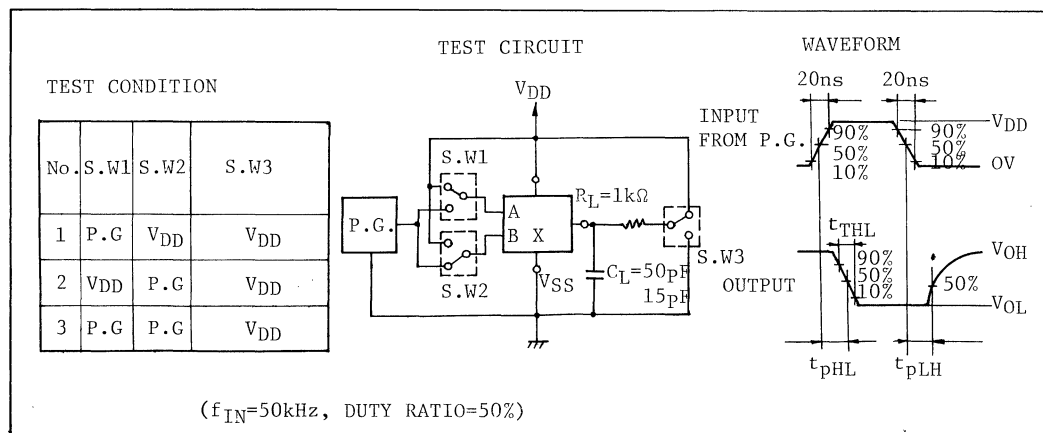
* All valid input combinations. Outputs open.

** R_L=20KΩ

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD}	MIN.	TYP.	MAX.	UNIT
			(V)				
Output Fall Time	t _{THL}	C _L =50pF	5	-	85	200	ns
			10	-	30	80	
			15	-	20	60	
(Low-High) Propagation Delay Time	t _{pLH}	R _L =1KΩ	5	-	230	500	ns
		C _L =15pF	10	-	120	200	
			15	-	100	150	
(High-Low) Propagation Delay Time	t _{pHL}	R _L =1KΩ	5	-	260	500	ns
		C _L =15pF	10	-	90	200	
			15	-	60	150	
(Low-High) Propagation Delay Time	t _{pLH}	R _L =10KΩ	5	-	830	1200	ns
		C _L =15pF	10	-	680	1000	
			15	-	610	850	
(High-Low) Propagation Delay Time	t _{pHL}	R _L =10KΩ	5	-	270	500	ns
		C _L =50pF	10	-	95	200	
			15	-	63	150	
Input Capacitance	C _{IN}			-	5	7.5	pF
Output Off Capacitance	C _{OUT}			-	25	-	pF

SWITCHING TIME TEST CIRCUIT AND WAVEFORM



TC5032P

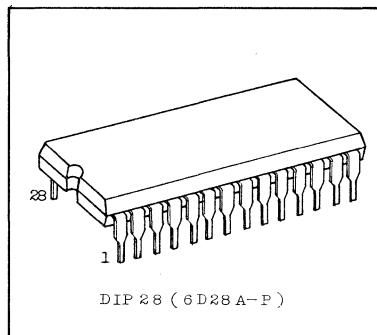
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5032P 6-DIGIT DECADE COUNTER

TC5032P is six digit decimal counter whose BCD output of each digit is dynamically output in sequence from the higher order digit on BCD OUTPUT in synchronism with SCAN input. As the carry outputs are available from all the digits, other counters and control circuits can be easily driven.

By using BC (Blanking Control) input, leading zero suppress from arbitrary digit can be achieved without external circuits.

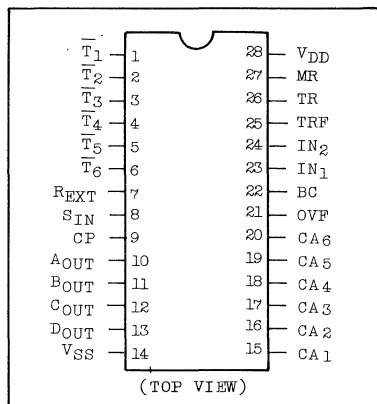
Since the first stage counter can respond up to 10MHz (V_{DD}=5 volts), this is also suitable for counting and frequency dividing of high frequency pulses.



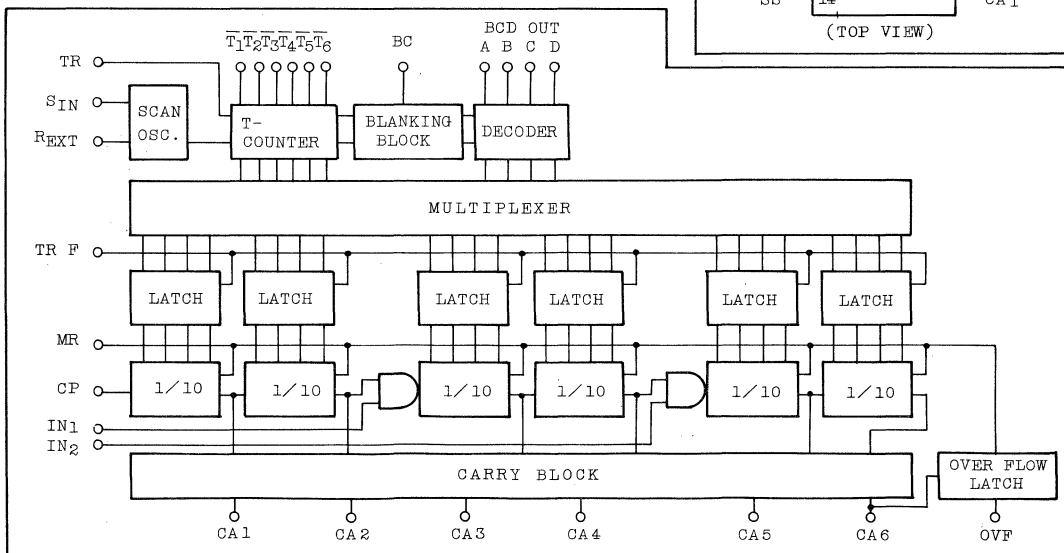
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-55 ~ 125	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



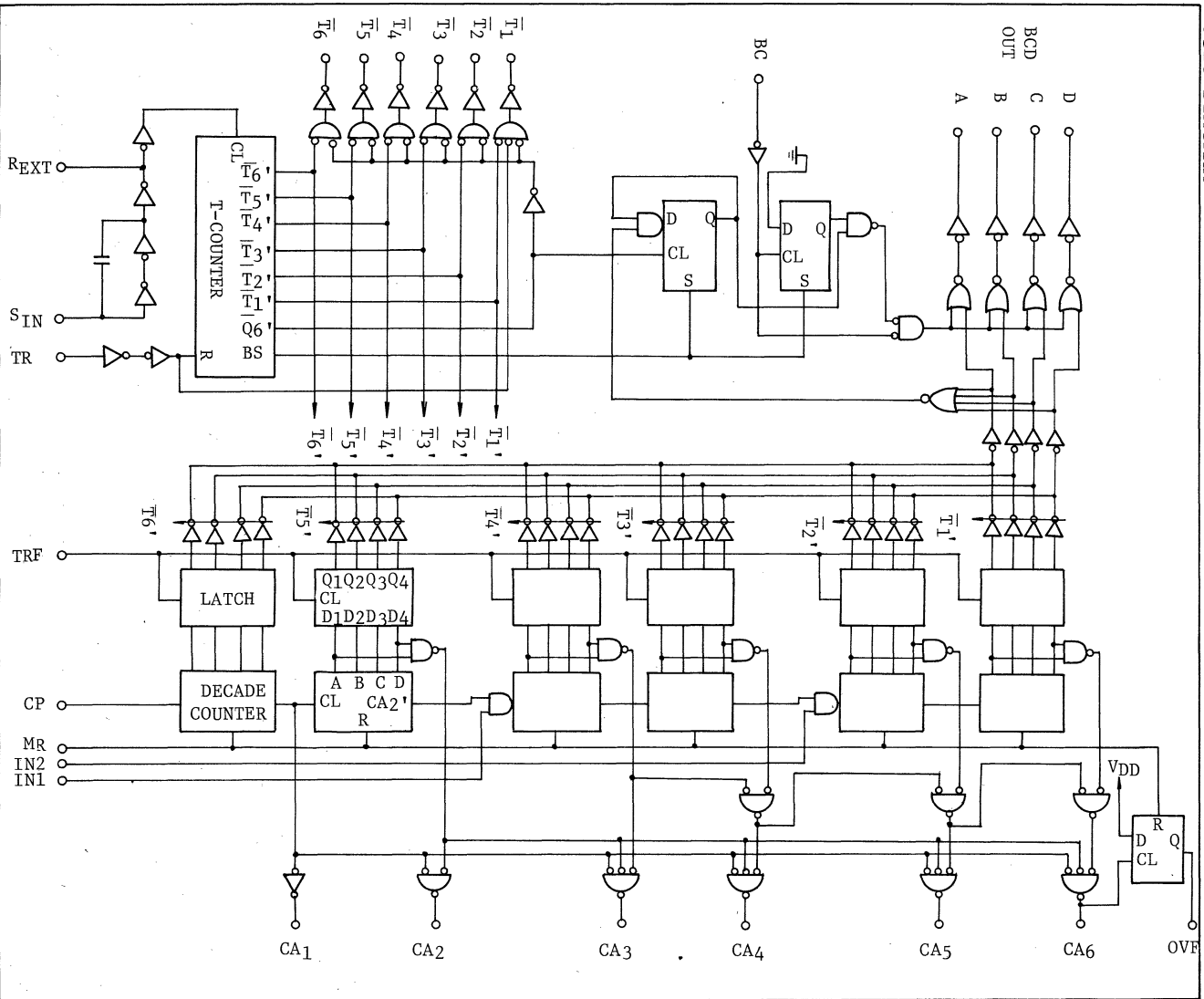
BLOCK DIAGRAM



PIN FUNCTION & NAME

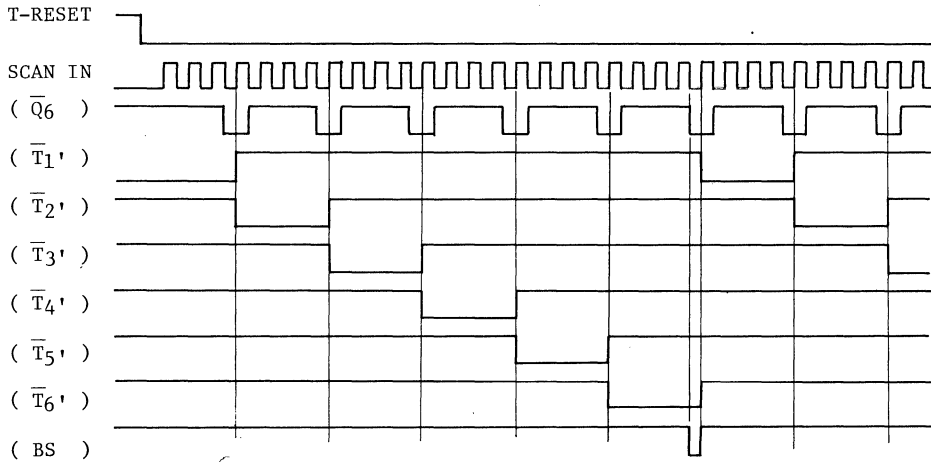
PIN NO.	SYMBOL	NAME	FUNCTION	
1	$\overline{T1}$	$\overline{T1}$	Outputs to indicate the digit of output signals A_{OUT} through D_{OUT} , the sequence is descending order from $\overline{T1}$. With $TR="H"$, all of $\overline{T1}$ through $\overline{T6}$ become "H", and when \overline{TR} falls, $\overline{T1}$ becomes "L". Then, "L" is shifted in sequence $\overline{T2}$, $\overline{T3}$ --- by each 4 clocks of S_{IN} .	
2	$\overline{T2}$	$\overline{T2}$		
3	$\overline{T3}$	$\overline{T3}$		
4	$\overline{T4}$	$\overline{T4}$		
5	$\overline{T5}$	$\overline{T5}$		
6	$\overline{T6}$	$\overline{T6}$		
7	R_{EXT}	RESISTOR EXTERNAL	Leave open when an external clock is applied from S_{IN} . When no external clock is available, clock can be generated by externally connecting a resistor between S_{IN} and R_{EXT} .	
8	S_{IN}	SCAN INPUT	T-COUNTER CLOCK input. T-COUNTER changes its state at the rising edge of S_{IN} .	
9	CP	CLOCK INPUT	Decimal counter clock input for the lowest order digit.	
10	A_{OUT}	A-OUTPUT	Decimal counter BCD output. When $\overline{T1}="L"$, the highest order digit (6th digit) is output. Then, 5th digit is output with $\overline{T2}="L"$, 4th digit with $\overline{T3}="L"$, ---, 1st digit with $\overline{T6}="L"$. During BLANKING, all the outputs become "H".	
11	B_{OUT}	B-OUTPUT		
12	C_{OUT}	C-OUTPUT		
13	D_{OUT}	D-OUTPUT		
14	V_{SS}	V_{SS}	(GND)	
15	CA1	CARRY 1	Carry output from n-th digit "L" when count is "xxxxx6"~"xxxxx9", otherwise "H". "L" when count is "xxxx96"~"xxxx99", otherwise "H". "L" when count is "xxx996"~"xxx999", otherwise "H". "L" when count is "xx9996"~"xx9999", otherwise "H". "L" when count is "x99996"~"x99999", otherwise "H". "L" when count is "999996"~"999999", otherwise "H".	
16	CA2	CARRY 2		
17	CA3	CARRY 3		
18	CA4	CARRY 4		
19	CA5	CARRY 5		
20	CA6	CARRY 6		
21	OVF	OVER FLOW	Detection terminal of OVER FLOW condition of counter. When the counter advances by one from "999999", it becomes "H". Once it has become "H", only MR can restore it to "L".	
22	BC	BLANKING CONTROL	"H" Zero suppress for all the digits.	If \overline{Tn} is connected to BC, zero suppress is activated for the higher order digits than (n-1)th digit.
			"L" No zero suppress.	
23	IN1	INPUT 1	"H" All the digits are counted.	Only the lower order two digits are counted.
			"L" Only the lower order two digits are counted.	
24	IN2	INPUT 2	"H" All the digits are counted.	Only the lower order four digits are counted.
			"L" Only the lower order four digits are counted.	
25	TRF	TRANSFER	"H" Decimal counter output is transferred to the multiplexer as it is.	Counter output at the falling edge of TRF is latched.
			"L" Counter output at the falling edge of TRF is latched.	
26	TR	T-COUNTER RESET	T-counter is initialized to T1 by "H" level input and $\overline{T1}$ retains "H" level only for the period of $TR="H"$.	
27	MR	MASTER RESET	"H" level input resets the counter to count "000000" and OVER FLOW to "L".	
28	V_{DD}	V_{DD}	V_{DD} power supply (3~8 volts)	

LOGIC DIAGRAM

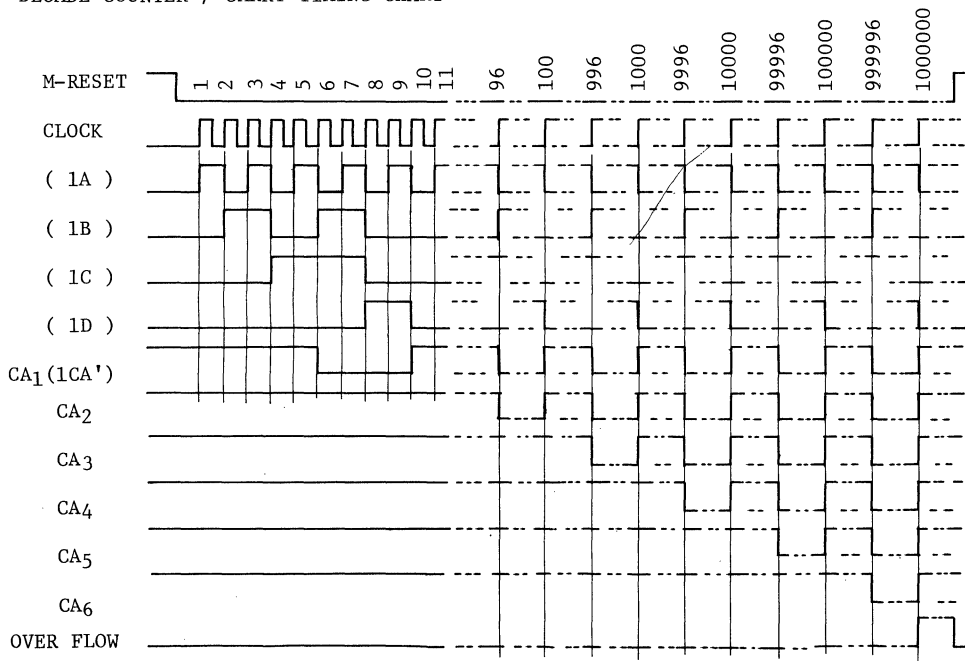


TIMING CHART

T-COUNTER TIMING CHART



DECADE COUNTER / CARRY TIMING CHART



* Waveform marked with () are timings of LSI's internals. (Refer to LOGIC DIAGRAM)

OPERATING CONSIDERATION

* Count Operation

Set input terminals IN1, IN2 and TRANSFER to "H" and apply "H" level to M-RESET terminal, then return it to "L" level. If pulse is fed to CLOCK terminal in this condition, the counter advances its count at the rising edge of CLOCK up to 999999.

Since CARRY outputs from all the digits are output in negative logic, the control of other CMOS logics can be easily achieved.

$\overline{CA1} - \overline{CA6}$ are output with "L" level for four clock periods. (Refer to the timing chart.)

If one more clock is given in the count of 999999, OVER FLOW terminal becomes "H" indicating the overflow condition of COUNTER. Once OVER FLOW terminal has become "H", it will never return to "L" unless M-RESET is applied.

* Latch Operation

When the level of TRANSFER terminal is "H", the counter output is transferred to the multiplexer as it is with the output always indicating the counter output, but if TRANSFER terminal changes the level from "H" to "L", the count output which has been being output immediately prior to the falling edge of TRANSFER is stored in the latch and even if the counter output varies, AOUT - DOUT will not vary.

If TRANSFER terminal is returned to "H" again, the correct counter output appears on AOUT - DOUT.

* Scan Operation

BCD outputs of all digits are output to common AOUT - DOUT on the time sharing basis and the basic clock for this operation is fed from outside to SCAN IN (leaving R_{EXT} open in this case) or obtained by connecting a resistor between R_{EXT} and SCAN IN.

BCD output for each digit appears on AOUT - DOUT corresponding to each digit of 6 digit scan signals (digit signals) which are in synchronism with the rising edge of SCAN IN. The digit output for digit selection is output with "L" level on $\overline{T1} - \overline{T6}$. As BCD outputs are output starting from the highest order digit ($\overline{T1}$ - 6th digit, $\overline{T6}$ - 1st digit), data transfer can be easily achieved.

* The relationship between external resistor between R_{EXT} and SCAN IN and oscillating frequency is given below

$$f \doteq \frac{1}{44 \times R} \times 10^{12} \text{ [Hz]}$$

* Blanking

By controlling BLANKING CONTROL terminal, leading zero suppress to an arbitrary digit can be easily achieved. When zero suppress is activated, all of AOUT - DOUT become "H".

BC Terminal and Zero Suppress

BRANKING CONTROL	Leading Zero Suppress
L	No zero suppress
H	Zero suppress for all digits *
Connected to $\overline{T_6}$	Zero suppress for five higher order digits and no zero suppress for the lowest order digit. *
Connected to $\overline{T_5}$	Zero suppress for four higher order digits and no zero suppress for two lower order digits. *
Connected to $\overline{T_4}$	Zero suppress for three higher order digits and no zero suppress for three lower order digits. *
Connected to $\overline{T_3}$	Zero suppress for two higher order digits and no zero suppress for four lower order digits. *
Connected to $\overline{T_2}$	Zero suppress for the highest order digit and no zero suppress for five lower order digits. *

* When carry is generated from lower order digit, the normal output may not be obtained only one cycle of T-COUNTER.

TC5032P

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	3	-	8	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
Operating Temperature	T_{opr}	-30	-	85	°C
R_{EXT} External Resistance	R_{EXT}	20K	-	10M	Ω

ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-30°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
Output Voltage	High Level	V_{OH}	$I_{OH}=-1\mu A$	5	4.95	-	4.95	-	-	4.95	-	V
	Low Level	V_{OL}	$I_{OL}=1\mu A$	5	-	0.05	-	-	0.05	-	0.05	
Output Current	High Level	I_{OH}	$V_{OH}=2.5V$	5	-0.7	-	-0.6	-2	-	-0.5	-	mA
	Low Level	I_{OL}	$V_{OL}=0.4V$	5	0.52	-	0.44	1.3	-	0.36	-	
Input Voltage	High Level	V_{IH}	$V_{OUT}=0.5V, 4.5V$	5	3.5	-	3.5	2.75	-	3.5	-	V
	Low Level	V_{IL}	$V_{OUT}=0.5V, 4.5V$	5	-	1.5	-	2.25	1.5	-	1.5	
Input Current	High Level	I_{IH}	$V_{IH}=8V$	8	-	0.15	-	-	0.15	-	1.0	μA
	Low Level	I_{IL}	$V_{IL}=0V$	8	-	-0.15	-	-	-0.15	-	-1.0	
Quiescent Current Consumption	I_{DD}	At all conditions	5	-	0.4	-	10^{-5}	0.4	-	0.8	mA	
			8	-	0.5	-	10^{-5}	0.5	-	1.0		

SWITCHING CHARACTERISTICS ($T_a=25^\circ C$, $V_{SS}=0V$, $C_L=15_pF$)

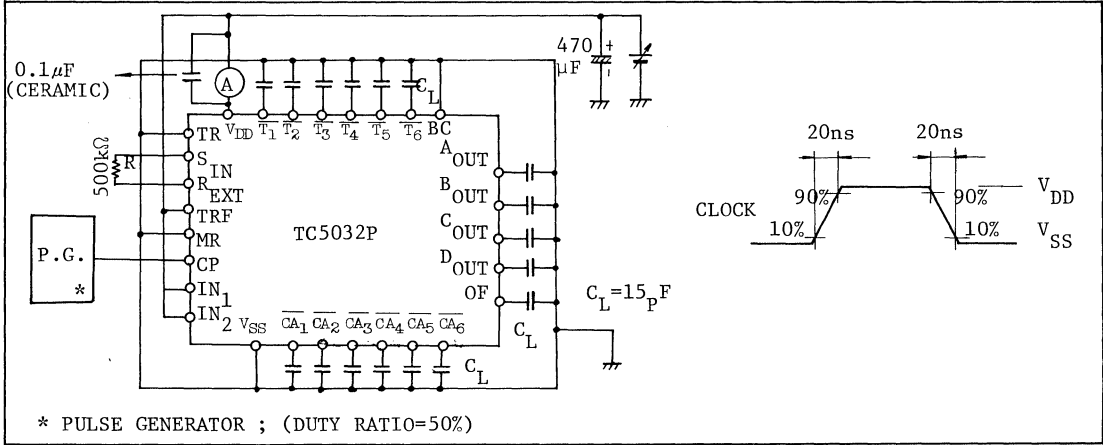
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time (CP - BCD OUT)	t_{PLH}	$(\overline{T6} = L)$	5	-	800	2000	ns
		$(\overline{T5} = L)$	5	-	1000	2200	
	t_{PHL}	$(\overline{T4} = L)$	5	-	1250	2500	
		$(\overline{T3} = L)$	5	-	1500	3000	
		$(\overline{T2} = L)$	5	-	1750	3500	
		$(\overline{T1} = L)$	5	-	2000	4000	
Propagation Delay Time (CP - CARRY OUT)	t_{PLH}	CA1	5	-	(200)	500	ns
		CA2	5	-	(200)	500	
		CA3	5	-	(250)	750	
	t_{PHL}	CA4	5	-	(250)	750	
		CA5	5	-	(300)	1000	
		CA6	5	-	(300)	1000	
Max. Clock Rise Time	$t_{r\phi}$	CP, IN_1 , IN_2	5	20	-	-	μs
Max. Clock Fall Time	$t_{f\phi}$						
Min. Clear Pulse Width	$t_{w(MR)}$	MASTER RESET	5	-	-	500	ns
	$t_{w(TR)}$	T-COUNTER RESET				400	

SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=15 pF)

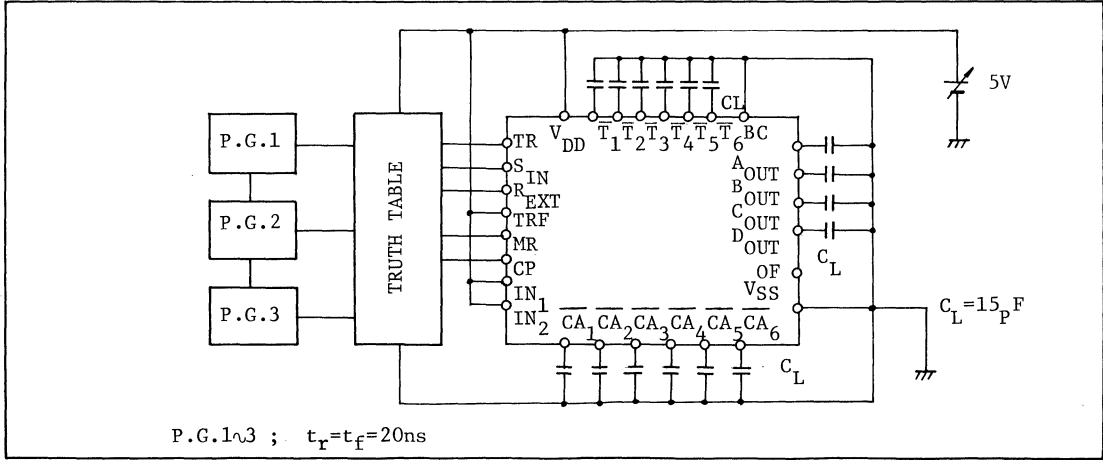
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT	
			5					
Propagation Delay Time	(High-Low)	t _{pHL}	MR-BCD OUT	5	-	-	2000	ns
	(Low-High)	t _{pLH}	TR-DIGIT OUT	5	-	-	1500	
Propagation Delay Time		t _{pLH, pHL}	SIN-BCD OUT	5	-	1000	2500	ns
		t _{pLH, pHL}	SIN-DIGIT OUT	5	-	500	1000	
Max. Frequency		f _{CL-1}	CLOCK IN *	5	10.0	14.0	-	MHz
		f _{CL-2}		5	1.0	2.0	-	
		f _{CL} SIN	SCAN IN	5	0.5	-	-	

* f_{CL-1}; Clock burst mode. f_{CL-2}; BCD outputs enable.

I_{DD} TEST CIRCUIT

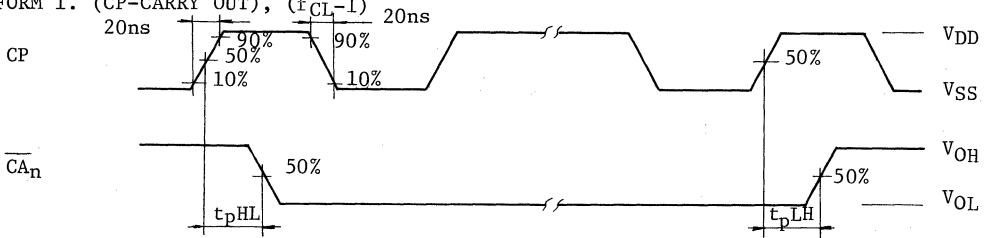


SWITCHING TIME TEST CIRCUIT



SWITCHING TIME TEST WAVEFORMS

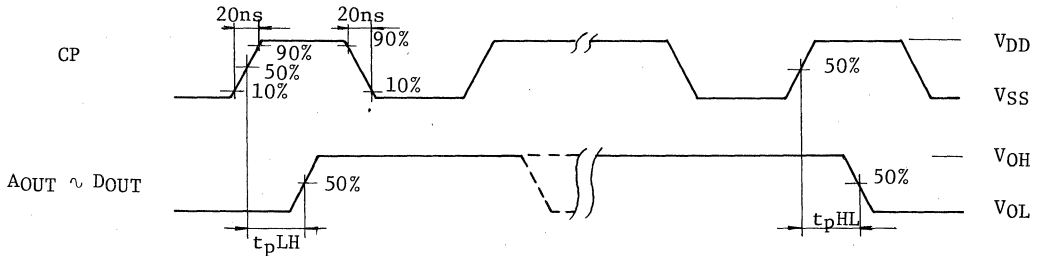
WAVEFORM 1. (CP-CARRY OUT), (f_{CL-1})



*MR, TR, SIN = "L"

**CP INPUT : $f=500kHz$ (except f_{CL}), DUTY RATIO=50%

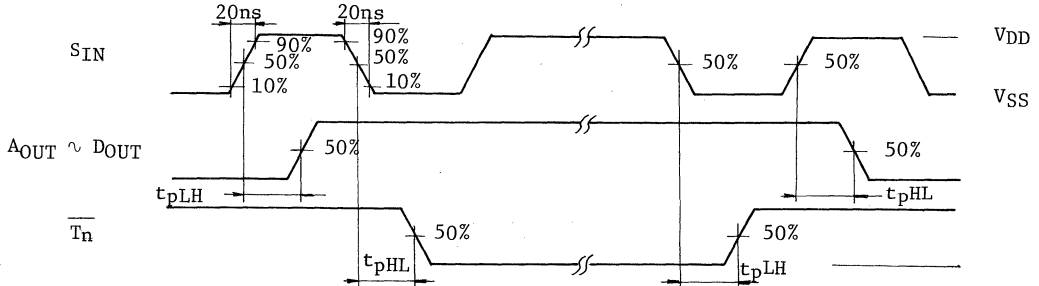
WAVEFORM 2. (CP-BCD OUT), (f_{CL-2})



* MR, TR="L" SIN=MANUAL PULSE

**CP INPUT : $f=250kHz$ (except f_{CL}), DUTY RATIO=50%

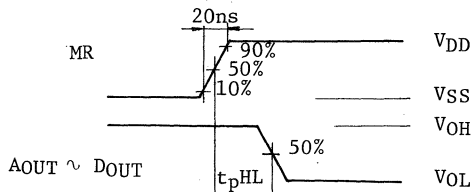
WAVEFORM 3. (SIN-DIGIT OUT), (SIN-BCD OUT), (f_{CL} SIN)



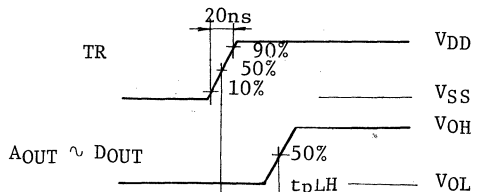
*MR, TR="L", CP : MANUAL PULSE

**SIN : $f=250kHz$, DUTY RATIO = 50%

WAVEFORM 4. (MR-BCD OUT)



WAVEFORM 5. (TR-DIGIT OUT)



*TR="L", CP: PULSE GENERATOR, SIN: MANUAL PULSE *MR="L", SIN: MANUAL PULSE, CP: PULSE GENERATOR

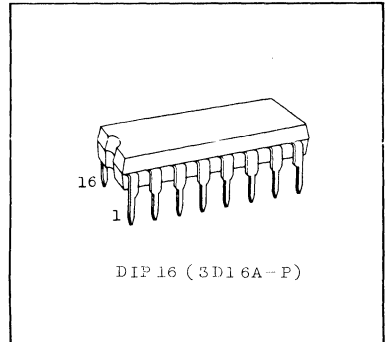
TC5036P, TC5048P 17-STAGE HIGH SPEED FREQUENCY DIVIDER

TC5036P and TC5048P are 17-stage ripple carry binary counters equipped with inverters for crystal oscillators.

As the first stage through the fourth stage are dynamic type counter, the high speed operation can be obtained but the operation starting from DC is not possible, so that these should be used in the range of $f_{MIN} \sim f_{MAX}$.

If ϕ input is opened ($\phi = "L"$), the inverted output of 9th stage appears on FC terminal. If ϕ input is set to "H", 9 stages from 9th stage through 17th stage can be also independently used having FC terminal as the clock input.

Outputs can be derived arbitrarily from stages 4, 12, 13, 14, 15, 16 and 17 of TC5036P and stages 4, 5, 6, 7, 14, 16 and 17 of TC5048P.



ABSOLUTE MAXIMUM RATINGS

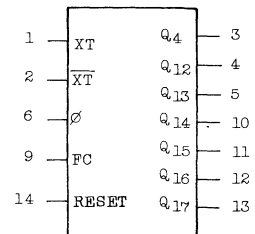
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VDD1	VSS1-0.5 ~ VSS1+10	V
	VDD2	VSS1-0.5 ~ VDD1+0.5	
Input Voltage	XT	VIN	V
	ϕ, FC	VIN	
Output Voltage	VOUT	VSS1-0.5 ~ VDD1+0.5	V
DC Input Current	IIN	± 10	mA
Power Dissipation	PD	300	mW
Storage Temperature Range	Tstg	-65 ~ 150	°C
Lead Temp./Time	Tsol	260°C · 10sec	

TRUTH TABLE

INPUTS				FUNCTION (See Timing Chart)
RESET	XT	ϕ	FC	
H		OPEN H	H *	$f_{Q4} = f_{XT} / 2^4$ $Q_5 \sim Q_{17} = "L" \text{ LEVEL}$
L		OPEN	$\overline{Q_9}$	$f_{Qn} = f_{XT} / 2^n$ $n; 5 \sim 17$
L		H		$f_{Qn} = f_{XT} / 2^n \quad n; 5 \sim 7$ $f_{Qm} = f_{FC} / 2^{(m-8)} \quad m; 12 \sim 17$
* Don't Care				

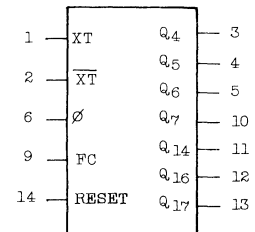
PIN ASSIGNMENT

TC5036P



VDD1 ; 16 VSS1 ; 8
VDD2 ; 15 VSS2 ; 7

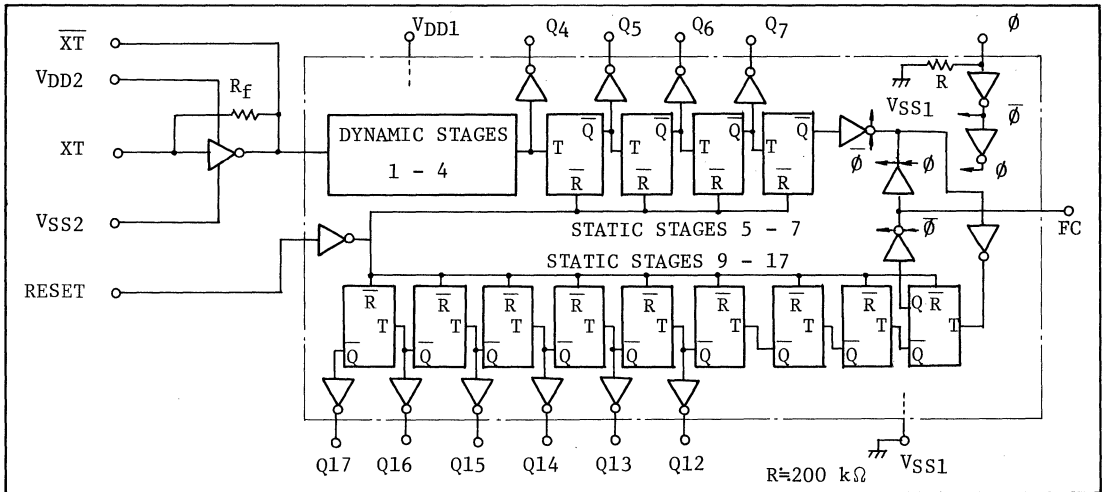
TC5048P



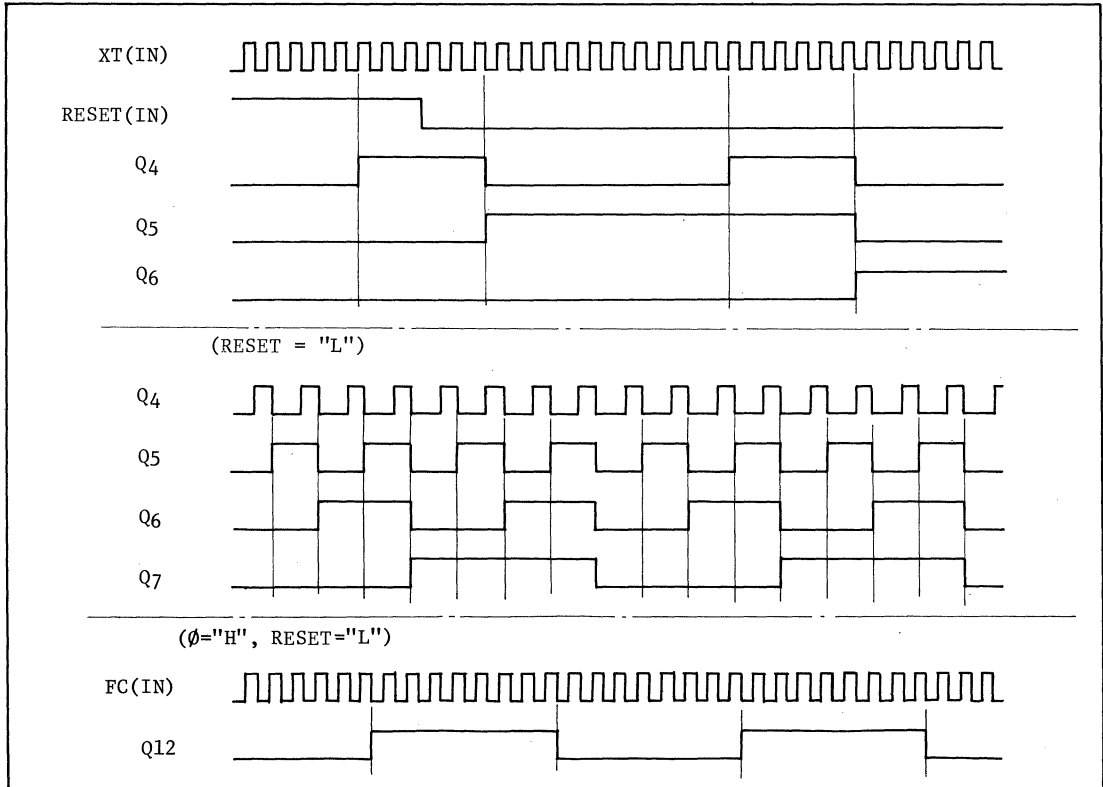
VDD1 ; 16 VSS1 ; 8
VDD2 ; 15 VSS2 ; 7

TC5036P, TC5048P

BLOCK DIAGRAM



TIMING CHART



RECOMMENDED OPERATING CONDITIONS (V_{SS1}=V_{SS2}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT.
Supply Voltage	V _{DD1} V _{DD2}	3	-	8	V
Input Voltage	V _{IN}	0	-	V _{DD2}	V
Operating Temp.	Topr	-40	-	85	°C

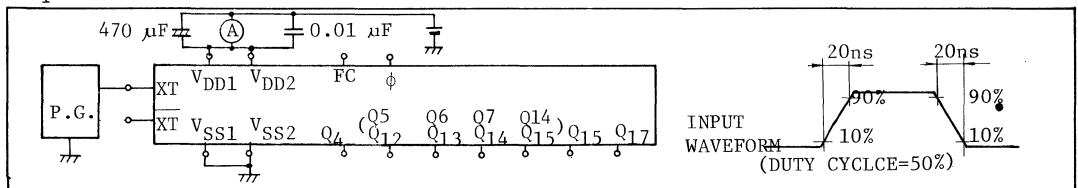
ELECTRICAL CHARACTERISTICS (V_{SS1}=V_{SS2}=0V, V_{DD1}=V_{DD2})

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	I _{OUT} < 1μA V _{IN} =V _{DD} , V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V	
Low Level Output Voltage	V _{OL}	I _{OUT} < 1μA V _{IN} =V _{DD} , V _{SS}	5	-	0.05	-	0.00	0.05	-	0.05	V	
High Level Output Current	Q FC XT	I _{OH}	5	V _{OH} =4.6V V _{IN} =V _{SS} , V _{DD}		-0.2	-	-0.16	-0.8	-	-0.12	-
				V _{OH} =4.6V V _{IN} =V _{SS} , V _{DD}		0.025	-	-0.02	-0.06	-	-0.015	-
Low Level Output Current	Q FC XT	I _{OL}	5	V _{OL} =0.4V V _{IN} =V _{DD} , V _{SS}		0.52	-	0.44	1.5	-	0.36	-
				V _{OL} =0.4V V _{IN} =V _{DD} , V _{SS}		0.10	-	0.08	0.25	-	0.06	-
High Level Input Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V I _{OUT} < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
Low Level Input Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V I _{OUT} < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
High Level Input Current (except XT, φ)	I _{IH}	V _{IH} =8V	8	-	0.2	-	10 ⁻⁵	0.2	-	1.0	μA	
Low Level Input Current (except, XT, φ)	I _{IL}	V _{IL} =0V	8	-	-0.2	-	-10 ⁻⁵	-0.2	-	-1.0	μA	
Operating Current Consumption (TC5048BP)	I _T	f _{XT} =1MHz	5	-	-	-	100	500	-	-	μA	

SWITCHING CHARACTERISTICS (V_{DD1}=V_{DD2}, V_{SS1}=V_{SS2}=0V, Ta=25°C, C_T=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT.
Output Rise Time (Q OUTPUT)	t _{TLH}		5	-	130	250	ns
Output Fall Time (Q OUTPUT)	t _{THL}		5	-	130	250	ns
Input Amp Vias Resistance	R _f		8	0.6	-	3.0	MΩ
Propagation Delay Time (XT-Q ₄)	t _{pLH} , t _{pHL}		5	-	250	600	ns
Propagation Delay Time (XT-Q ₁₇)	t _{pLH} , t _{pHL}		5	-	-	8.0	μs
Prop. Delay Time (RESET-Q)	t _{pHL} (RESET)		5	-	-	2000	ns
Min. Clear Pulse Width	t _w (RESET)		5	-	-	1000	ns
Max. Clock Frequency	f _{MAX} (XT)		5	8	14	-	MHz
Min. Clock Frequency	f _{MIN} (XT)		5	-	-	20	kHz
Max. Clock Frequency	f _{MAX} (FC)		5	1.0	-	-	MHz
Max. Clock Rise Time	t _{rCL}	(XT, FC)	5	20	-	-	μs
Max. Clock Fall Time	t _{fCL}	(XT, FC)	5	20	-	-	μs
Input Capacitance	C _{IN}	except FC		-	5	7.5	pF

I_T TEST CIRCUIT

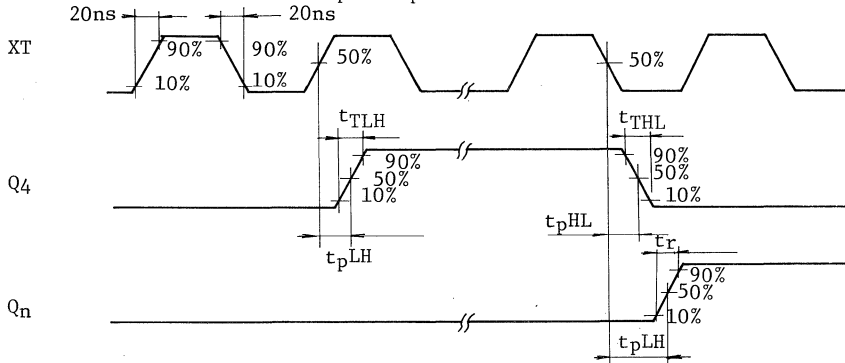


TC5036P, TC5048P

SWITCHING TIME TEST WAVEFORMS

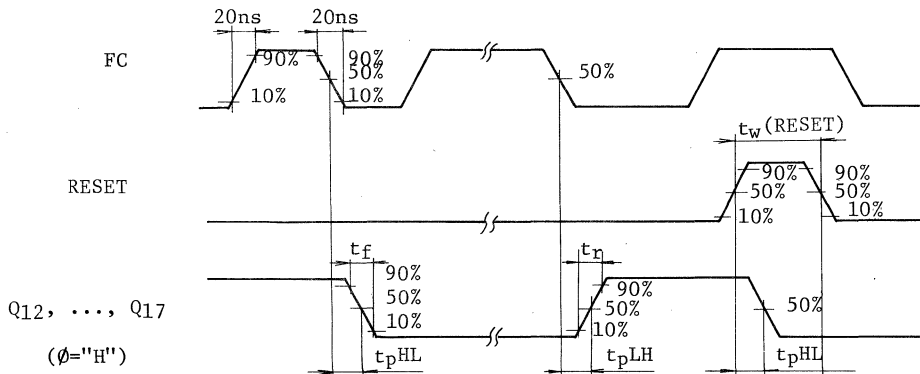
WAVEFORM 1.

1. $f_{MAX}(XT)$, $f_{MIN}(XT)$, t_{TLH} , t_{THL} , t_{pLH} , t_{pHL}

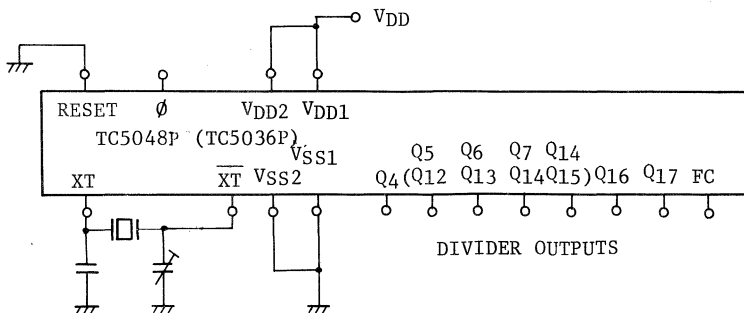


WAVEFORM 2.

2. $f_{MAX}(FC)$, $t_w(\text{RESET})$, $t_{pHL}(\text{RESET})$



TYPICAL APPLICATION



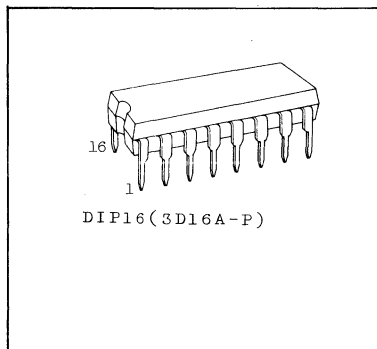
TC5036AP TC5048AP 17-STAGE HIGH SPEED FREQUENCY DIVIDER

TC5036AP and TC5048AP are 17-stage ripple carry binary counters equipped with inverters for crystal oscillators.

If ϕ input is opened ($\phi = "L"$), the inverted output of 9th stage appears on FC terminal. If ϕ input is set to "H", 9 stages from 9th stage through 17th stage can be also independently used having FC terminal as the clock input.

Outputs can be derived arbitrarily from stages 4, 12, 13, 14, 15, 16 and 17 of TC5036AP and stages 4, 5, 6, 7, 14, 16 and 17 of TC5048AP.

Both devices are improved to have 50% duty Q4 output as same as others by changing the divider stage of TC5036P and TC5048P to static type counter.



PIN ASSIGNMENT

ABSOLUTE MAXIMUM RATINGS

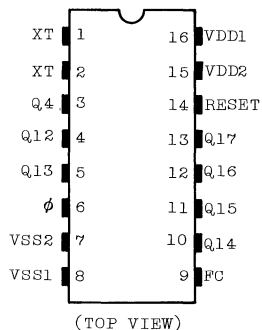
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD1}	V _{SS1} -0.5 ~ V _{SS1} +10	V
	V _{DD2}	V _{SS1} -0.5 ~ V _{DD1} +0.5	
Input Voltage	XT	V _{IN}	V
	ϕ , FC	V _{IN}	
Output Voltage	V _{OUT}	V _{SS1} -0.5 ~ V _{DD1} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10 sec	

TRUTH TABLE

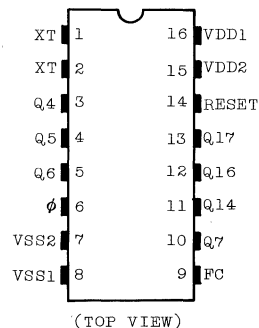
INPUTS				FUNCTION (See Timing Chart)
RESET	XT	ϕ	FC	
H		OPEN H	H *	$f_{Q4} = f_{XT}/2^4$ Q5 ~ Q17 = "L" LEVEL
L		OPEN	$\bar{Q}9$	$f_{Qn} = f_{XT}/2^n$ n; 5 ~ 17
L		H		$f_{Qn} = f_{XT}/2^n$ n; 5 ~ 7 $f_{Qm} = f_{FC}/2^{(m-8)}$ m; 12 ~ 17

* Don't Care

TC5036AP

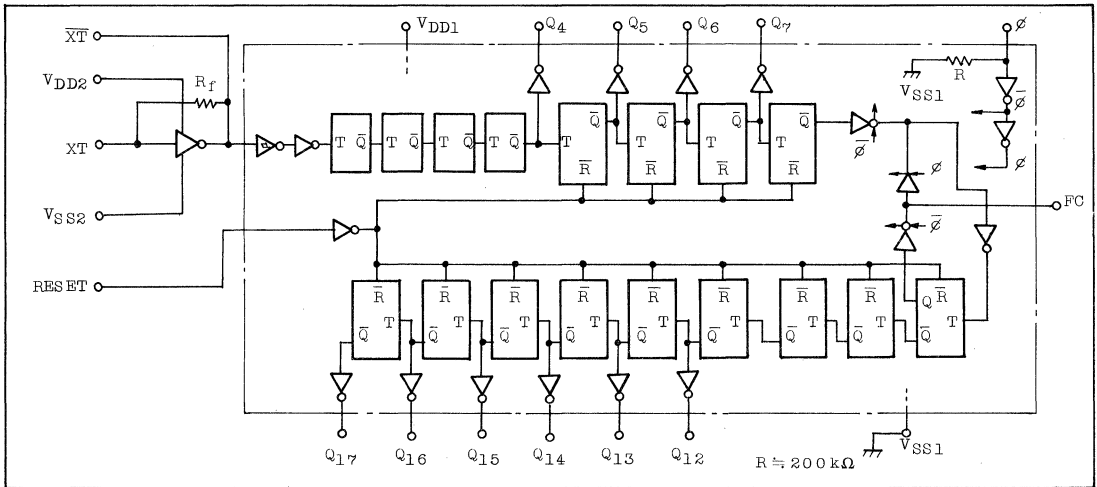


TC5048AP

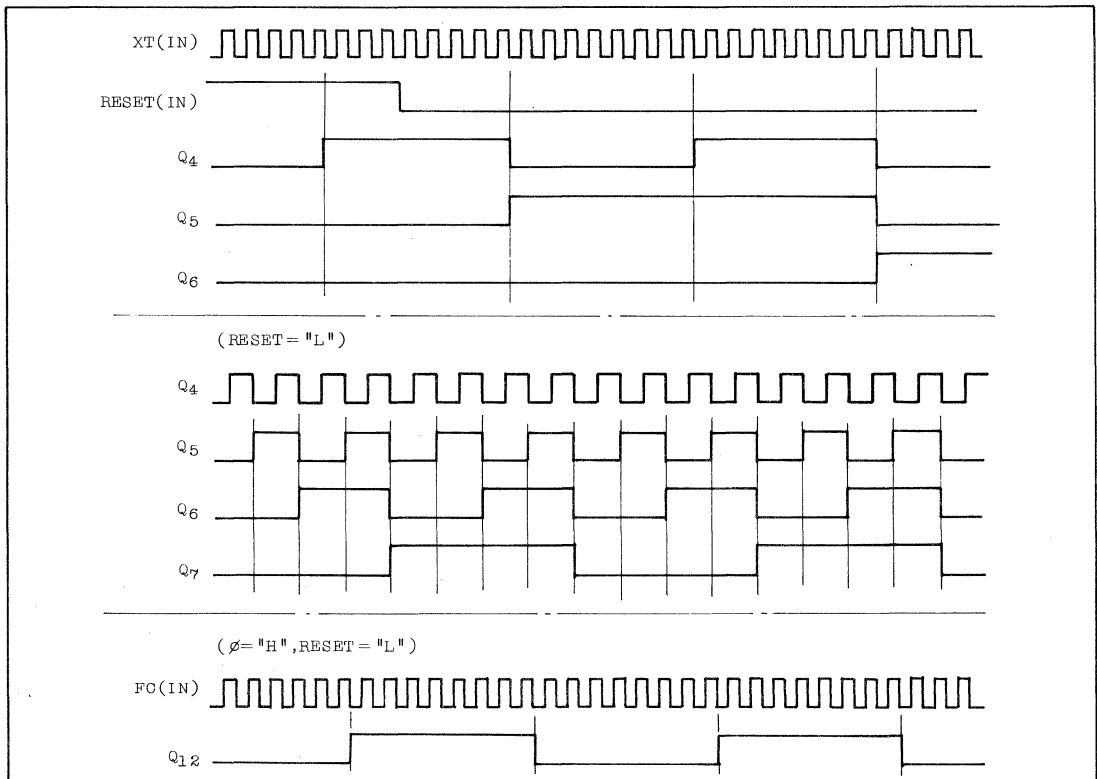


TC5036AP, TC5048AP

BLOCK DIAGRAM



TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS1}=V_{SS2}=0V$)

CHARACTERISTIC	SYMBOL		MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD1}		3	-	8	V
	V_{DD2}		3	-	V_{DD1}	
Input Voltage	V_{IN}	Except XT	0	-	V_{DD1}	
Operating Temp.	T_{opr}		-40	-	85	°C

ELECTRICAL CHARACTERISTICS ($V_{SS1}=V_{SS2}=0V, V_{DD1}=V_{DD2}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{DD}, V_{SS}$	5	4.95	-	4.95	5.00	-	4.95	-	V
Low Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{DD}, V_{SS}$	5	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Current	Q	I_{OH}	5	-0.61	-	-0.51	-1.0	-	-0.42	-	mA
	FC, \overline{XT}										
Low Level Output Current	Q	I_{OL}	5	0.61	-	0.51	1.5	-	0.42	-	
	OUTPUT FC, \overline{XT}										
High Level Input Voltage	V_{IH}	$V_{OUT}=0.5V, 4.5V$	5	3.5	-	3.5	2.75	-	3.5	-	V
		$|I_{OUT}| < 1\mu A$									
Low Level Input Voltage	V_{IL}	$V_{OUT}=0.5V, 4.5V$	5	-	1.5	-	2.25	1.5	-	1.5	
		$|I_{OUT}| < 1\mu A$									
High Level Input Current (except XT, ϕ)	I_{IH}	$V_{IH}=8V$	8	-	0.2	-	10^{-5}	0.2	-	1.0	μA
Low Level Input Current (except XT, ϕ)	I_{IL}	$V_{IL}=0V$	8	-	-0.2	-	-10^{-5}	-0.2	-	-1.0	
Quiescent Device Current	I_{DD1}	$V_{IN}=V_{DD}, V_{SS} *$	8	-	5	-	0.005	5	-	150	

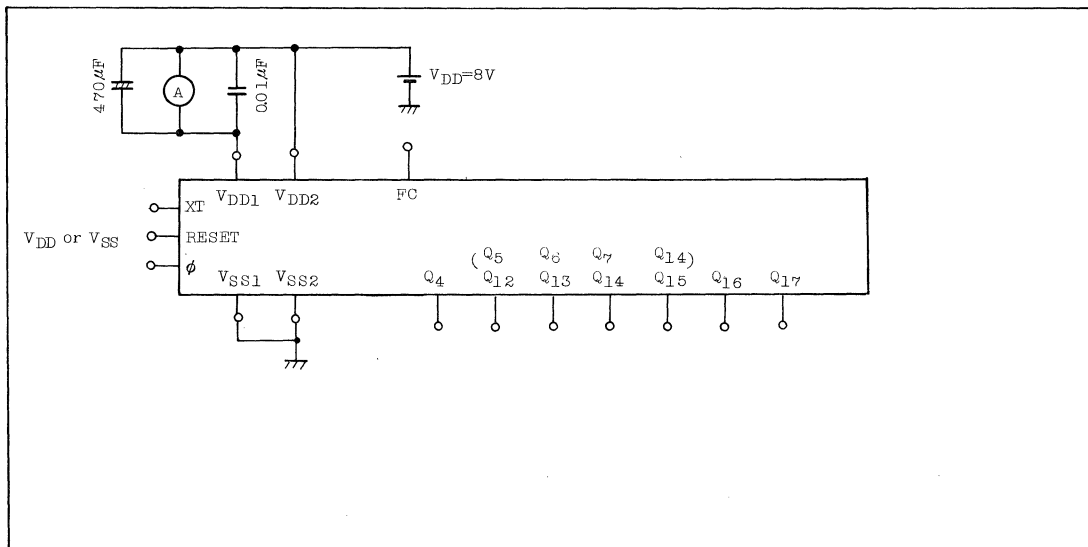
* All valid input combinations.

TC5036AP, TC5048AP

SWITCHING CHARACTERISTICS (VDD1=VDD2, VSS1=VSS2=0V, Ta=25°C, CL=50pF)

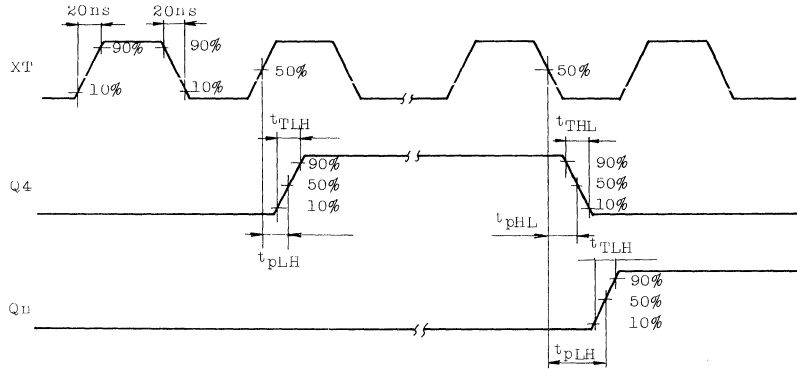
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD	MIN.	TYP.	MAX.	UNIT
			(V)				
Output Rise Time (Q OUTPUT)	t_{TLH}		5	-	70	200	ns
Output Fall Time (Q OUTPUT)	t_{THL}						
Input Amp Vias Resistance	R_f		8	0.6	1.6	3.0	MΩ
Propagation Delay Time (XT-Q4)	t_{pLH}, t_{pHL}		5	-	200	400	ns
Propagation Delay Time (XT-Q17)	t_{pLH}, t_{pHL}		5	-	0.78	1.6	μs
Propagation Delay Time (FC-Q12)	t_{pLH}, t_{pHL}		5	-	240	480	ns
Propagation Delay Time (FC-Q17)	t_{pLH}, t_{pHL}		5	-	420	900	ns
Propagation Delay Time (RESET-Q)	$t_{pHL}(\text{RESET})$		5	-	100	200	ns
Min. Pulse Width	$t_w(\text{RESET})$		5	-	35	70	ns
Max. Clock Frequency	$f_{CL}(\text{XT})$		5	10	20	-	MHz
Max. Clock Frequency	$f_{CL}(\text{FC})$		5	8	16	-	
Max. Clock Rise Time	t_{rCL}	(XT)	5	No Limit			μs
Max. Clock Fall Time	t_{fCL}						
Max. Clock Rise Time	t_{rCL}	(FC)	5	20	-	-	
Max. Clock Fall Time	t_{fCL}						
Input Capacitance	C_{IN}	except FC	-	5	7.5	pF	

I_{DD1} TEST CIRCUIT

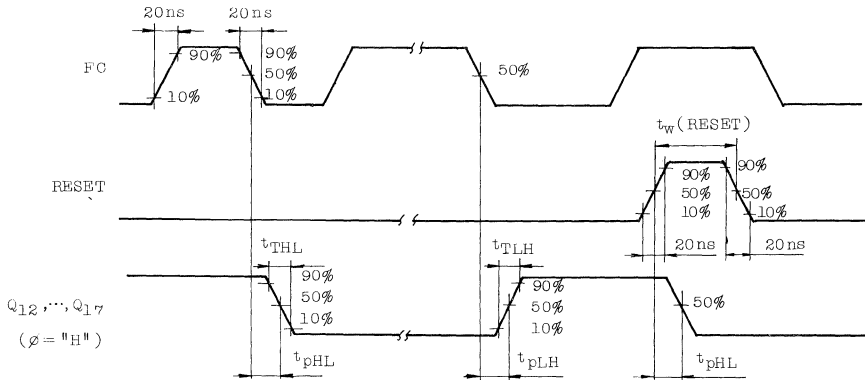


SWITCHING TIME TEST WAVEFORMS

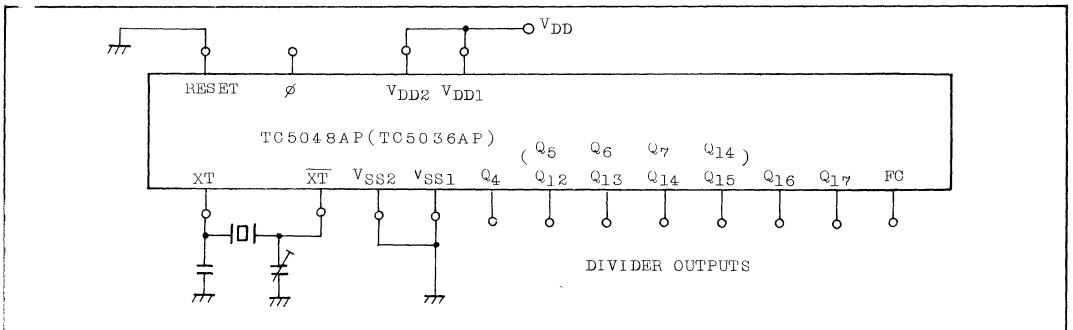
1. $f_{CL}(XT)$, t_{TLH} , t_{THL} , t_{pLH} , t_{pHL}



2. $f_{CL}(FC)$, $t_w(\text{RESET})$, $t_{pHL}(\text{RESET})$



TYPICAL APPLICATION



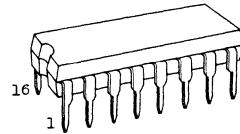
TC5037P

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5037P 4-DIGIT DECADE COUNTER

TC5037P is four digit decimal counter including the latch multipliexer circuit and has the digit signal outputs for dynamic display and the clock generator for dynamic display.

When TRANSFER input is set to "L", the latches hold the counts immediately prior to the falling edge of TRANSFER, so that even if the contents of counters vary, the outputs will not be changed. RESET is activated by "H" level and sets the counter outputs of all digits to "L". The outside is 16 pin plastic packages.

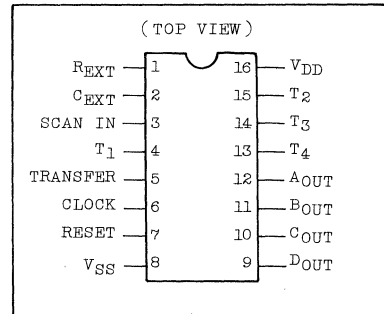


DIP 16 (3D16A-P)

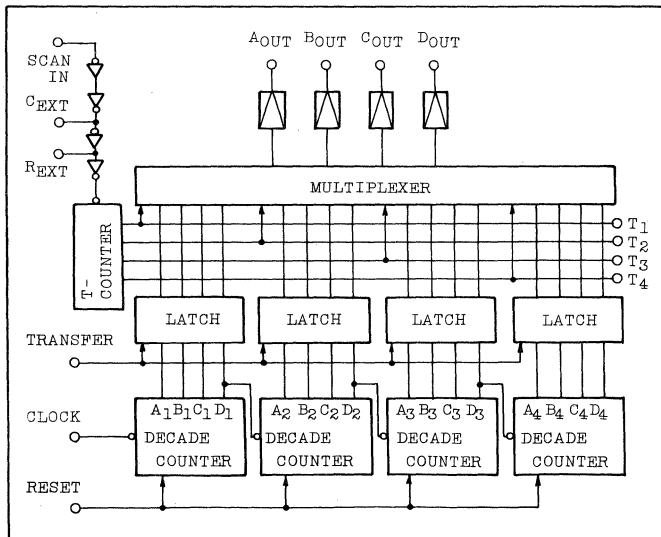
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-55 ~ 125	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



BLOCK DIAGRAM



TRUTH TABLE

RESET	TRANS-FER	AOUT	BOUT	COUT	DOUT
H	H	L	L	L	L
*	L	LA	LA	LA	LA
L	H	C	C	C	C

* ; Don't care

C ; Count operation.

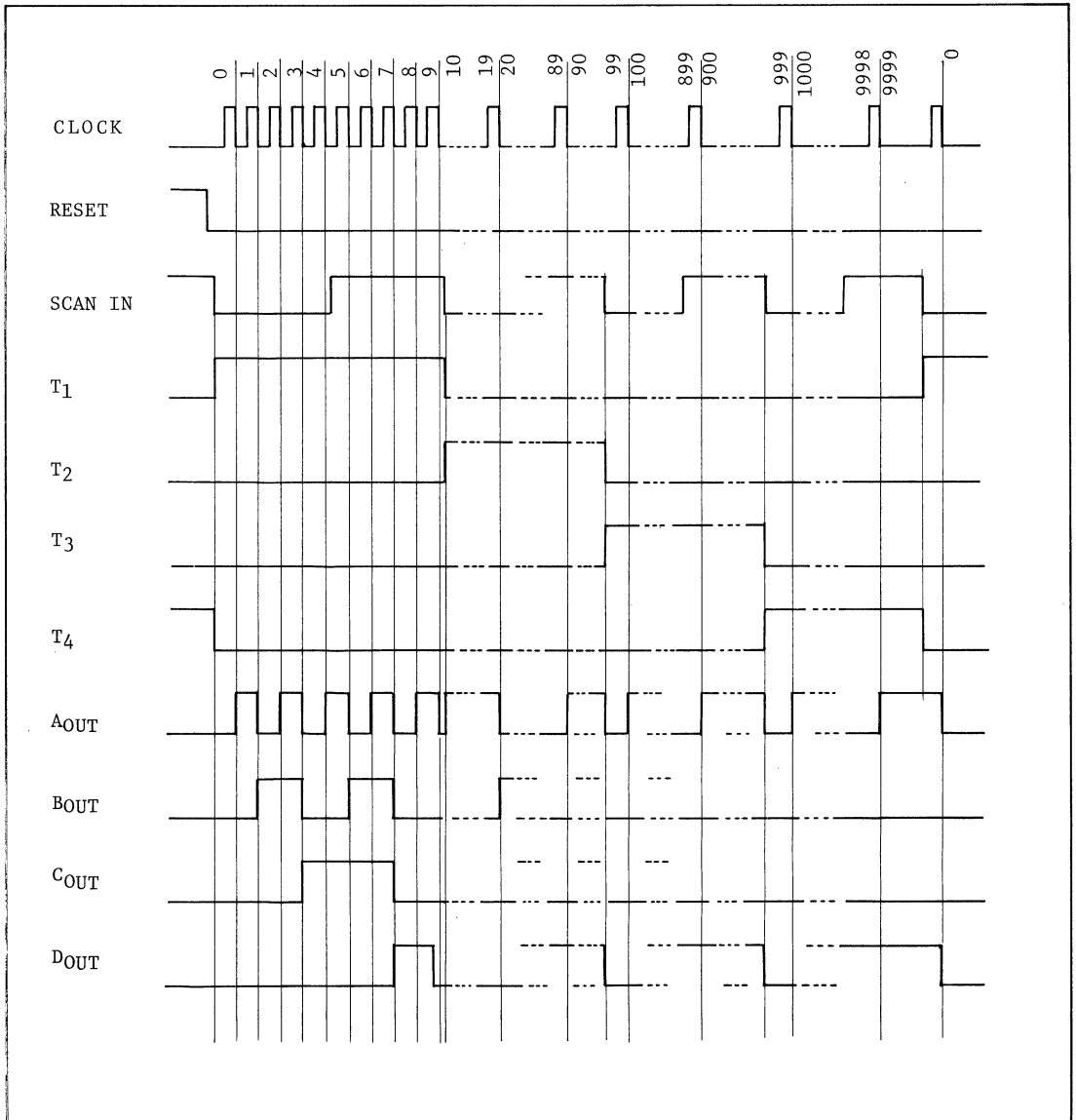
(Counter outputs are dynamically output to A_{IN}-D_{IN} as they are.)

LA ; Latch operation. (Counting is performed but the outputs are not changed.)

Note 1. The outputs vary at the falling edge of CLOCK.

2. T₁ ~ T₄ vary at the falling edge of SCAN IN.

TIMING CHART



OPERATING CONSIDERATION

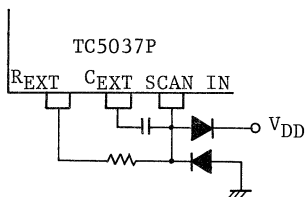
1. SCAN Operation

The scan signal for dynamic display applied to SCAN INPUT terminal is converted to four digit scan signal by T-COUNTER (4 digit ring counter) and controls the multiplexer circuit. The four digit information stored in the latches is transferred to the output in synchronism with $T_1 - T_4$ outputs.

By applying DC for SCAN signal, arbitrary digit can be statically output. $T_1 - T_4$ are used for the digit selection circuit.

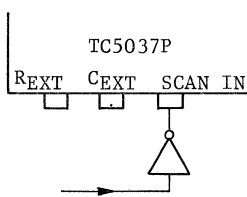
There are two methods of supplying SCAN signal. One is AUTO SCAN method (Fig. 1) which consists of the multivibrator fabricated with a resistor and a capacitor externally connected to R_{EXT} and C_{EXT} terminals respectively and the internal inverter, and another is to supply external signal to SCAN IN terminal

Fig. 1



$R = 100 \text{ k}\Omega$ 1S1588
 $C = 0.02 \mu\text{F}$

Fig. 2



EXTERNAL PULSE

(Fig. 2). (Note: R_{EXT} and C_{EXT} are left open in Fig. 2.)

2. Latch Operation

Flickering of output caused by the count pulse with high frequency can be eliminated by controlling TRANSFER terminal.

TRANSFER = "H" : The counter information is transferred to the multiplexer as it is.

TRANSFER = "L" : The content of counter immediately prior to the falling edge of TRANSFER is latched and the multiplexer input is not changed.

(Note) The counter, in this case, still continues counting.

3. Count Operation

For normal count operation, this chip should be used with TRANSFER = "H" and RESET = "L". The output changes its state at the falling edge of CLOCK.

The content of counter can be reset to "0000" by setting RESET terminal to "H". It should be noticed that CLOCK is not active unless RESET is returned to "L".

This LSI can count up to "9999", and if five or more digits are required, TC4510P or TC4518P should be connected in the preceding stage of this LSI.

TC5037P

RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	3	-	8	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
Operating Temperature	T_{opr}	-30	-	85	$^{\circ}C$
R_{EXT} External Resistance	R	5	100	1000	$k\Omega$
C_{EXT} External Capacitance	C	10^{-4}	0.02	1.0	μF

ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

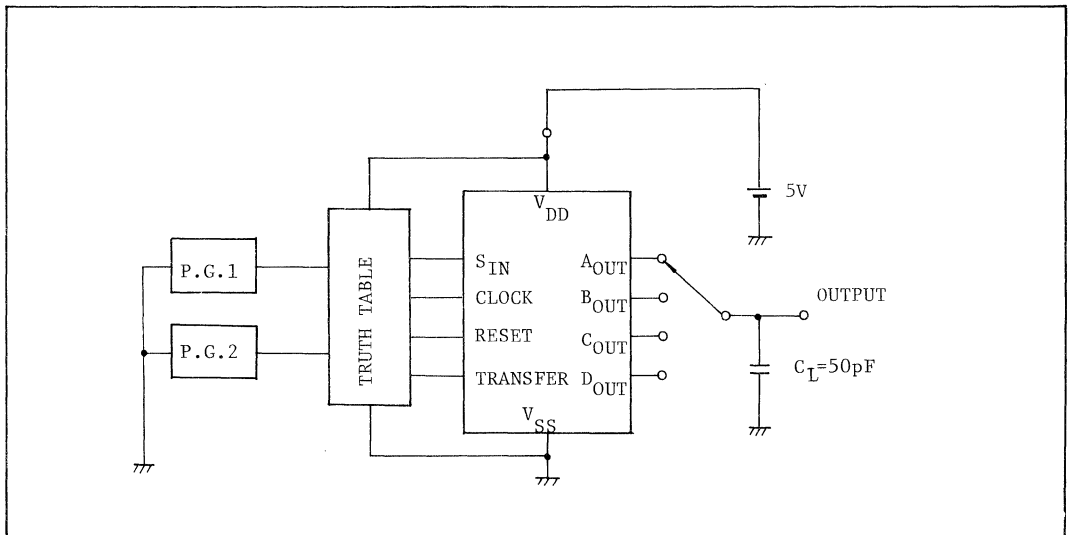
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-30 $^{\circ}C$		25 $^{\circ}C$			85 $^{\circ}C$		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{DD}, V_{SS}$	5	4.95	-	4.95	-	-	4.95	-	V	
Low Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{DD}, V_{SS}$	5	-	0.05	-	-	0.05	-	0.05		
High Level Output Current	A_{OUT}, B_{OUT} C_{OUT}, D_{OUT}	I_{OH} $V_{OH}=2.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	-1.2	-	-1.0	-	-	-0.75	-	mA	
	T1, T2 T3, T4		5	-1.2	-	-1.0	-	-	-0.75	-		
	R_{EXT}, C_{EXT}		5	-0.35	-	-0.3	-	-	-0.2	-		
Low Level Output Current	A_{OUT}, B_{OUT} C_{OUT}, D_{OUT}	I_{OL} $V_{OL}=0.4V$ $V_{IN}=V_{SS}, V_{DD}$	5	2.4	-	2.0	-	-	1.6	-	mA	
	T1, T2 T3, T4		5	0.52	-	0.44	-	-	0.36	-		
	R_{EXT}, C_{EXT}		5	0.28	-	0.24	-	-	0.2	-		
Input Voltage	H. Level	V_{IH}	$V_{OUT}=0.1V, 4.9V$	5	3.8	-	3.8	2.75	-	3.8	-	V
	L. Level	V_{IL}$	|I_{OUT}| < 1\mu A$	5	-	1.2	-	2.25	1.2	-	1.2	
Input Current	H. Level	I_{IH}	$V_{IH}=8V$	8	-	0.2	-	10^{-5}	0.2	-	1.0	μA
	L. Level	I_{IL}	$V_{IL}=0V$	8	-	-0.2	-	-10^{-5}	-0.2	-	-1.0	
Quiescent Current Consumption	I_{DD}	$V_{IN}=V_{SS}, V_{DD}$ *	8	-	50	-	-	50	-	500	μA	

* All valid input combinations

SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

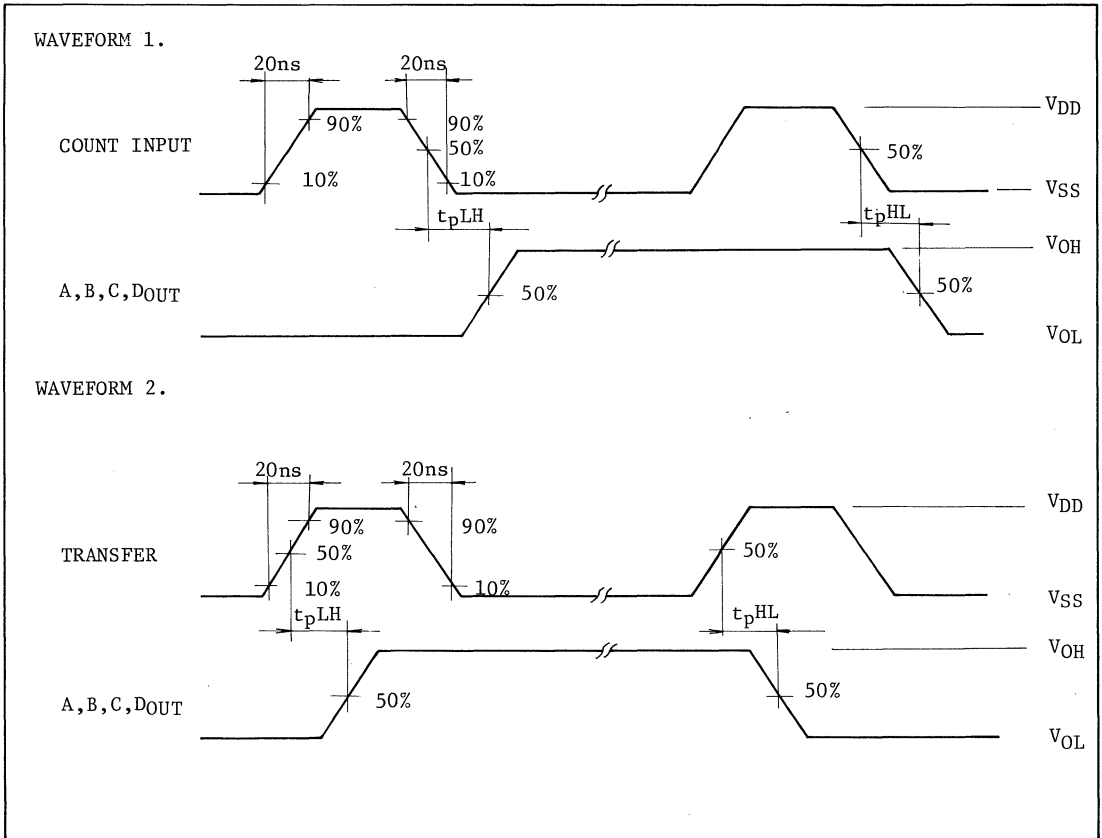
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
(Low-High) Propagation Delay Time	t _{pLH}	COUNT INPUT → A,B,C, D _{OUT} (WAVEFORM 1)	5	-	600	1000	ns
(High-Low) Propagation Delay Time	t _{pHL}		5	-	600	1000	
(Low-High) Propagation Delay Time	t _{pLH}	TRANSFER → A,B,C, D _{OUT} (WAVEFORM 2)	5	-	400	1000	
(High-Low) Propagation Delay Time	t _{pHL}		5	-	400	1000	
Max. Clock Rise/Fall Time	t _{rCL} , t _{fCL}		5	20	-	-	μs
Min. Clear Pulse Width	t _w (RE)	RESET(0), (9)	5	-	-	1000	ns
Min. Transfer Pulse Width	t _w (TR)	TRANSFER	5	-	-	1000	
Input Capacitance	6, 7 PIN	C _{IN}		-	5	7.5	pF
	3 PIN	C _{IN}		-	7	10	
	5 PIN	C _{IN}		-	9	15	
Max. Frequency	f _{CL}		5	0.5	2.0	-	MHz

SWITCHING TIME TEST CIRCUIT



TC5037P

SWITCHING TIME TEST WAVEFORMS



TC5043P PROGRAMMABLE CR TIMER/DIVIDER

TC5043P is an timer consisting of CR oscillation circuit and frequency division circuit. The oscillation circuit is made up by externally installing one resistor and one capacitor, being able to be set in a wide range of cycle. The frequency division circuit consists of fixed stage of 1/1000 and variable stage of 1/1~1/600, being capable of performing frequency division of 6×10^5 max. Therefore, TC5043P can cover all the regions ranging from conventional CR timers to motor timers. This device is so designed that the external parts required may be reduced to the minimum by means of the built-in zener diode, auto reset circuit, and pull-up/pull-down resistance.

FEATURES:

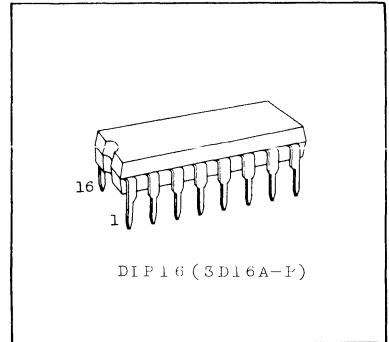
- Wide time range of timer (5ms~1500Hr)
- Wide range of fine adjustment of oscillation frequency ($\pm 50\%$ or over)
- Low power consumption (2mW Typ.)
- Little supply voltage regulation of oscillation cycle (1%/V)
- Narrow temperature variations of oscillation cycle (0.02%/°C)
- Internal auto reset function
- Precision CR oscillation circuit
- Internal zener diode
- Timer/Divider switchable
- Simple display of time elapsed of oscillation
- Programmable frequency division ratio able to be set in eight ways

APPLICATIONS:

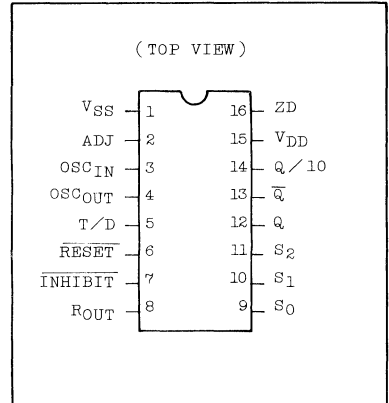
- Industrial timers
- Timers for various commercial equipment
- Low-frequency oscillators

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +12	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	
Output Voltage	ROUT, Q/10	V _{SS} -0.5~V _{SS} +12	
	Q, Q̄, OSCOUT	V _{SS} -0.5~V _{DD} +0.5	
DC Input Current	I _{IN}	±10	mA
Zener Current	I _Z	10	
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _{opr}	-40~85	°C
Storage Temperature Range	T _{stg}	-65~150	



PIN ASSIGNMENT

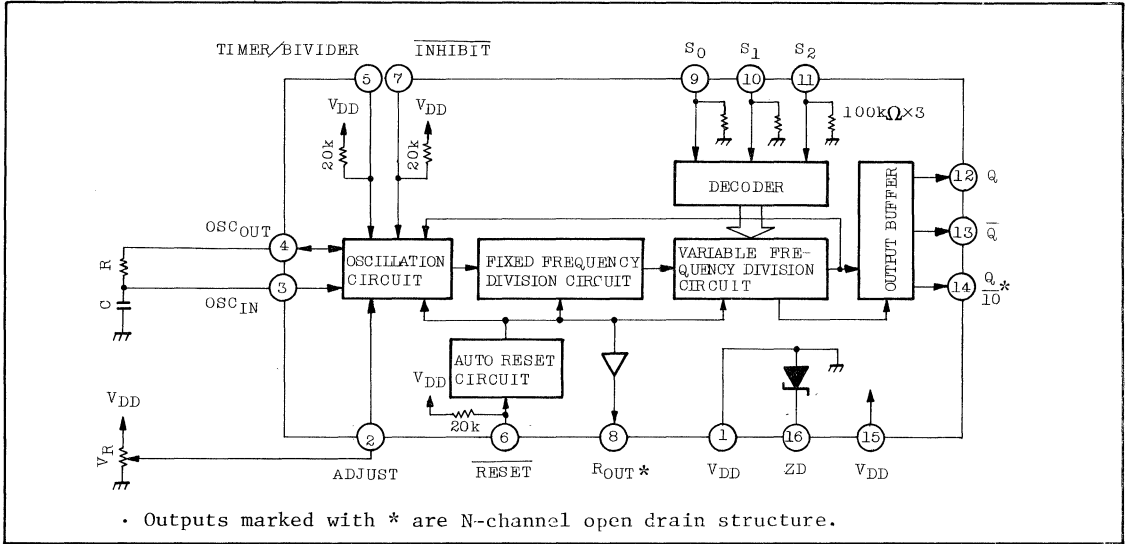


TRUTH TABLE

R̄	T/D	INH̄	OPERATION
L	*	*	RESET
H	H	H	TIMER OPERATION
H	L	H	DIVIDER OPERATION
H	*	L	TEMPORARY STOP OF OPERATION
* Don't Care			

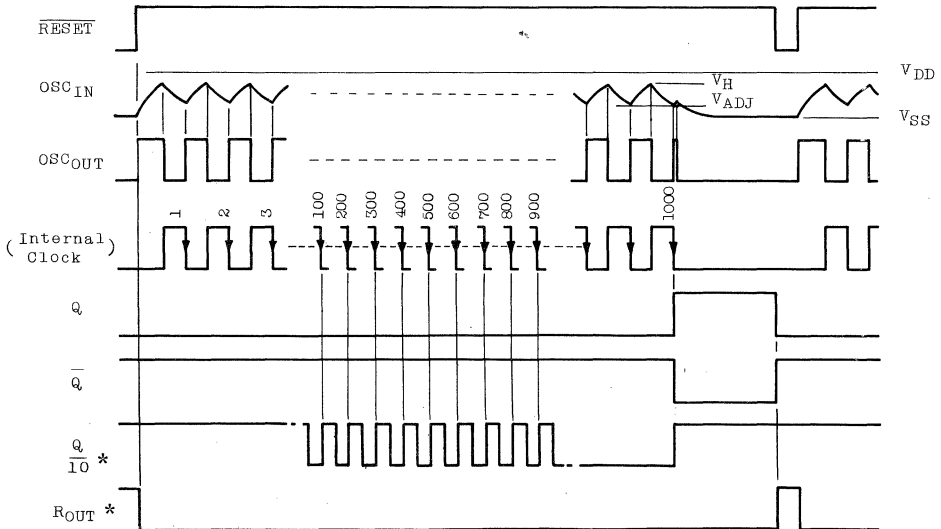
TC5043P

SYSTEM DIAGRAM



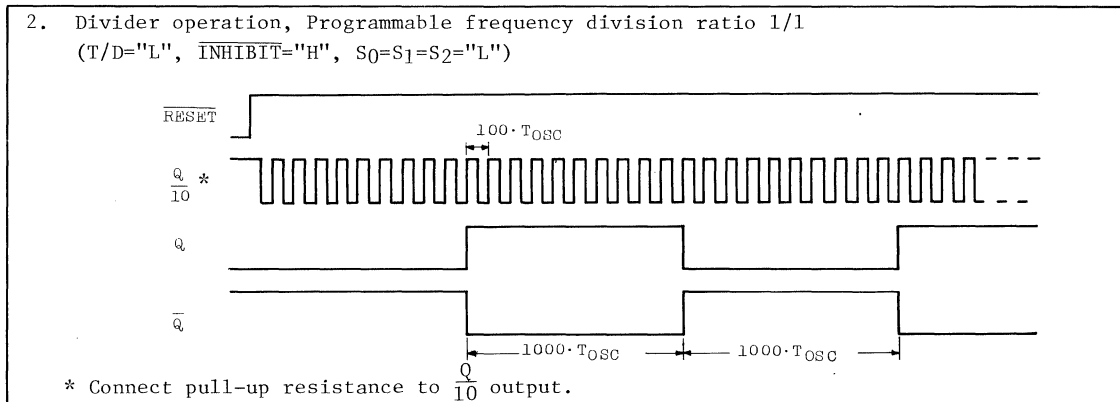
TIMING DIAGRAM (1)

1. Timer operation, Programmable frequency division ratio 1/1
 (T/D="H", INHIBIT="H", S₀=S₁=S₂"H")



• For outputs marked with *, add pull-up resistance to VDD.

TIMING DIAGRAM



PIN FUNCTION

PIN NO.	SYMBOL	FUNCTION
1	V _{SS}	GND (0V) Pin
2	ADJUST	Pin for fine adjustment for oscillation frequency. Externally apply the voltage ranging from 0.2V _{DD} to 0.55V _{DD} .
3	OSC _{IN}	Oscillation circuit configuration pins : These pins start oscillation when resistor R is connected between OSC _{IN} and OSC _{OUT} and capacitor C between OSC _{IN} and V _{SS} , respectively. In case V _{ADJ} is 0.39V _{DD} , oscillation cycle becomes almost T _{OSC} =RC.
4	OSC _{OUT}	
5	TIMER /DIVIER	Timer/divider switching input. At time of open (or "H" level), this device operates as a timer, and at time of "L" level it operates as a divider.
6	RESET	All the counters are reset at "L" level. At the rising edge of this input, the device begins to count.
7	INHIBIT	When this pin is set at "L" level, the device keeps stopping oscillation during the period of "L" level state. The pin is used for temporary stop of oscillation.
8	RESET _{OUT}	Only at time of timer operation, reset signal is output. (At the time when RESET = "L" and during the period of auto reset at the rising time of power supply, output is off.) For the divider mode, this pin should be open.
9	S ₀	S ₀ [~] S ₃ are frequency division ratio switching inputs of the counter. Eight time intervals can be predetermined by combining pins, S ₀ ~ S ₂ . (T = 1000 × $\frac{1}{f_{OSC}}$)

PIN NO.	SYMBOL	FUNCTION																																				
10	S ₁	<table border="1"> <thead> <tr> <th>S₂</th> <th colspan="4">L</th> <th colspan="4">H</th> </tr> <tr> <th>S₁</th> <th colspan="2">L</th> <th colspan="2">H</th> <th colspan="2">L</th> <th colspan="2">H</th> </tr> <tr> <th>S₀</th> <th>L</th> <th>H</th> <th>L</th> <th>H</th> <th>L</th> <th>H</th> <th>L</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>Time intervals of timer</td> <td>T</td> <td>3T</td> <td>6T</td> <td>10T</td> <td>60T</td> <td>30T</td> <td>300T</td> <td>600T</td> </tr> </tbody> </table>	S ₂	L				H				S ₁	L		H		L		H		S ₀	L	H	L	H	L	H	L	H	Time intervals of timer	T	3T	6T	10T	60T	30T	300T	600T
		S ₂	L				H																															
S ₁	L		H		L		H																															
S ₀	L	H	L	H	L	H	L	H																														
Time intervals of timer	T	3T	6T	10T	60T	30T	300T	600T																														
11	S ₂	* In the divider operation mode, the above time intervals of timer become half cycles of Q and \bar{Q} .																																				
12	Q	Q and \bar{Q} are time-up outputs. After the end of time intervals, Q reaches "H" level and \bar{Q} reaches "L" level. While the divider is operating, these outputs oscillate at double the cycle of time range of timer.																																				
13	\bar{Q}																																					
14	$\frac{Q}{10}$	Q/10 is a pin which outputs the elapsed time of timer, and outputs the pulse of 1/10 cycle of timer time. This is N-channel open drain output.																																				
15	V _{DD}	Power supply pin																																				
16	ZD	The cathode terminal of zener diode is put out of this pin. This pin is used as a stabilized power supply by making the connection to V _{DD} .																																				

OPERATIONAL DESCRIPTION

1. Oscillation Circuit

The oscillation circuit can be made up by connecting resistor R between OSC_{IN} and OSC_{OUT} and capacitor C between OSC_{IN} and V_{SS}(GND) as shown in Fig. 1.

This IC has two levels of built-in reference voltage V_H(0.62 V_{DD}) and reference voltage V_L(=V_{ADJ}) externally supplied to ADJ pin, and performs oscillation in such a form as the charge and discharge wave of CR runs between these two levels.

Therefore, oscillation cycle can be adjusted by varying the voltage of ADJ pin.

When $V_{ADJ} \approx 0.39 V_{DD}$, the oscillation cycle is decided from the equation of $T_{OSC} = RC$ (T : [S], R[Ω], C[F]). V_{ADJ} should be used within the range of 0.2V_{DD} ~ 0.55V_{DD}.

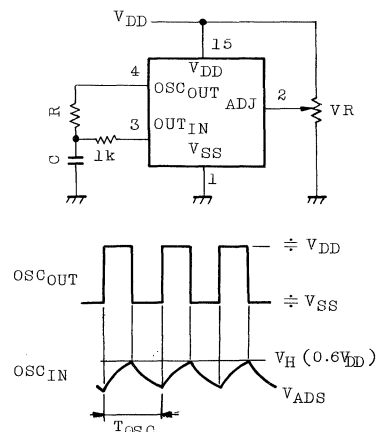


Fig. 1 Oscillation Circuit

2. Counting circuit (Frequency dividing circuit)

This circuit consists of the fixed frequency dividing stage of 1/1000 and the variable frequency dividing stage of 1/1 ~ 1/600.

Time intervals of timer can be predetermined in eight ways by combining three inputs of S₀ ~ S₂.

Select Input	S ₂	L				H			
	S ₁	L		H		L		H	
	S ₀	L	H	L	H	L	H	L	H
Time intervals of Timer	T	3T	6T	10T	60T	30T	300T	600T	

Note 1.

$$T=1000 \cdot T_{OSC}$$

Note 2.

"L" level may be open.

3. Reset operation

The internal counter is kept reset by the built-in auto reset circuit until the power supply level reaches reset release voltage (V_{RD}) at time of application of power. However, the power rising time of more than 500 μ s should be taken for abrupt rising edge of power supply because there may be no possibility of the internal counter being reset. In case of the rising time of 500 μ s or below, differentiation circuit is made up by adding the capacitor to RESET terminal. (Refer to Fig. 2)

It is a matter of course that the internal circuit can be reset even by setting RESET input at "L" level. When the reset operation is released, oscillating and counting operations start. The reset signal is being output to this IC.

In case where this pin (R_{OUT}) is internally reset, it is off (at the rising time of power supply and during "L" level of RESET); therefore, this pin can be used for making the external circuit synchronize by use of pull-up resistance or equivalent. While R_{OUT} is not in use, it should be kept set open (or at "L" level).

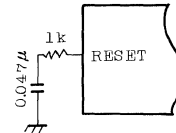
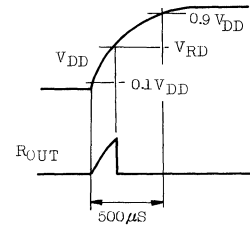


Fig. 2 Auto Reset Circuit

4. Inhibit operation

Oscillation can be stopped by setting $\overline{INHIBIT}$ input at "L" level.

Normal operation can be performed by setting $\overline{INHIBIT}$ input open (or at "H" level).

5. Divider function

When the T/D pin is set open (or at "H" level), this device operates as a timer. When this pin is set at "H" level, this device can be used as a divider which continues operating oscillation/counting without creating time-up signal.

For the divider mode, however, R_{OUT} cannot be used. (Open or "L").

TC5043P

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

ITEM	SYMBOL		MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		6.2	-	10	V
High Level Input Voltage	V _{IH}		0.8V _{DD}	-	V _{DD}	V
Low Level Input Voltage	V _{IL}		0	-	0.2V _{DD}	V
External Resistor	R		5K	-	2M	Ω
External Capacity	C		1000P	-	5μ	F
Output Voltage	V _{OUT}	* Applicable to R _{OUT} ' Q/10	0	-	10	V

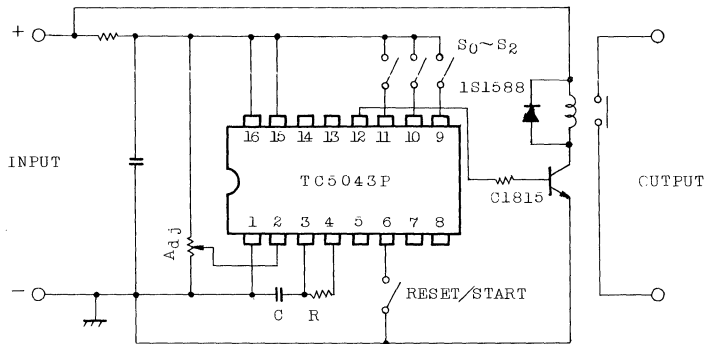
ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

ITEM	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Zener Voltage	V _Z	I _Z =1mA	-	6.2	8.1	6.5	7.2	8.2	6.6	8.5	V
		I _Z =10mA	-	6.2	8.1	6.5	7.3	8.2	6.6	8.5	
High Level Output Current	I _{OH}	V _{OH} =6V	7	-1.2	-	-1.2	-2.5 ¹⁾	-	-1.0	-	mA
		V _{OH} =3V	7	-5.2	-	-5.2	-9.0	-	-4.0	-	
Low Level Output Current	I _{OL}	V _{OL} =0.4V	7	1.0	-	1.0	2.0	-	0.8	-	
High Level Input Current	I _{IH}	V _{IH} =10V, (Exclusive of S ₀ ~S ₂)	10	-	5	-	10 ⁻³	5	-	5	μA
Low Level Input Current	I _{IL}	V _{IL} =0V, (Exclusive of R, $\overline{\text{INH}}$, T/D)	10	-	-5	-	10 ⁻³	-5	-	-5	
Pull-up Resistance	R _{PU}	R, $\overline{\text{INH}}$, T/D Inputs	-	7	50	10	20	50	10	75	kΩ
Pull-down Resistance	R _{PD}	S ₀ , S ₁ , S ₂ Inputs	-	45	200	66	100	200	66	300	
Output OFF Current	I _{OFF}	V _{OH} =10V, R _{OUT} , Q/10 Outputs	10	-	1.0	-	10 ⁻³	1.0	-	10.0	μA
Auto Reset Release Voltage	V _{RD}		-	-	-	2.6	-	5.2	-	-	V
Supply Current	I _{DD}	C=0.1μF, R=1MΩ*	10	-	-	-	0.3	-	-	-	mA

* All inputs and outputs are open.

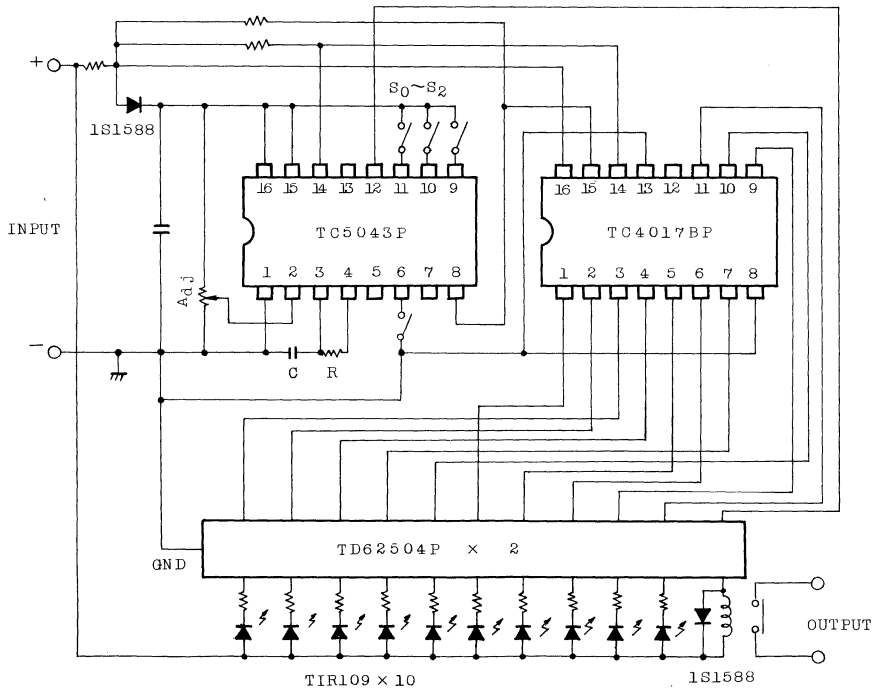
EXAMPLES OF APPLIED CIRCUIT

◦ Timer Circuit I (Basic Type)



(Time of timer can be varied to linear by using resistor R deciding time constant with variable resistance.)

◦ Timer Circuit II (Elapsed Time Displaying Type)



TC5050P

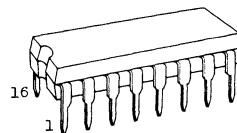
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5050P DUAL 50/64 STAGE STATIC SHIFT REGISTER

TC5050P is static shift register consisting of D type flip-flops, and can be used as either 50 bit shift register or 64 bit shift register depending on OUTPUT MODE input.

Since one of two input data can be selected by INPUT MODE input, the applications for scratch pad memories, etc. can be realized by connecting one of data inputs to the output. And if two circuits are connected in series, this can be expanded to 100 bit, 114 bit or 128 bit shift register.

When used with 5 volts power supply, one of TTL or DTL can be directly driven.

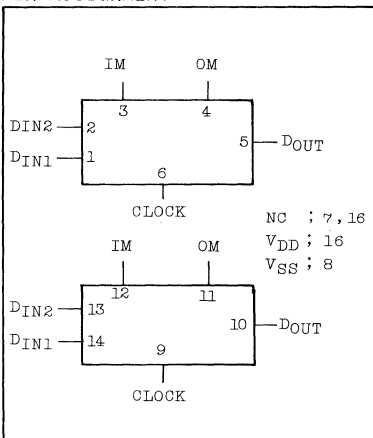


DIP 16 (3D16A-P)

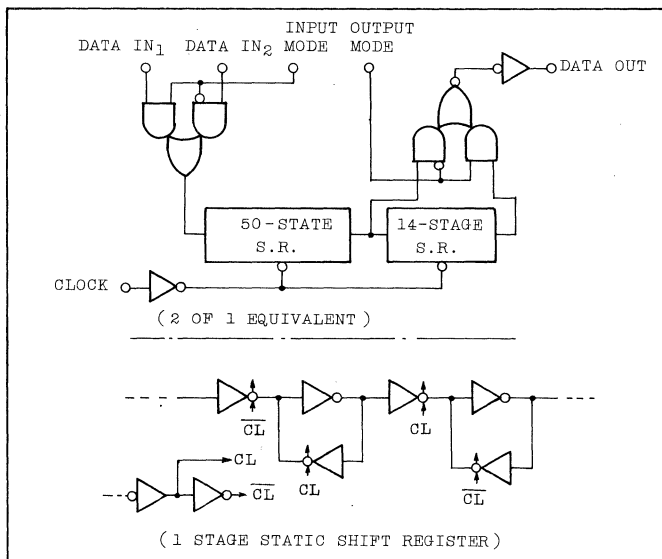
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-55 ~ 125	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



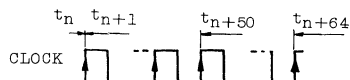
LOGIC DIAGRAM



TRUTH TABLE

t_n		t_{n+1}		t_{n+50}		t_{n+64}	
D _{IN1}	D _{IN2}	IM	OM	D _{OUT}	OM	D _{OUT}	D _{OUT}
H	*	H	L	H	H	H	H
L	*	H	L	L	H	L	L
*	H	L	L	H	H	H	H
*	L	L	L	L	H	L	L

* Don't Care



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	8	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temperature	Topr	-30	-	85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

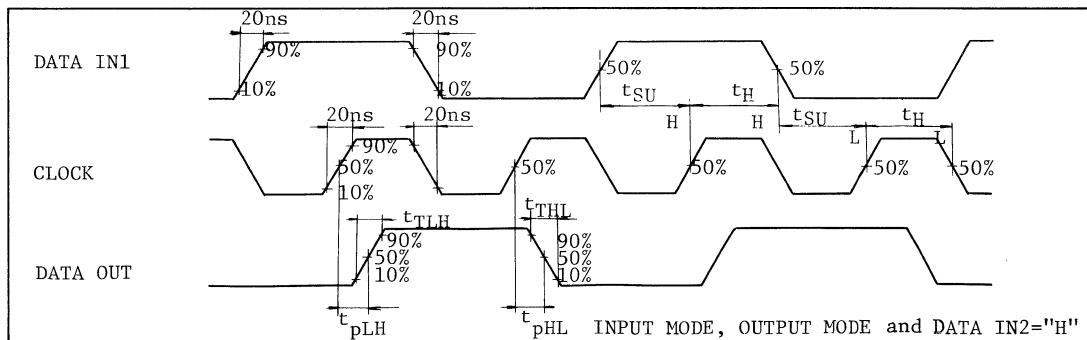
CHARACTERISTIC	SYM-BOL	TEST CONDITIONS	V _{DD} (V)	-30°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{DD} , V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{DD} , V _{SS}	5	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Current	I _{OH}	V _{OH} =2.5V V _{IN} =V _{DD} , V _{SS}	5	-1.25	-	-1.25	-5.0	-	-1.0	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{DD} , V _{SS}	5	3.2	-	3.2	7.0	-	2.4	-	
High Level Input Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V
Low Level Input Voltage	V _{IL}	V _{OUT} =0.5V, 4.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	
H.Level Input Current	I _{IH}	V _{IH} =8V	8	-	0.2	-	10 ⁻⁵	0.2	-	1.0	μA
L.Level Input Current	I _{IL}	V _{IL} =0V	8	-	-0.2	-	-10 ⁻⁵	-0.2	-	-1.0	μA
Quiescent Current C.	I _{DD}	*V _{IN} =V _{SS} , V _{DD}	5	-	50	-	-	50	-	375	μA

* All valid input combination

SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
			5				
Output Rise Time	t _{TLH}		5	-	135	400	ns
Output Fall Time	t _{THL}		5	-	100	200	ns
(Low-High)P.Delay Time	t _{pLH}		5	-	500	1000	ns
(High-Low)P.Delay Time	t _{pHL}		5	-	400	1000	
Max.Clock Rise Time	t _{rCL}		5	20	-	-	μs
Max.Clock Fall Time	t _{fCL}		5	-	-	-	
Max. Clock Frequency	f _{CL}		5	1.0	2.5	-	MHz
Data Set Up Time	t _{SU}		5	-	100	250	ns
Data Hold Time	t _H		5	-	-100	50	ns
Input Capacitance	CLOCK INPUT	C _{IN}	5	-	10	15	pF
	OTHER INPUT							5	7.5

SWITCHING TIME TEST WAVEFORM



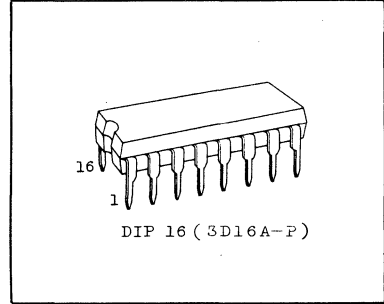
TC5051P, TC5052P

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5051P 4 DIGIT DECADE COUNTER WITH BLANKING CONTROL
TC5052P 4 DIGIT DECADE COUNTER WITH CLOCK ENABLE

TC5051P and TC5052P are four digit decimal up counters. The contents of counter are dynamically output digit by digit in sequence from the higher-order digit to BCD OUTPUT. When the content of counter reaches "9999", CARRY OUT is output with "H" level, and it holds "L" level for other counter contents.

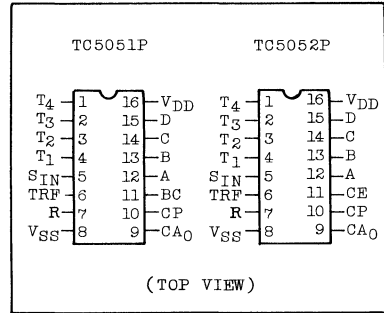
TC5051P has BLANKING CONTROL input which facilitates the leading zero suppress operation for higher order digits than arbitrary digit position. And TC5052P is capable to inhibit CLOCK by means of CLOCK ENABLE input.



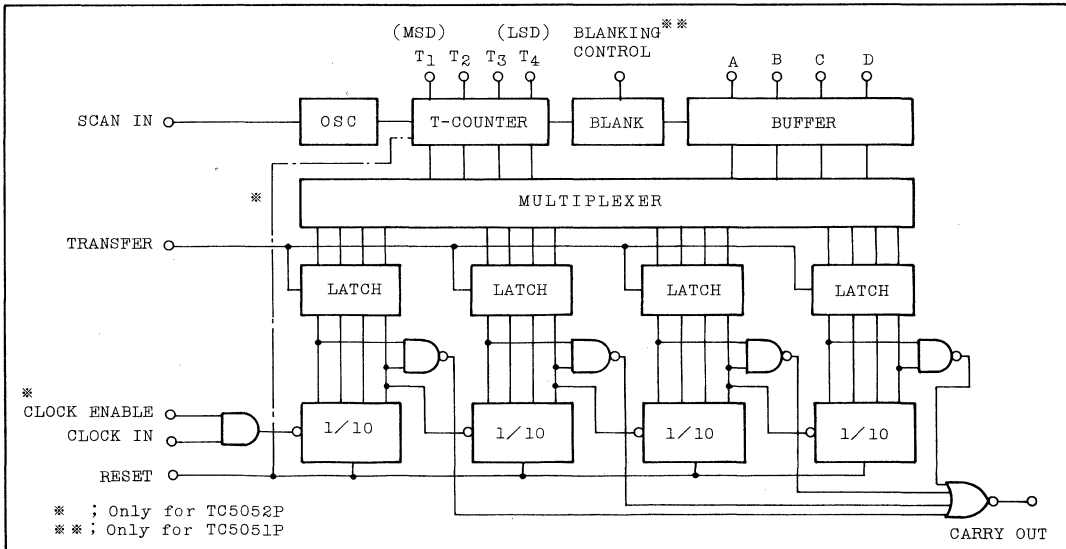
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +14	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT



BLOCK DIAGRAM



DESCRIPTION OF PIN FUNCTION

PIN No.	SYMBOL	NAME	FUNCTION
1	T ₄	DIGIT SELECT 4	Outputs to select the digit of BCD OUT (Output signal) and correspond in ascending order from T ₁ . "H" level is shifted from T ₁ , T ₂ , T ₃ then T ₄ in sequence for every eight clocks of S _{IN} . In the case of TC5052P, when RESET is set to "H", all of T ₁ ~T ₄ become "L" and when RESET falls the scan is always started from T ₁ . T ₁ ~T ₄ are not affected by RESET for TC5051P.
2	T ₃	DIGIT SELECT 3	
3	T ₂	DIGIT SELECT 2	
4	T ₁	DIGIT SELECT 1	
5	S _{IN}	SCAN INPUT	T-COUNTER CLOCK input. The clock can be generated by connecting a capacitor between this terminal and GND.
6	TRF	TRANSFER	H | Decimal counter outputs are transferred to the multiplexer as they are.
			L | The counter outputs at the falling edge of TRF are latched.
7	R	RESET	The counter is reset to "0000" by "H" level input. TC5052P establishes the synchronism of T-counter by means of CLEAR input.
8	V _{SS}	V _{SS}	(GND)
9	CA ₀	CARRY OUT	"H" level is output as long as the counter holds "9999". This becomes "L" level for all other counts.
10	CP	CLOCK INPUT	First stage decimal counter clock, which triggers at the falling edge.
11	CE	CLOCK ENABLE (TC5052P)	Clock input is inhibited by "L" level
	BC	BLANK CONTROL (TC5051P)	All digits are displayed by "H" level, leading zero suppress can be achieved by "L" level and zero suppress for higher order digits than a specific digit position can be achieved by connecting T output to BC.
12	A	BCD OUT A	BCD outputs of decimal counter. When T ₁ ="H", the highest order digit (4th digit) is output. When T ₂ ="H", 3rd digit is output, when T ₃ ="H", 2nd digit is output and when T ₄ ="H", 1st digit is output. If zero suppress is activated, all the outputs become "H" level.
13	B	BCD OUT B	
14	C	BCD OUT C	
15	D	BCD OUT D	
16	V _{DD}	V _{DD}		V_{DD} Power Supply (3 - 12 volts)

OPERATING CONSIDERATION

* Count and Reset Operations

When RESET input is set at "H" level, the counter is reset to "0000". If pulse is applied to CLOCK input after returning RESET input to "L", the counter advances its count up to "9999" at the falling edge of clock providing CLOCK ENABLE to be "H". If CLOCK ENABLE is "L", CLOCK is inhibited. CARRY OUT is output with "H" level only when the count is "9999".

* Latch Operation - When TRANSFER input is set to "H", the counter output is transferred to the multiplexer as it is, and output dynamically to BCD OUT in synchronism with S_{IN}. When TRANSFER input is changed from "H" to "L", the counter content at the falling edge of TRANSFER is stored in the latch and BCD OUT is not varied even if the count changes.

* Scan Operation - BCD output of each digit is output on common A_{OUT}~D_{OUT} on time sharing basis and switching of digit is achieved by connecting a capacitor between SCAN IN input and V_{SS}(GND)(internal oscillation) or by supplying external clock from SCAN IN.

TC5051P, TC5052P

OPERATING CONSIDERATION

Capacitance of approximately 1000pF is recommended for the internal oscillation.

Switching of digit is in synchronism with the timing outputs of $T_1 - T_4$.

When T_1 is "H" thousand's digit is output to BCD OUT, when T_2 is "H" hundred's digit is output, when T_3 is "H" ten's digit is output, and when T_4 is "H" unit's digit is output.

* Blanking Operation (TC5051P)

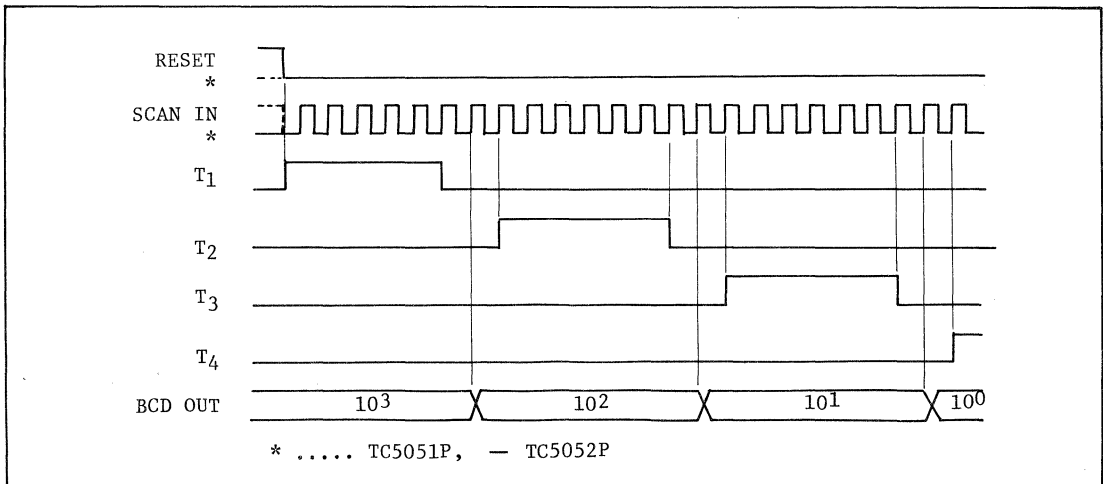
By controlling BLANKING CONTROL, leading zero suppress of higher order digit positions than a specific digit position can be achieved by the function of internal circuit.

BLANKING CONTROL = VSS	.....	Zero Suppress for all digits	*	
"	"	= VDD	..... No Zero Suppress	
"	"	= T_2	..... Zero Suppress for only thousand's digit	*
"	"	= T_3	..... Zero Suppress for thousand's and hundred's digits	*
"	"	= T_4	..... Zero Suppress for all except unit's digit	*

When blanking is activated, all of AOUT - DOUT become "H".

* (Note) When a carry occurs from the counter and during one cycle of T counter, normal output may not be seen.

TIMING CHART



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	3	-	12	V
Input Voltage	V_{IN}	0	-	V_{DD}	V
S_{IN} Connecting Capa.	C_{EXT}	50	-	30000	pF
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS ($V_{SS}=0V$)

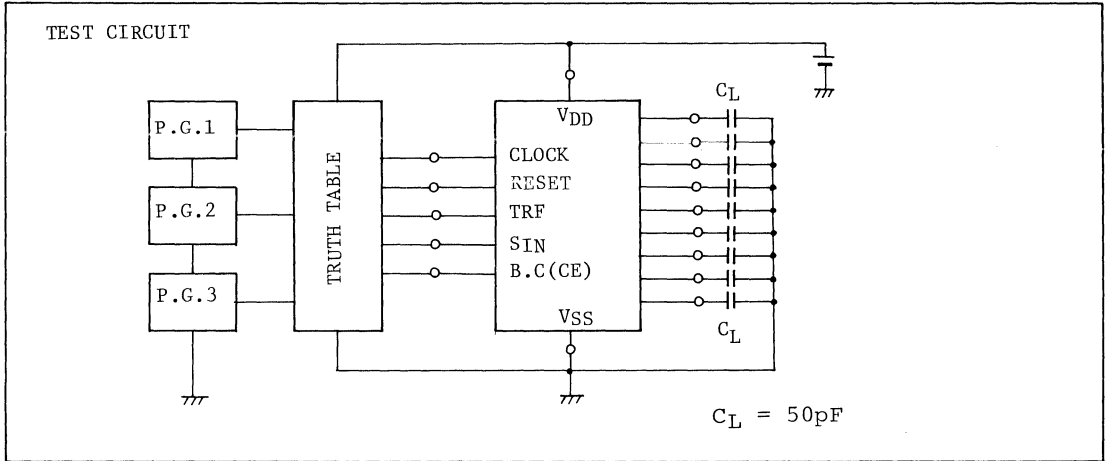
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V_{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V_{OH}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
Low Level Output Voltage	V_{OL}$	|I_{OUT}| < 1\mu A$ $V_{IN}=V_{SS}, V_{DD}$	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Current	I_{OH}	$V_{OH}=4.6V$ $V_{OH}=9.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	-0.2	-	-0.16	-	-	-0.12	-	mA
			10	-0.5	-	-0.4	-	-	-0.3	-	
Low Level Output Current	I_{OL}	$V_{OL}=0.4V$ $V_{OL}=0.5V$ $V_{IN}=V_{SS}, V_{DD}$	5	0.52	-	0.44	-	-	0.36	-	mA
			10	1.3	-	1.11	-	-	0.9	-	
High Level Input Voltage	V_{IH}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $|I_{OUT}| < 1\mu A$	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
Low Level Input Voltage	V_{IL}	$V_{OUT}=0.5V, 4.5V$ $V_{OUT}=1.0V, 9.0V$ $|I_{OUT}| < 1\mu A$	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
High Level Input Current (other than S_{IN})	I_{IH}	$V_{IH}=12V$	12	-	0.3	-	10^{-5}	0.3	-	1.0	μA
Low Level Input Current (other than S_{IN})	I_{IL}	$V_{IL}=0V$	12	-	-0.3	-	-10^{-5}	-0.3	-	-1.0	
High Level Input Current (S_{IN})	I_{IH}	$V_{IH}=12V$	12	-	-	50	-	200	-	-	μA
Low Level Input Current (S_{IN})	I_{IL}	$V_{IL}=0V$	12	-	-	1.5	-	6	-	-	mA
Quiescent Current Consumption	I_{DD}	$V_{IN}=V_{SS}, V_{DD}$	5	-	-	200	-	200	-	500	μA
			10	-	-	500	-	500	-	1000	

TC5051P, TC5052P

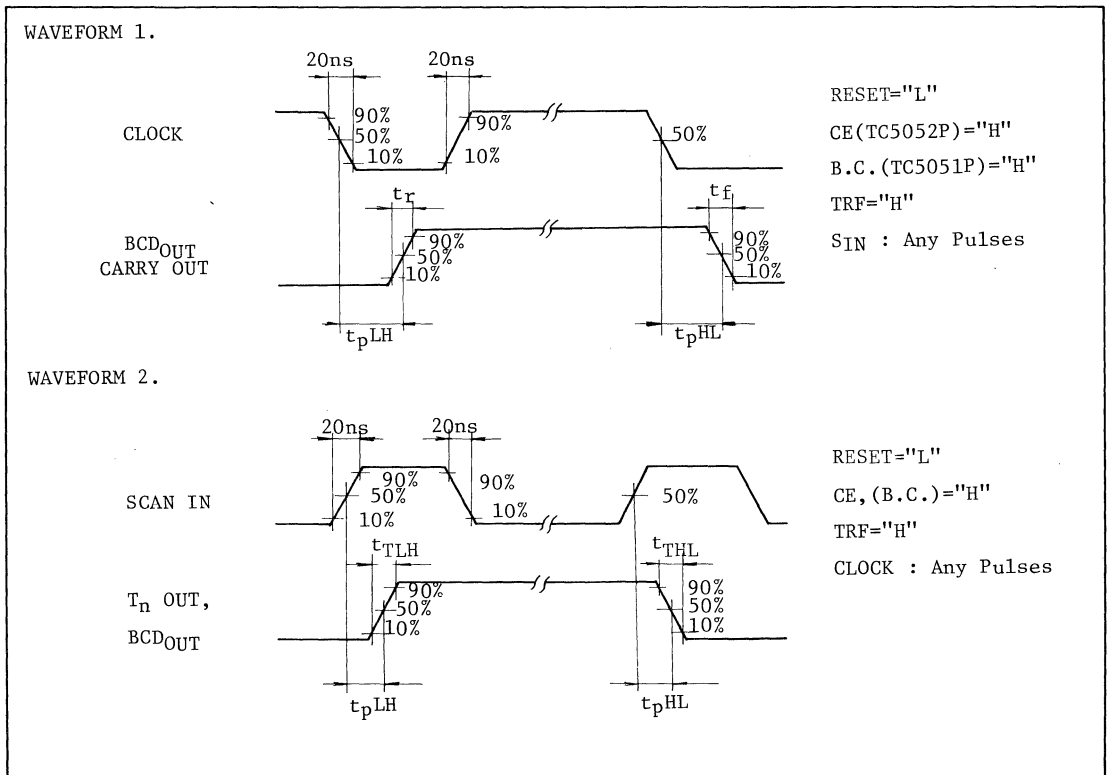
SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTICS	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
Output Fall Time	t _{THL}		5	-	100	200	ns
			10	-	50	100	
Propagation Delay Time (CLOCK-BCD _{OUT})	t _{pLH} t _{pHL}	T ₄ ="H"	5	-	1200	2500	ns
			10	-	450	1000	
Propagation Delay Time (CLOCK-CARRY)	t _{pLH} t _{pHL}		5	-	900	2000	ns
			10	-	400	800	
Propagation Delay Time (S _{IN} - T _n)	t _{pLH} t _{pHL}		5	-	1200	2500	ns
			10	-	450	1000	
Propagation Delay Time (S _{IN} -BCD _{OUT})	t _{pLH} t _{pHL}		5	-	1600	2500	ns
			10	-	700	1400	
Propagation Delay Time (CLEAR-BCD _{OUT})	t _{pHL}		5	-	900	2000	ns
			10	-	350	800	
Min. RESET Pulse Width	t _w (RESET)		5	-	700	1500	ns
			10	-	350	750	
Min. Transfer Pulse Width	t _w (TRANSFER)		5	-	140	500	ns
			10	-	50	250	
Max. Clock Frequency	f _{CL}		5	1.0	1.5	-	MHz
			10	2.0	3.5	-	
Max. Scan Frequency	f _{CL} (SCAN)		5	0.5	1.0	-	MHz
			10	1.0	2.0	-	
Min. Removal Time (RESET - COLOCK)	t _{rem}		5				ns
			10				
Min. Set Up Time (TRANSFER-CLOCK)	t _{SU}		5				ns
			10				
Min. Set Up Time (TRANSFER-CLEAR)	t _{SU}		5				ns
			10				
Max. Clock Rise Time	t _{rCL}		5	20	-	-	μs
Max. Clock Fall Time	t _{fCL}		10	2.5	-	-	μs
Input Capacitance	C _{IN}						pF

SWITCHING TIME TEST CIRCUIT

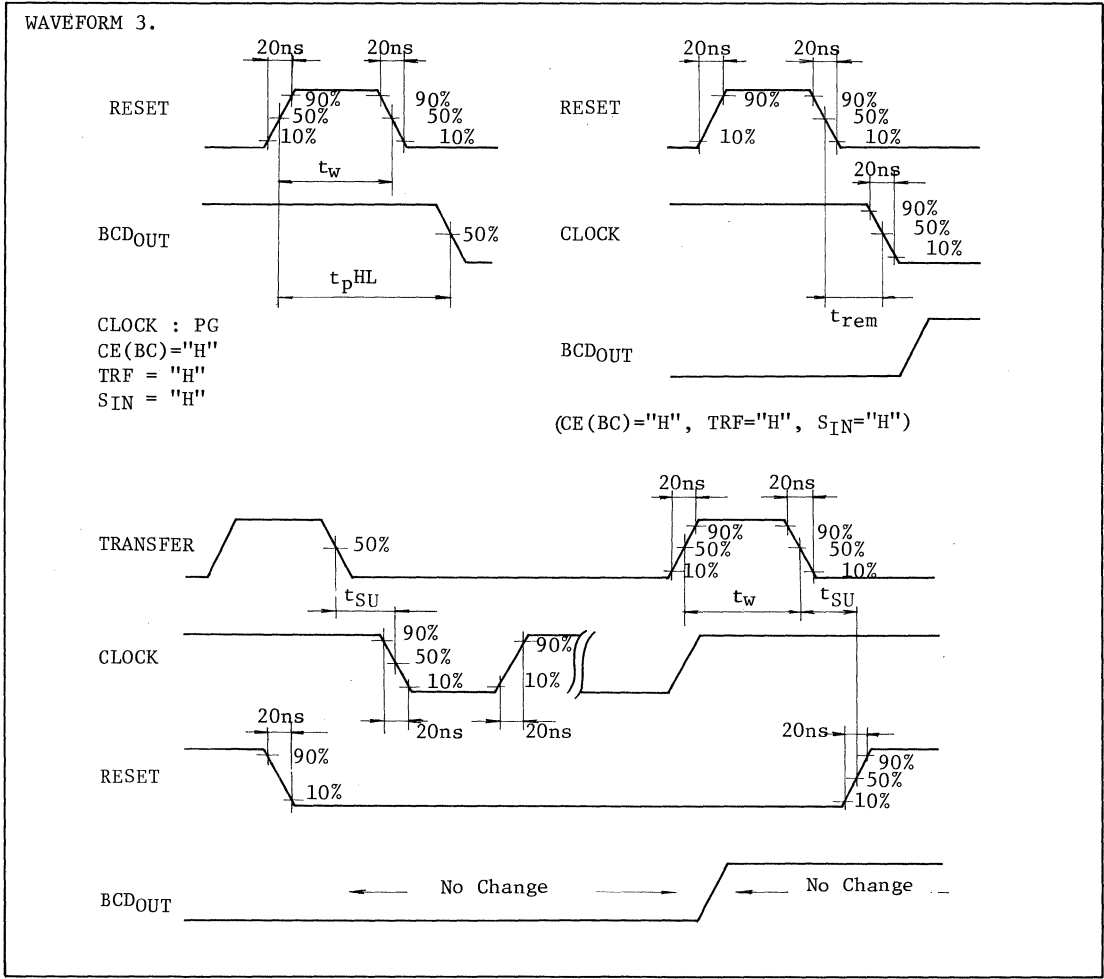


SWITCHING TIME TEST WAVEFORMS



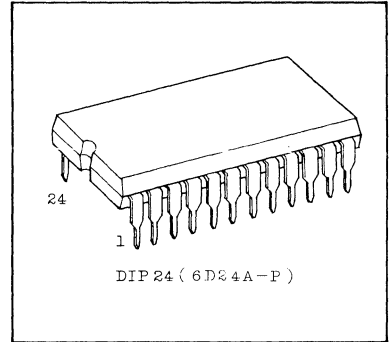
TC5051P, TC5052P

SWITCHING TIME TEST WAVEFORMS



TC5053P 4-DIGIT UP/DOWN DECADE COUNTER
TC5054P 4-DIGIT UP/DOWN DECADE COUNTER

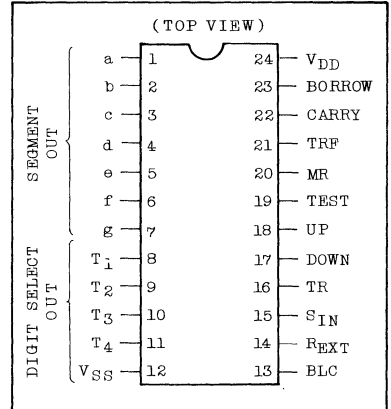
TC5053P/TC5054P is a 4-digit decimal up/down counter containing 7-segment decoder/driver. The counter consists internally of a 4-digit latch, multiplexer, scan oscillating circuit, and decoder/driver capable of directly driving LED. The clock input is independently equipped with an up-clock and a down-clock. Each input has the function of a Schmitt trigger. This type of up/down counter can be widely applied to counters, panelmeters, etc.



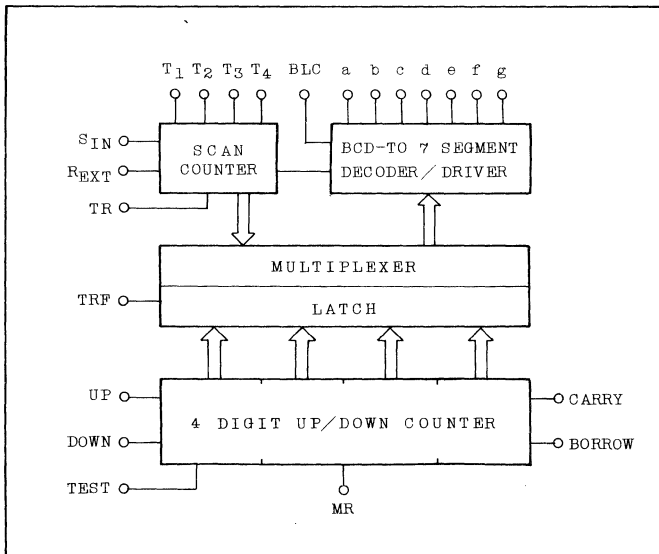
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5~V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-55~125	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

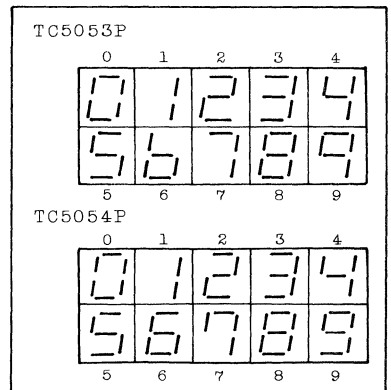
PIN ASSIGNMENT



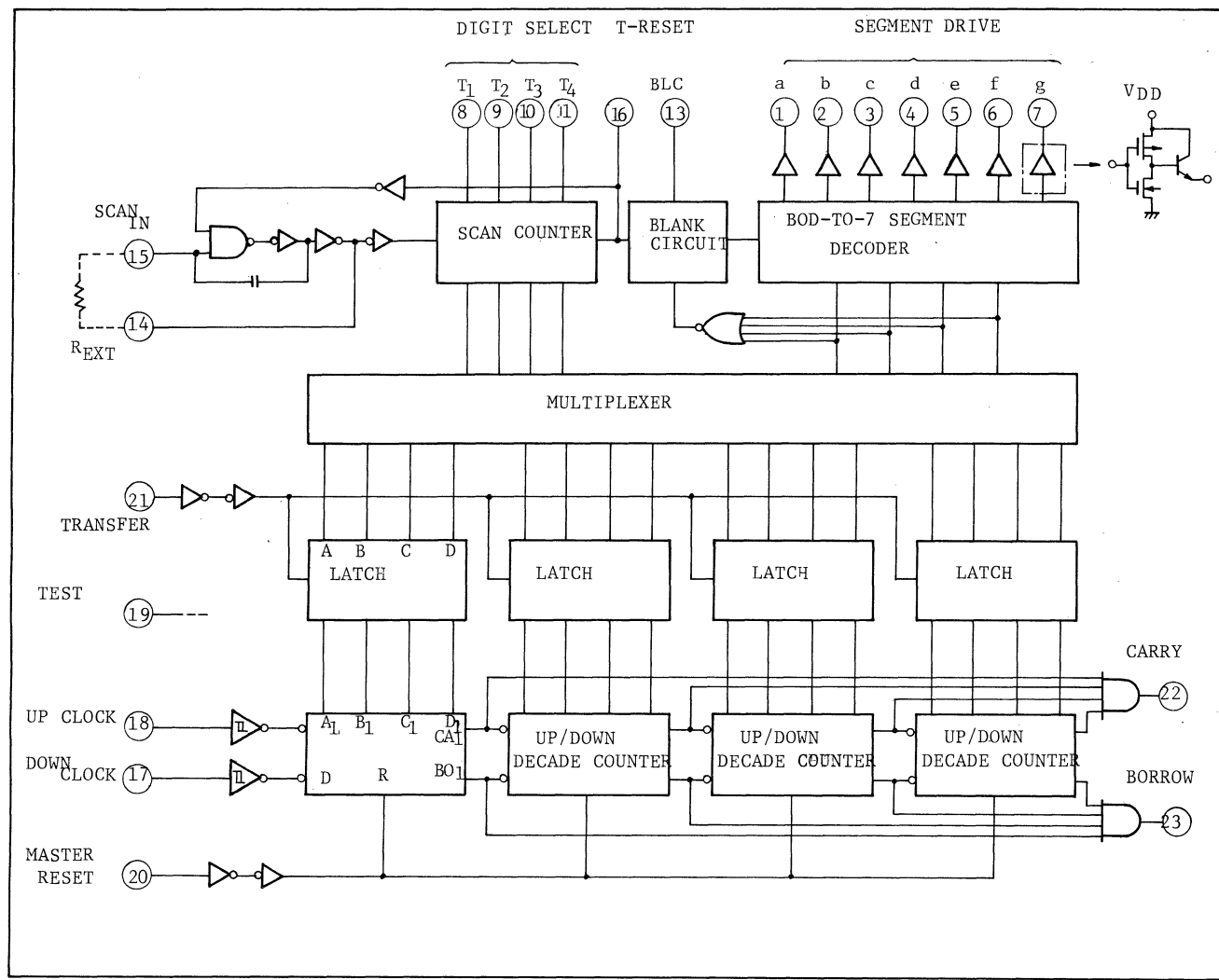
BLOCK DIAGRAM



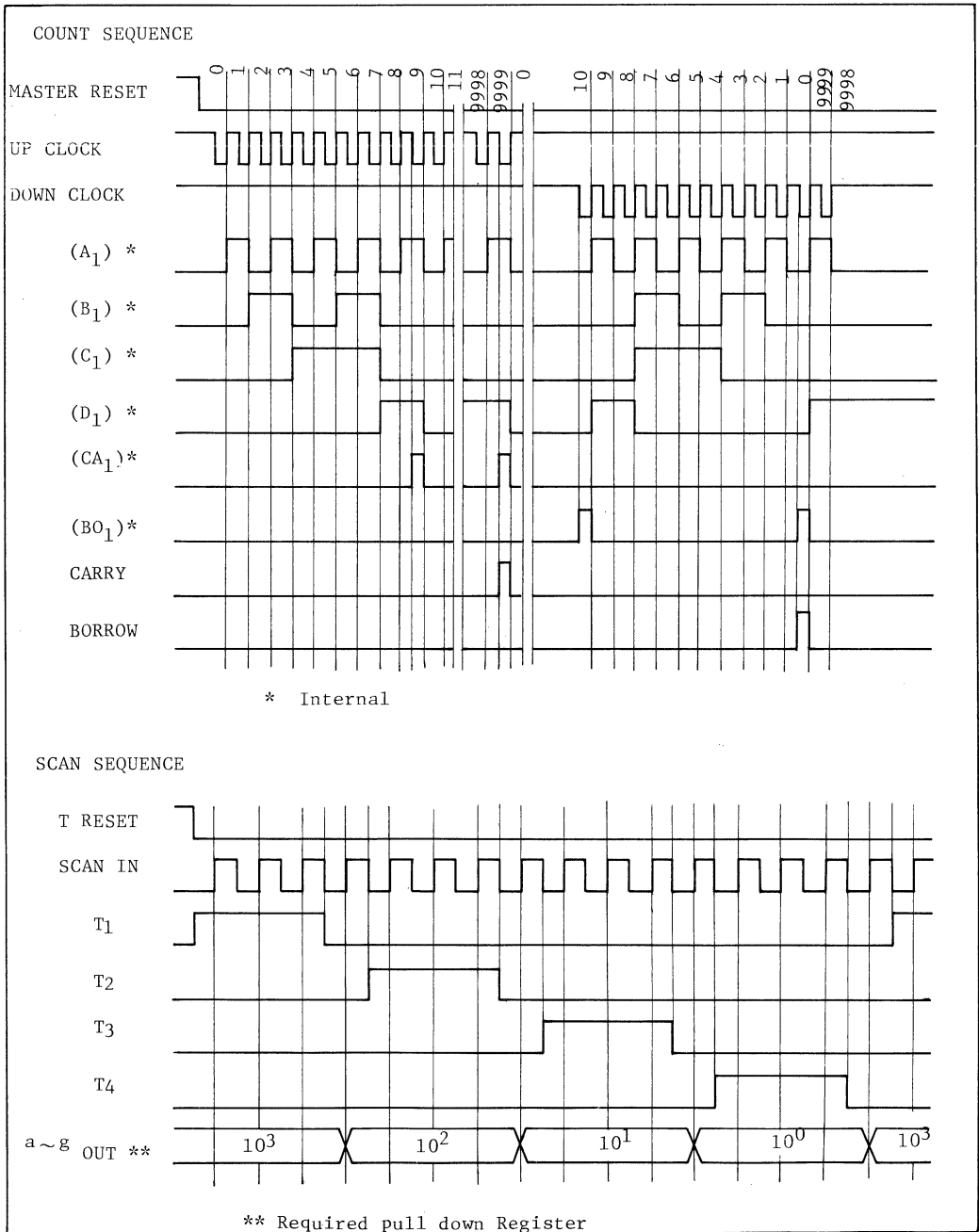
SEGMENT OUTPUTS MODE



BLOCK DIAGRAM



TIMING CHART



TC5053P, TC5054P

DESCRIPTION OF PIN FUNCTION

PIN NO.	SYMBOL	NAME	FUNCTION		
1	a	SEGMENT a	The segments a ~ g are the outputs that have converted the decimal up/down counter BCD outputs into 7-segment display element driving codes. These segment signals are synchronous with SCAN inputs and are dynamically output from the higher order digit. Since they are designed so that I _{OH} is large, they can directly drive a cathod common type LED.		
2	b	" b			
3	c	" c			
4	d	" d			
5	e	" e			
6	f	" f			
7	g	" g			
8	T ₁	DIGIT SELECT 1	These are the outputs indicating the digits of the outputs a ~ g and correspond to the higher-order positions from T ₁ upward. These outputs are automatically switched in order of T ₁ - T ₂ - T ₃ - T ₄ - T ₁ by giving clock to SCAN input.		
9	T ₂	" 2			
10	T ₃	" 3			
11	T ₄	" 4			
12	V _{SS}	V _{SS}	(GND)		
13	BLC	BLANKING CONTROL	"H"	No 0 suppression	The leading 0 suppression of the digits of more than the higher-order(N-1) can be made by connecting this terminal to T _n .
			"L"	Leading zero suppression of All digits	
14	R _{EXT}	REGISTER EXTERNAL	SCAN clock is produced by connecting a resistor between R _{EXT} and S _{IN} . In case S _{IN} is externally provided, R _{EXT} should be opened.		
15	S _{IN}	SCAN IN	This is a clock input of digit selection counter. If a resistor is connected between S _{IN} and R _{EXT} , SCAN Counter can make self-oscillation. (Pulse may be externally applied)		
16	TR	T-COUNTER RESET	Operation of SCAN counter can be stopped by "H" level. Whenever TR is fallen, SCAN counter starts scanning from T ₁ .		
17	DOWN	DOWN COUNT	The internal counter makes down count at the rising edge of a pulse if the pulse is provided to the in a state where UP input is kept at "H" level.		
18	UP	UP COUNT	The internal counter makes up count at the rising edge of a pulse if the pulse is provided to the in a state where DOWN input is kept at "H" level.		
19	TEST	TEST	This set to "L" level. (When it is set to "H" level, counting varies with the rising or falling edge.)		
20	MR	MASTER RESET	A state of count is cleared to "0000" at the "H" level.		
21	TRF	TRANSFER	In case of "H" level input, the counter contents are always being output through a multiplexer. In case of "L" level input, however, the counter contents before the change to "L" level are not changed by the change in counter contents because the previous contents remain kept in the latch circuit.		
22	CARRY	CARRY	In UP COUNT, when the COUNTER contents reaches "9999", "H" level is output as long as UP COUNTER input holds "L" level.		
23	BORROW	BORROW	In DOWN COUNT, when the COUNTER contents reaches "0000", "H" level is output as long as DOWN COUNTER input holds "L" level.		
24	V _{DD}	V _{DD}	(V _{DD})		

RECOMMENDED OPERATING CONDITION (V_{SS}=0V)

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	8	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temperature	T _{opr}	-30	-	85	°C
R _{EXT} EXTERNAL RESISTANCE	R _{EXT}	5K	-	1M	Ω

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

ITEM	SYMBOL	TEST CONDITION	V _{DD} (V)	-30°C		25°C		85°C		UNIT
				MIN	MAX	MIN	TYP	MAX	MIN		MAX
High Level Output Voltage	T ₁ ~T ₄ , Carry, Borrow	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	-	-	4.95	V
	a ~ g			4.0	-	4.0	4.5	-	4.0	
	R _{EXT}			4.95	-	4.95	-	-	4.95	
Low Level Output Voltage	T ₁ ~T ₄ , Carry, Borrow	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	-	0.05	-	V
	R _{EXT}			-	0.05	-	-	0.05	-	
				-	0.05	-	-	0.05	-	
High Level Output Current	T ₁ ~T ₄ , Carry, Borrow	V _{OH} =4.6V V _{OH} =3.5V V _{OH} =4.6V	5	-0.2	-	-0.16	-	-	-0.12	mA
	a ~ g			-0.2	-	-0.2	-	-	-0.15	
	R _{EXT}			-0.02	-	-0.02	-	-	-0.01	
Low Level Output Current	T ₁ ~T ₄ , Carry, Borrow	V _{OL} =0.4V	5	0.52	-	0.44	-	-	0.36	mA
	R _{EXT}			0.02	-	0.02	-	-	0.01	
Disable Current (a~g)	I _{DL}	V _{OL} =0V	8	-	-3.0	-	-10 ⁻⁴	-	-3.0	μA
High Level Input Voltage	UP/DOWN CLOCK	V _{IH}	5	3.5	-	3.5	-	-	3.5	V
	OTHER			3.5	-	3.5	2.75	-	3.5	
Low Level Input Voltage	UP/DOWN CLOCK	V _{IL}	5	-	1.5	-	-	1.5	-	V
	OTHER			-	1.5	-	2.25	1.5	-		1.5
High Level Input Current	I _{IH}	V _{IH} =8V	8	-	0.15	-	10 ⁻⁵	0.15	-	1.0
Low Level Input Current	I _{IL}	V _{IL} =0V	8	-	0.15	-	10 ⁻⁵	0.15	-	1.0
Quiescent Current Consumption	I _{DD}	V _{IN} =V _{SS} , V _{DD} OUTPUT OPEN	8	-	-	-	-	-	-	μA

SWITCHING CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}	T ₁ ~T ₄ , Carry, Borrow	-	70	180	ns
		a~g (R _L =1kΩ)	-	40	100	
Output Fall Time	t _{THL}	T ₁ ~T ₄ , Carry, Borrow	-	50	130	ns
Propagation Delay Time	t _{pLH} t _{pHL}	CLOCK-a~g (R _L =1kΩ, T ₁ =H)	-	5000	12000	ns
		CLOCK-Carry, Borrow	-	700	1500	
		SCAN-T ₁ ~T ₄	-	450	1000	
		SCAN-a~g (R _L =1kΩ)	-	750	1700	
Max. Frequency	f _{CL-1} *	CLOCK	2.0	4.0	-	MHz
	f _{CL-2} *		0.7	1.4	-	
	f _{CL-1} **	SCAN	2.0	4.0	-	
	f _{CL-2} **		0.7	1.1	-	

TC5053P, TC5054P

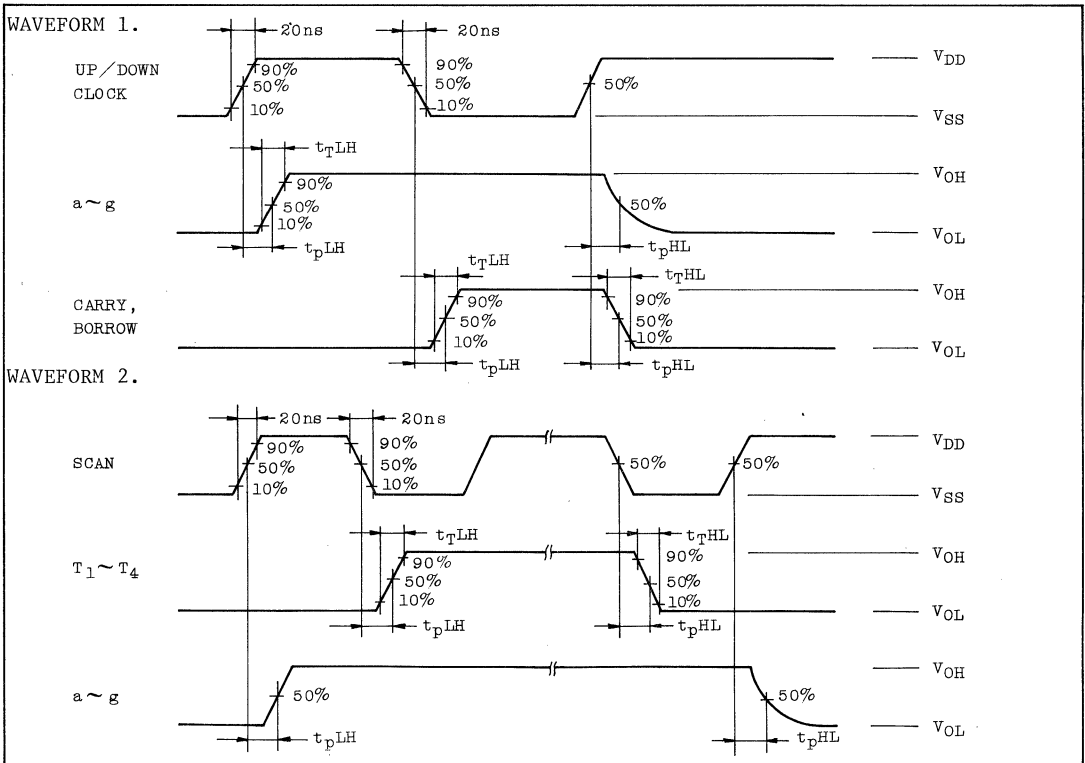
SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF) (Continued)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Min. Pulse Width	$t_w(MR)$	MASTER RESET	-	150	450	ns
	$t_w(TR)$	T-COUNTER RESET	-	100	300	
	$t_w(TRF)$	TRANSFER	-	50	200	
Minimum Removal Time	t_{rem}	MR-CLOCK	-	-100	250	ns
		TR-SCAN	-	250	750	
		TRF-CLOCK	-	100	400	
Max. Clock Rise Time Max. Clock Fall Time	t_{rCL} t_{fCL}	UP/DOWN CLOCK	No Limit			μs
Input Capacitance	C_{IN}	except SCAN	-	5	7.5	pF

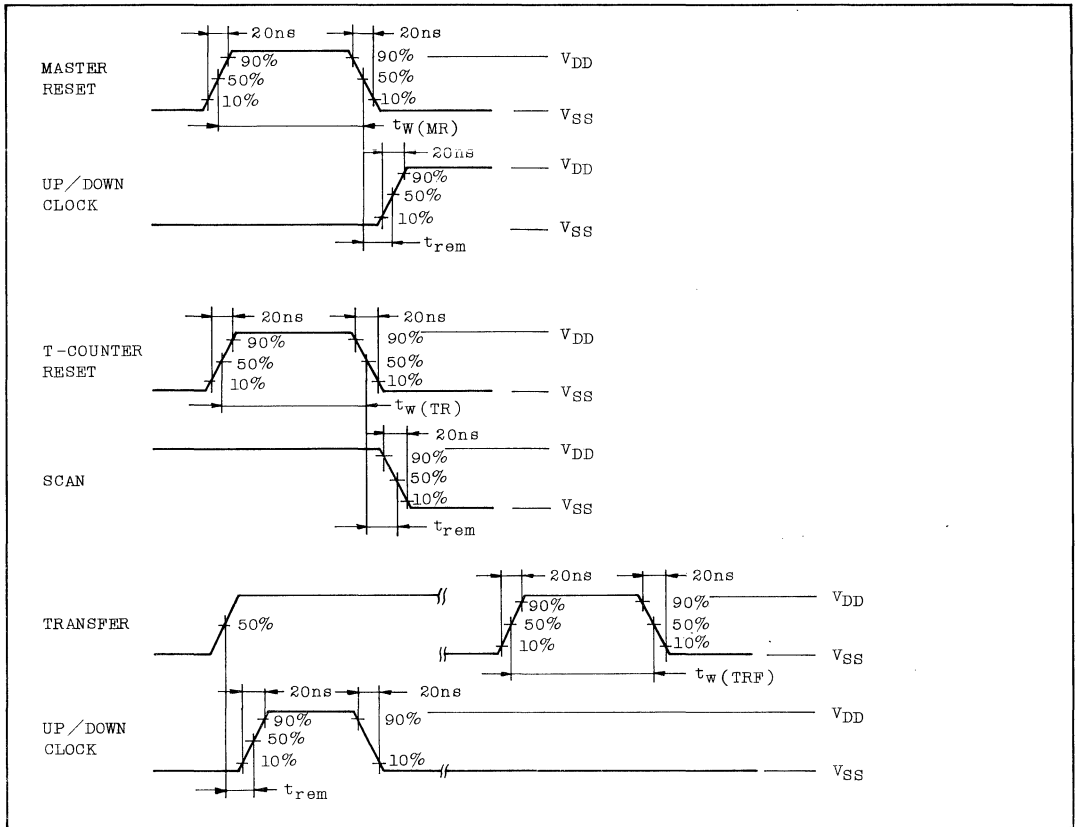
* Counter operation : f_{CL-1} , CARRY, BORROW operation : f_{CL-2}

** Leading zero suppression : f_{CL-2} , No zero suppression : f_{CL-1}

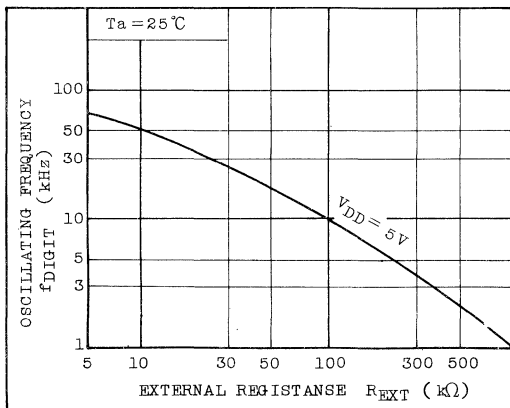
SWITCHING TIME TEST WAVEFORMS



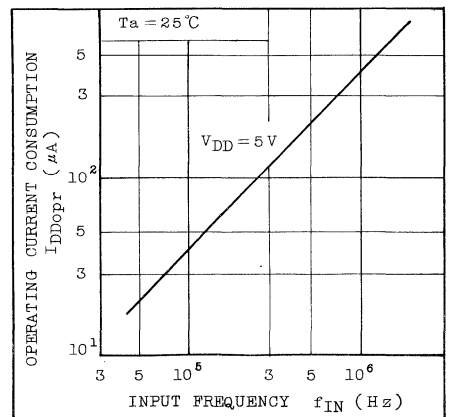
SWITCHING TIME TEST WAVEFORMS (Continued)



$f_{DIGIT} - R_{EXT} (TYP.)$



$I_{DDopr} - f_{IN} (TYP.)$



TC5064BP, TC5065BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

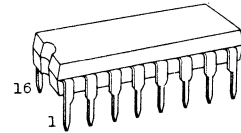
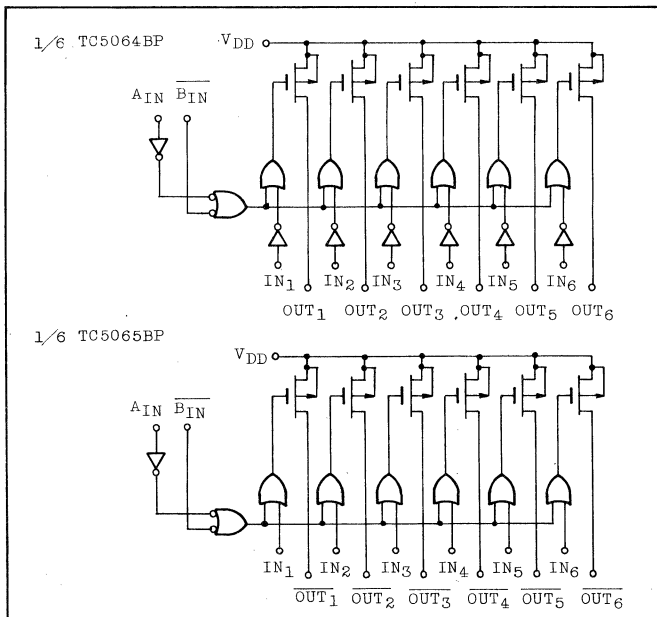
TC5064BP HEX HIGH VOLTAGE BUFFER WITH INHIBIT/NON INVERTING TYPE
TC5065BP HEX HIGH VOLTAGE BUFFER WITH INHIBIT/INVERTING TYPE

TC5064BP and TC5065BP contain six circuits of buffers having two common INHIBIT inputs ($\overline{A_{IN}}$, $\overline{B_{IN}}$). As both have the output of open drain structure with high breakdown voltage P-channel MOS FET (-50 volts... Maximum Rating), these are suitable for driving fluorescent display tubes and for interfacing with high voltage MOS LSI's. TC5064BP is non-inverting type and TC5065BP is inverting type.

ABSOLUTE MAXIMUM RATINGS

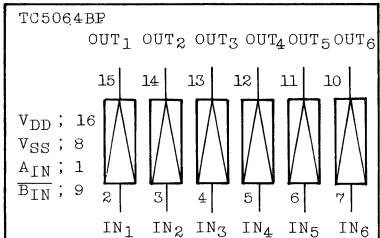
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{DD} -50 ~ V _{DD} +0.5	V
Power Dissipation	P _D	300	mW
DC Input Current	I _{IN}	±10	mA
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

LOGIC DIAGRAM

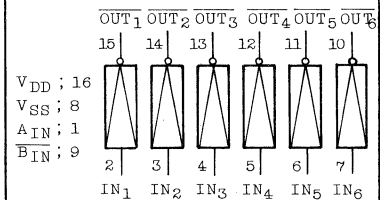


DIP 16 (3D16A-P)

PIN ASSIGNMENT



TC5065BP



TRUTH TABLE

INPUT			OUTPUT	
A _{IN}	B _{IN}	IN	TC5064BP	TC5065BP
L	H	L	HZ	H
L	H	H	H	HZ
*	L	*	HZ	HZ
H	*	*	HZ	HZ

HZ; High Impedance
*; Don't care

RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VDD	3		18	V
Input Voltage	VIN	0		VDD	V
Operating Temp.	Topr	-40		85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	VOH	|IOUT| < 1μA VIN=VSS or VDD	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
High Level Output Current	IOH	VOH=3V (VDD-2V) VOH=2V (VDD-3V) VOH=7V (VDD-3V) VOH=12V(VDD-3V)	5	- 6	-	- 5	-10	-	- 4	-	mA
			10	- 9	-	- 8	-13	-	- 6	-	
			15	-12	-	-10	-25	-	- 8	-	
			15	-17	-	-15	-35	-	-12	-	
High Level Input Voltage	* VIH	VOUT=0.5V,4.5V VOUT=1.0V,9.0V VOUT=1.5V,13.5V	5	3.5	-	3.5	2.75	-	3.5	-	V
			10	7.0	-	7.0	5.5	-	7.0	-	
			15	11.0	-	11.0	8.25	-	11.5	-	
Low Level Input Voltage	* VIL	VOUT=0.5V,4.5V VOUT=1.0V,9.0V VOUT=1.5V,13.5V	5	-	1.5	-	2.25	1.5	-	1.5	V
			10	-	3.0	-	4.5	3.0	-	3.0	
			15	-	4.0	-	6.75	4.0	-	4.0	
Output OFF Current	IOFF	VOUT = 0V VOUT = VDD-45V	15	-	- 3	-	-0.01	-3	-	-10	μA
			15	-	-10	-	-1	-10	-	-20	
Input Current	IIH IIL	VIH = 18V VIL = 0V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
			18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	IDD	VIN=VSS, VDD, OUTPUTS OPEN	5	-	4.0	-	0.005	4.0	-	30	μA
			10	-	8.0	-	0.010	8.0	-	60	
			15	-	16.0	-	0.015	16.0	-	120	

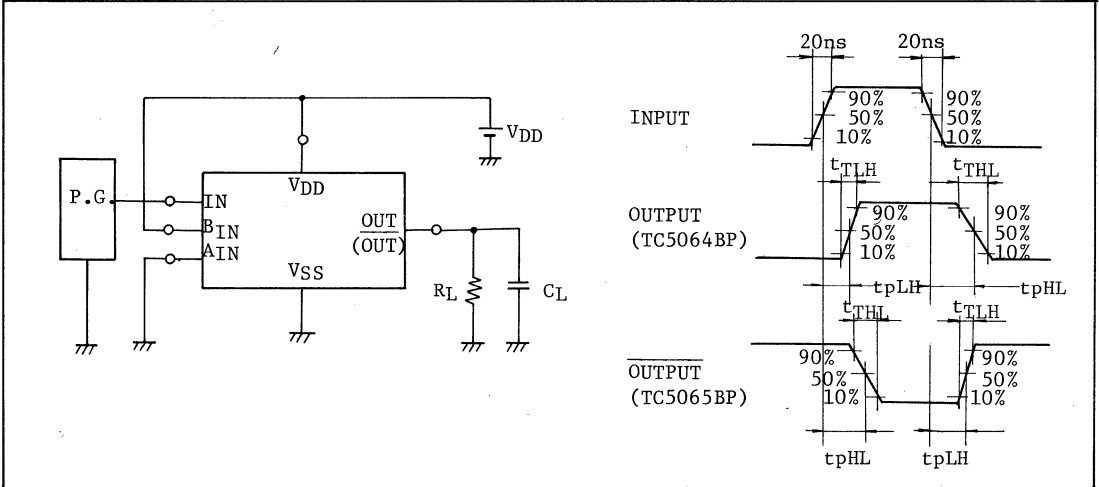
* RL = 20 kΩ

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	tTLH	RL = 20 kΩ	5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
Output Fall Time	tTHL	RL = 20 kΩ	5	-	5.0	8.0	μs
			10	-	5.0	8.0	
			15	-	5.0	8.0	
(LOW-HIGH) Propagation Delay Time	tpLH	RL = 20 kΩ	5	-	200	500	ns
			10	-	100	250	
			15	-	80	200	
(HIGH-LOW) Propagation Delay Time	tpHL	RL = 20 kΩ	5	-	2.0	4.0	μs
			10	-	2.0	4.0	
			15	-	2.0	4.0	
Input Capacity	CIN			5	7.5	pF	

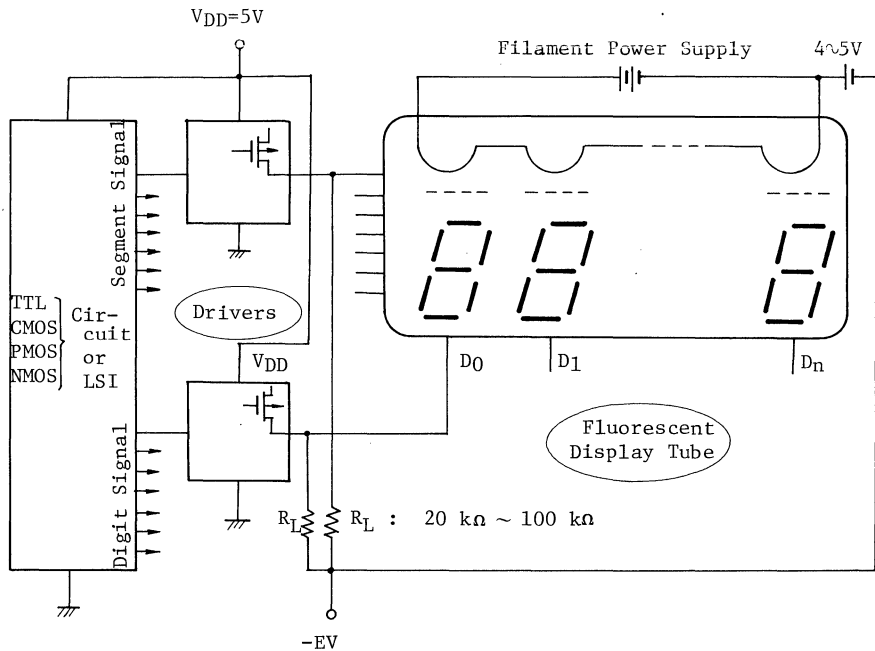
TC5064BP, TC5065BP

SWITCHING TIME TEST CIRCUIT AND WAVEFORM

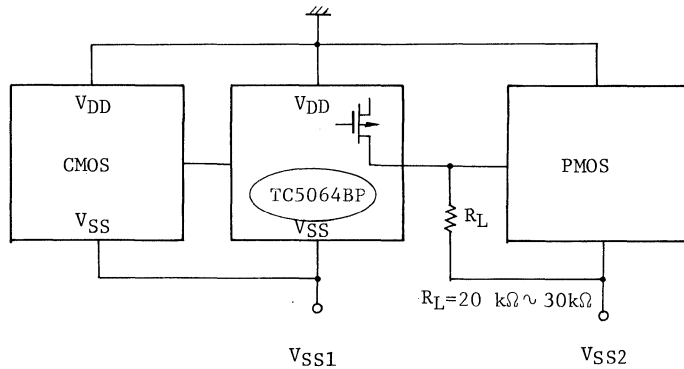


EXAMPLES OF APPLICABLE CIRCUITS

(1) Fluorescent Display Tube Driving Circuit



(2) Interface between CMOS and PMOS



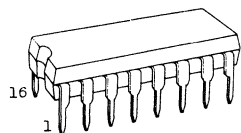
TC5066BP, TC5067BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5066BP 7-HIGH VOLTAGE BUFFER/NON INVERTING TYPE
TC5067BP 7-HIGH VOLTAGE BUFFER/INVERTING TYPE

TC5066BP and TC5067BP contain seven independent circuits of buffers. TC5066BP in non-inverting type and TC5067BP is inverting type.

As both have the output of open drain structure with high breakdown voltage P-channel MOS FET (-50 volts..Maximum Rating), these are suitable for driving fluorescent display tubes and for interfacing with high voltage MOS LSI's.



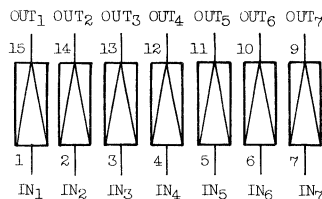
DIP 16 (3D16A-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{DD} -50 ~ V _{DD} +0.5	V
Power Dissipation	P _D	300	mW
DC Input Current	I _{IN}	±10	mA
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

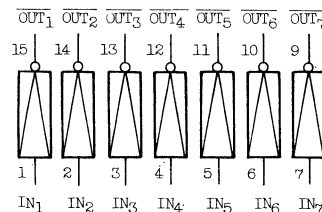
PIN ASSIGNMENT

TC5066BP



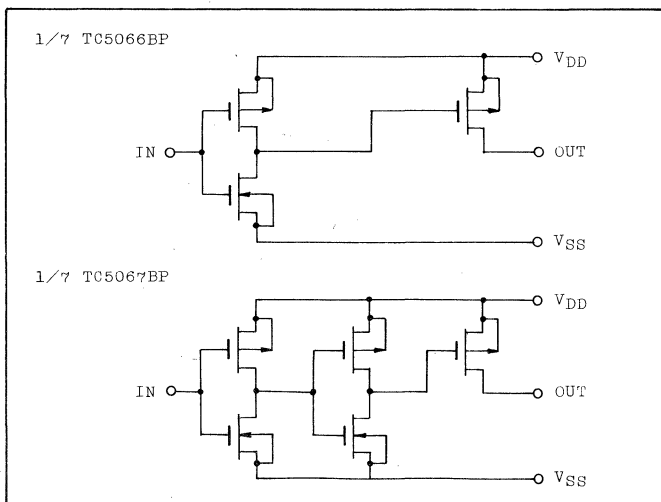
V_{DD} : 16 , V_{SS} : 8

TC5067BP



V_{DD} : 16 , V_{SS} : 8

LOGIC DIAGRAM



TC5066BP, TC5067BP

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3		18	V
Input Voltage	V _{IN}	0		V _{DD}	V
Operating Temp.	T _{OP}	-40		85	°C

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} or V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
High Level Output Current	I _{OH}	V _{OH} =3V (V _{DD} -2V) V _{OH} =2V (V _{DD} -3V) V _{OH} =7V (V _{DD} -3V) V _{OH} =12V (V _{DD} -3V) V _{IN} =V _{SS} or V _{DD}	5	-6	-	-5	-10	-	-4	-	mA	
			5	-9	-	-8	-13	-	-6	-		
			10	-12	-	-10	-25	-	-8	-		
			15	-17	-	-15	-35	-	-12	-		
High Level Input Voltage (TC5066BP)	V _{IH}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V *	5	4.0	-	4.0	-	4.0	-	V		
			10	8.0	-	8.0	-	8.0	-			
			15	12.5	-	12.5	-	12.5	-			
Low Level Input Voltage (TC5066BP)	V _{IL}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V *	5	-	1.0	-	1.0	-	1.0	V		
			10	-	2.0	-	2.0	-	2.0			
			15	-	2.5	-	2.5	-	2.5			
High Level Input Voltage (TC5067BP)	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V *	5	3.5	-	3.5	2.75	-	3.5	V		
			10	7.0	-	7.0	5.5	-	7.0			
			15	11.0	-	11.0	8.25	-	11.0			
Low Level Input Voltage (TC5067BP)	V _{IL}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V *	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Output OFF Leak Current	I _{OFF}	V _{OUT} = 0V V _{OUT} = -30V	15	-	3	-	0.01	3	-	10	μA	
			15	-	10	-	1	10	-	20		
Input Current	H Level	I _{IH}	V _{IH} = 18V	18	-	0.3	-	10 ⁵	0.3	-	1.0	μA
	L Level	I _{IL}	V _{IL} = 0V	18	-	-0.3	-	10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	I _{DD}	V _{IN} = V _{DD} , V _{SS} Outputs Open	5	-	4.0	-	0.005	4.0	-	30	μA	
			10	-	8.0	-	0.010	8.0	-	60		
			15	-	16.0	-	0.015	16.0	-	120		

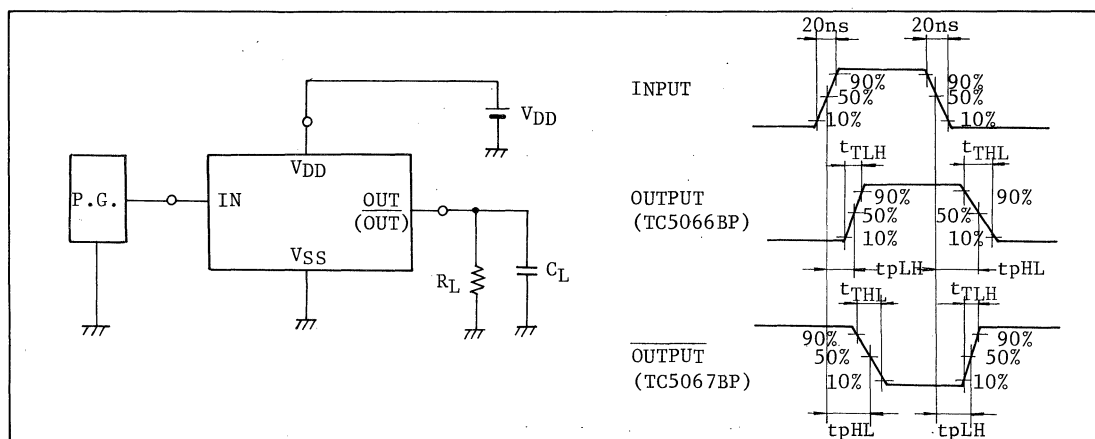
* R_L = 20 kΩ

TC5066BP, TC5067BP

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

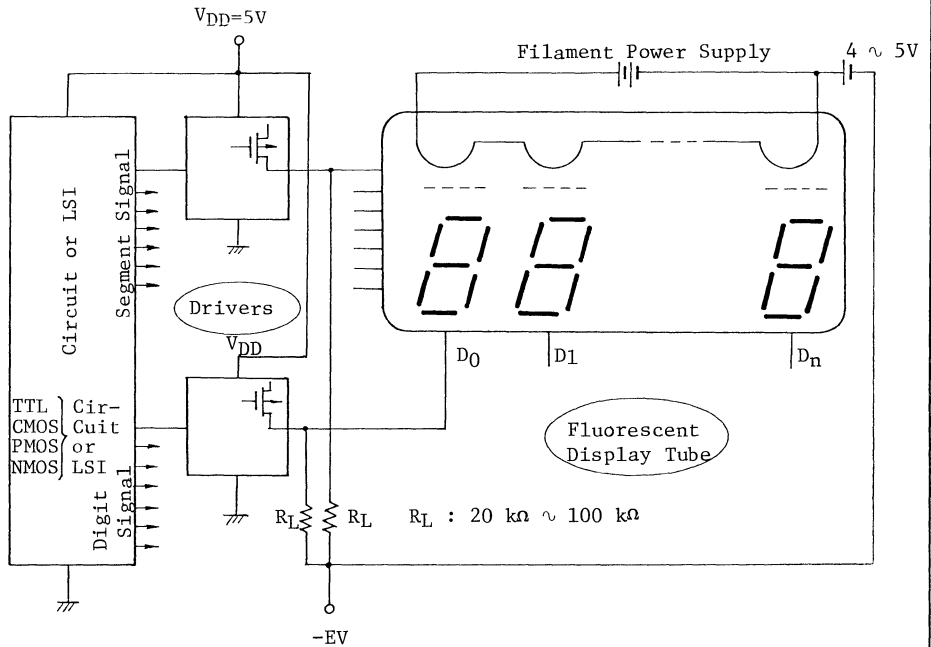
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD(V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}	R _L = 20 kΩ	5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
Output Fall Time	t _{THL}	R _L = 20 kΩ	5	-	5.0	8.0	μs
			10	-	5.0	8.0	
			15	-	5.0	8.0	
(LOW-HIGH) Propagation Delay Time	tpLH	R _L = 20 kΩ	5	-	200	500	ns
			10	-	100	250	
			15	-	80	200	
(HIGH-LOW) Propagation Delay Time	tpHL	R _L = 20 kΩ	5	-	2.0	4.0	μs
			10	-	2.0	4.0	
			15	-	2.0	4.0	
Input Capacity	C _{IN}			-	5	7.5	pF

SWITCHING TIME TEST CIRCUIT AND WAVEFORM

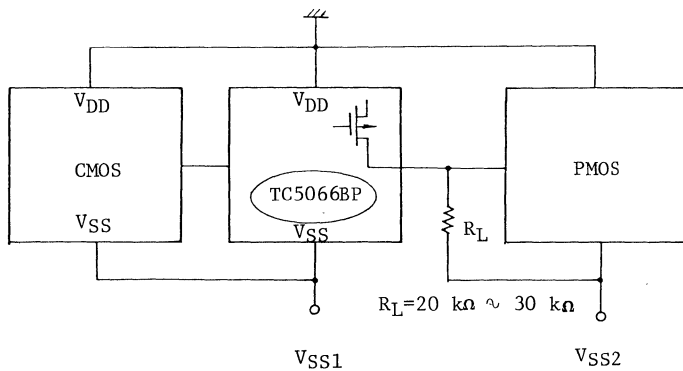


EXAMPLES OF APPLICABLE CIRCUITS

(1) Fluorescent Display Tube Driving Circuit



(2) Interface between CMOS and PMOS



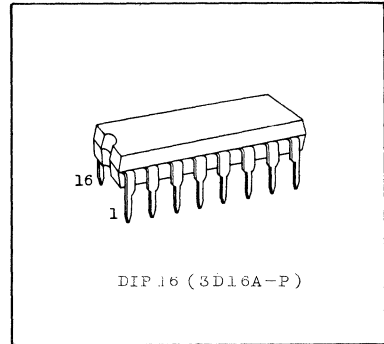
TC5068BP, TC5069BP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5068BP, TC5069BP BCD TO 7-SEGMENT LATCH/DECODER/DRIVER

The TC5068BP and TC5069BP are decoders which convert the inputs of BCD codes into the 7-segment display element driving signals. Since the segment output is of an open drain structure with high breakdown voltage P-channel FET, these decoders can directly drive fluorescent display tubes.

Each of four input lines contains a latch controlled by common strobe input, to facilitate static drive. Each BL input is used for forcing all the segments to the OFF state; therefore, the decoders can be applied to the leading zero suppress by combining zero output (When input code is at "0", "H" level is output). The TC5068BP is of a hexadecimal display indicating type, and the TC5069BP is of a BCD display puls "L", "H", "A", "p", "-", and "blank" display indicating type.

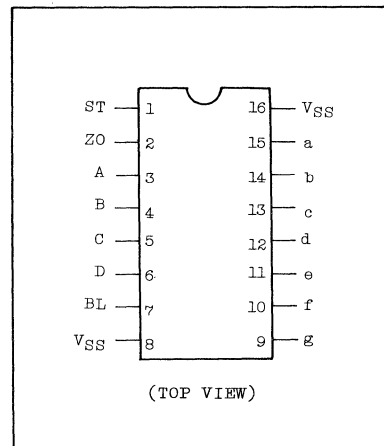


ABSOLUTE MAXIMUM RATINGS

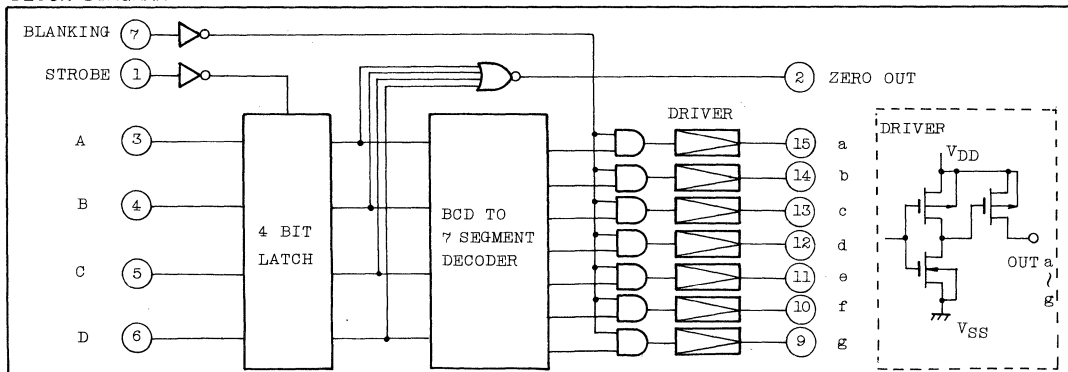
CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage *	V _{OUT1}	V _{DD} -50 ~ V _{DD} +0.5	V
	V _{OUT2}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Operating Temperature Range	T _{opr}	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C

* V_{OUT1} is applied to segment output, and V_{OUT2} to zero output.

PIN ASSIGNMENT



BLOCK DIAGRAM



TRUTH TABLE

INPUTS						OUTPUTS												ZERO OUT			
						TC5068BP Δ						TC5069BP Δ									
ST	BL	D	C	B	A	a	b	c	d	e	f	g	a	b	c	d	e	f	g		
※	H	※	※	※	※	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	☆
H	L	L	L	L	L	H	H	H	H	H	H	L	H	H	H	H	H	H	L	L	H
H	L	L	L	L	H	L	H	H	L	L	L	L	L	H	H	L	L	L	L	L	L
H	L	L	L	H	L	H	H	L	H	H	L	H	H	H	H	L	H	H	L	H	L
H	L	L	L	H	H	H	H	H	H	L	L	H	H	H	H	H	H	L	L	H	L
H	L	L	H	L	L	L	H	H	L	L	H	H	L	H	H	L	L	L	H	H	L
H	L	L	H	H	L	H	L	H	H	L	H	H	H	H	L	H	H	H	H	H	L
H	L	L	H	H	H	H	H	H	L	L	H	L	H	H	H	L	L	L	H	L	L
H	L	H	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
H	L	H	L	L	H	H	H	H	L	L	H	H	L	L	L	H	H	H	L	L	L
H	L	H	L	H	H	L	L	H	H	H	H	H	L	H	H	L	H	H	H	L	L
H	L	H	H	L	L	H	L	L	H	H	H	L	H	H	H	L	L	H	H	H	L
H	L	H	H	L	H	L	H	H	H	H	L	H	H	H	H	L	L	L	L	L	L
H	L	H	H	H	L	H	L	L	H	H	H	H	L	L	L	L	L	L	L	L	L
H	L	H	H	H	H	H	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L
L	L	※	※	※	※	$\Delta\Delta$															

※ ; Don't care
 ☆ ; Undetermined
 $\Delta\Delta$; Depends Upon the BCD code previously applied when ST= "H"
 Δ ; Required pull down resistor "R_L"

DISPLAY INDICATING TYPE

TC5068BP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	1	2	3	4	5	6	7	8	9	A	B	C	d	E	F
TC5069BP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	1	2	3	4	5	6	7	8	9	L	H	A	P	—	BLANK

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

項 目	記 号	MIN	TYP	MAX	単 位
電 源 電 圧	V _{DD}	3	—	18	V
入 力 電 圧	V _{IN}	0	—	V _{DD}	V

TC5068BP, TC5069BP

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} or V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
Low Level Output Voltage (ZERO OUT)	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} or V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
High Level Output Current (Segment OUT)	I _{OH}	V _{OH} = 3V(V _{DD} -2V) V _{OH} = 2V(V _{DD} -3V) V _{OH} = 7V(V _{DD} -3V) V _{OH} =12V(V _{DD} -3V) V _{IN} =V _{SS} or V _{DD}	5	-6	-	-5		-	-4	-	mA	
			5	-9	-	-8		-	-6	-		
			10	-12	-	-10		-	-8	-		
			15	-17	-	-15		-	-12	-		
High Level Output Current (Zero OUT)	I _{OH}	V _{OH} = 4.6V V _{OH} = 9.5V V _{OH} =13.5V V _{IN} =V _{SS} or V _{DD}	5	-0.2	-	-0.16		-	-0.12	-	mA	
			10	-0.5	-	-0.4		-	-0.3	-		
			15	-1.4	-	-1.2		-	-1.0	-		
Low Level Output Current (Zero OUT)	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V V _{IN} =V _{SS} or V _{DD}	5	0.52	-	0.44		-	0.36	-	mA	
			10	1.3	-	1.1		-	0.9	-		
			15	3.6	-	3.0		-	2.4	-		
High Level Input Voltage	V _{IH} *	V _{OUT} =0.5, 4.5V V _{OUT} =1.0, 9.0V V _{OUT} =1.5, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
Low Level Input Voltage	V _{IL} *	V _{OUT} =0.5, 4.5V V _{OUT} =1.0, 9.0V V _{OUT} =1.5, 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Output Off-leak Current (Segment OUT)	I _{OFF}	V _{OUT} =0V V _{OUT} =-30V	15	-	-3	-	-0.01	-3	-	-10	μA	
			15	-	-10	-	-1	-10	-	-20		
Input Current	"H" Level	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	I _{DD}	V _{IN} =V _{SS} or V _{DD} Outputs Open **	5	-	20	-	0.005	20	-	150	μA	
			10	-	40	-	0.010	40	-	300		
			15	-	80	-	0.015	80	-	600		

* R_L = 20 kΩ

** All valid input combinations.

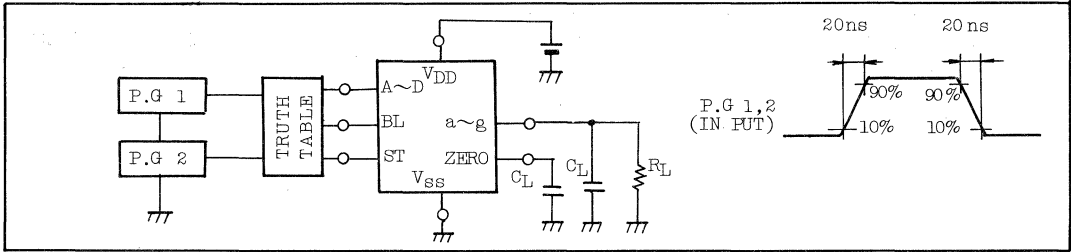
TC5068BP, TC5069BP

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

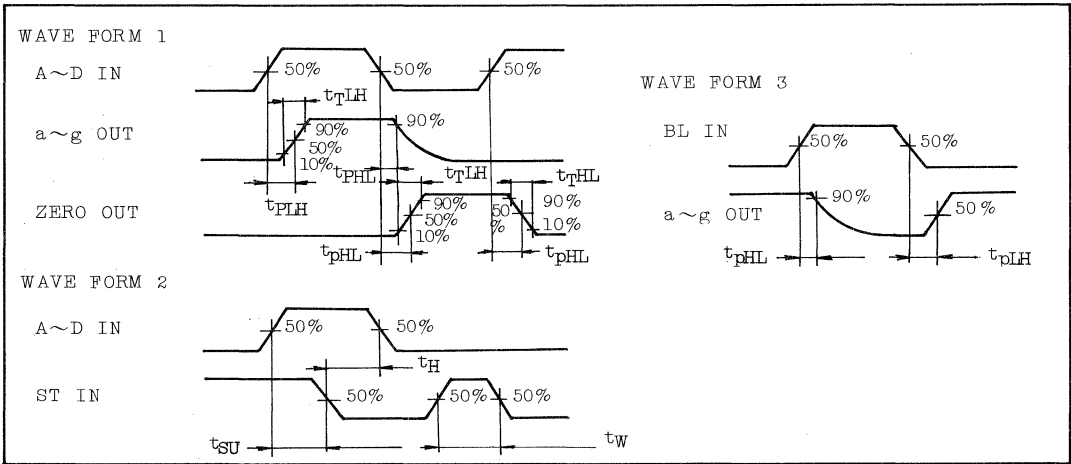
CHARACTERISTIC	SYMBOL	TEST CONDITION	VDD	MIN.	TYP.	MAX.	UNIT
			(V)				
Output Rise Time (SEGMENT OUT)	t _{TLH}	R _L = 1 kΩ	5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
Output Rise Time (ZERO OUT)	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time (ZERO OUT)	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	
(Low-High) Propagation Delay Time (A,B,C,D-SEGMENT OUT)	t _{pLH}	R _L = 1 kΩ	5	-	750	1800	ns
			10	-	300	600	
			15	-	200	400	
(High-Low) Propagation Delay Time (A,B,C,D-SEGMENT OUT)	t _{pHL}	R _L = 1 kΩ	5	-	750	1800	ns
			10	-	300	600	
			15	-	200	400	
(Low-High) Propagation Delay Time (A,B,C,D-ZERO OUT)	t _{pLH}		5	-	250	500	ns
			10	-	125	250	
			15	-	100	200	
(High-Low) Propagation Delay Time (A,B,C,D-ZERO OUT)	t _{pHL}		5	-	250	500	ns
			10	-	125	250	
			15	-	100	200	
(Low-High) Propagation Delay Time (BL-SEGMENT OUT)	t _{pLH}	R _L = 1 kΩ	5	-	200	400	ns
			10	-	100	200	
			15	-	80	160	
(High-Low) Propagation Delay Time (BL-SEGMENT OUT)	t _{pHL}	R _L = 1 kΩ	5	-	200	400	ns
			10	-	100	200	
			15	-	80	160	
Minimum ST Pulse Width	t _w (ST)		5	-	60	200	ns
			10	-	30	100	
			15	-	25	80	
Minimum Setup Time (ST-A,B,C,D IN)	t _{SU}		5	-	35	200	ns
			10	-	20	100	
			15	-	10	80	
Minimum Hold Time (ST-A,B,C,D IN)	t _H		5	-	-	100	ns
			10	-	-	60	
			15	-	-	40	
Input Capacitance	C _{IN}			-	5	7.5	pF

TC5068BP, TC5069BP

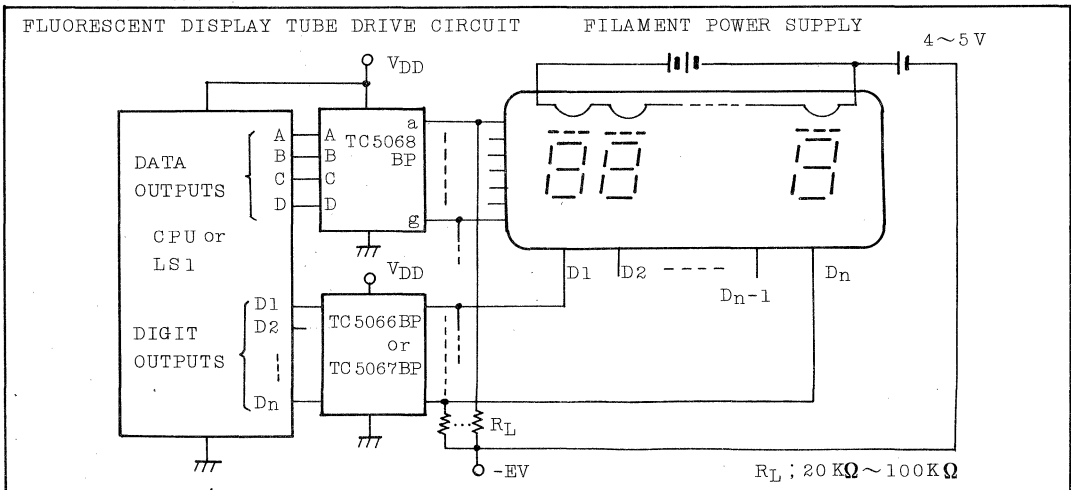
SWITCHING TIME TEST CIRCUIT



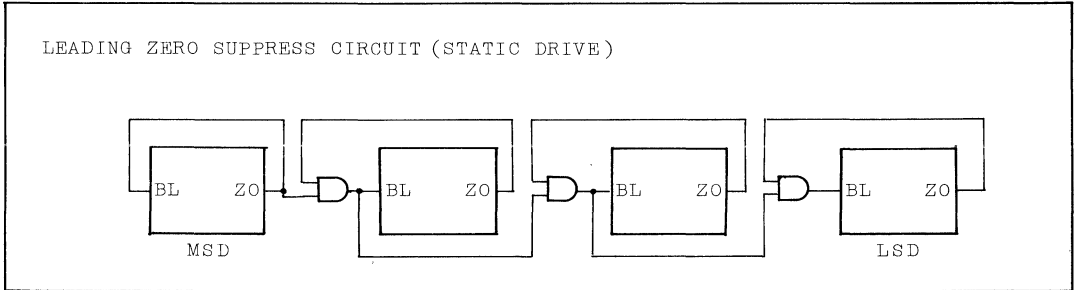
SWITCHING TIME TEST WAVEFORM



APPLICATION EXAMPLE



APPLICATION EXAMPLE



TC5070P, TC5071P, TC5072P

CMOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5070P/TC5071P/TC5072P 6 DIGIT UNIVERSAL COUNTER

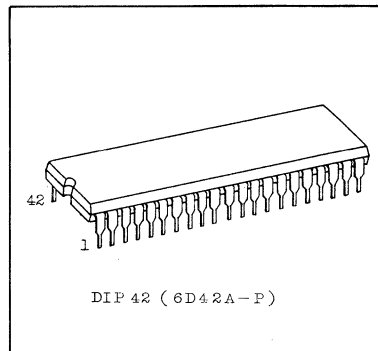
TC5070P/TC5071P/TC5072P are 6-digit universal counter containing 6-digit memory register in addition to functions of up/down counting, data presetting, zero suppress, and latch.

The counted contents are output in BCD and seven segment dynamically stepwise from most significant digit in synchronization with input of SCAN.

The seven-segment output can directly drive the common cathode type LED.

In addition to CARRY and ZERO outputs, these counter are provided with EQUAL output, permitting a wide range of applications such as for measuring instruments, timers, etc.

Maximum counting value
TC5070P 999999 COUNTER
TC5071P 995959 TIMER
TC5072P 595999 TIMER

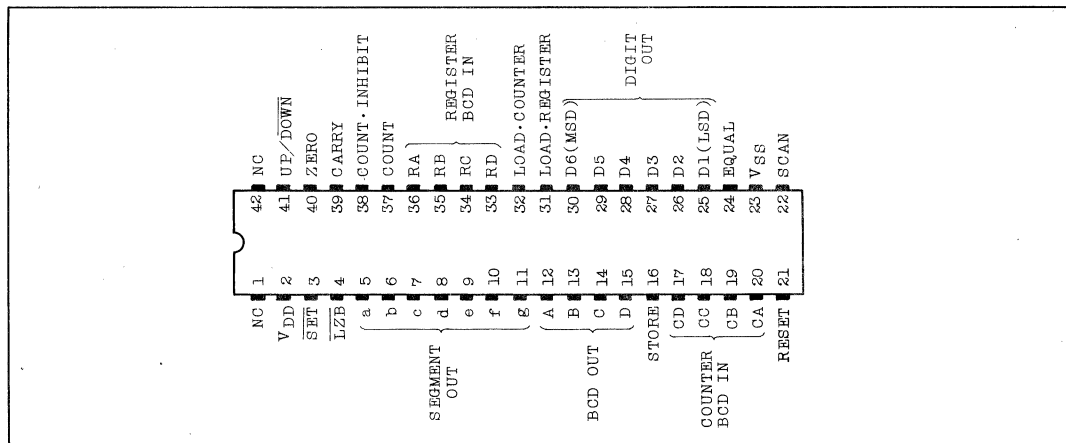


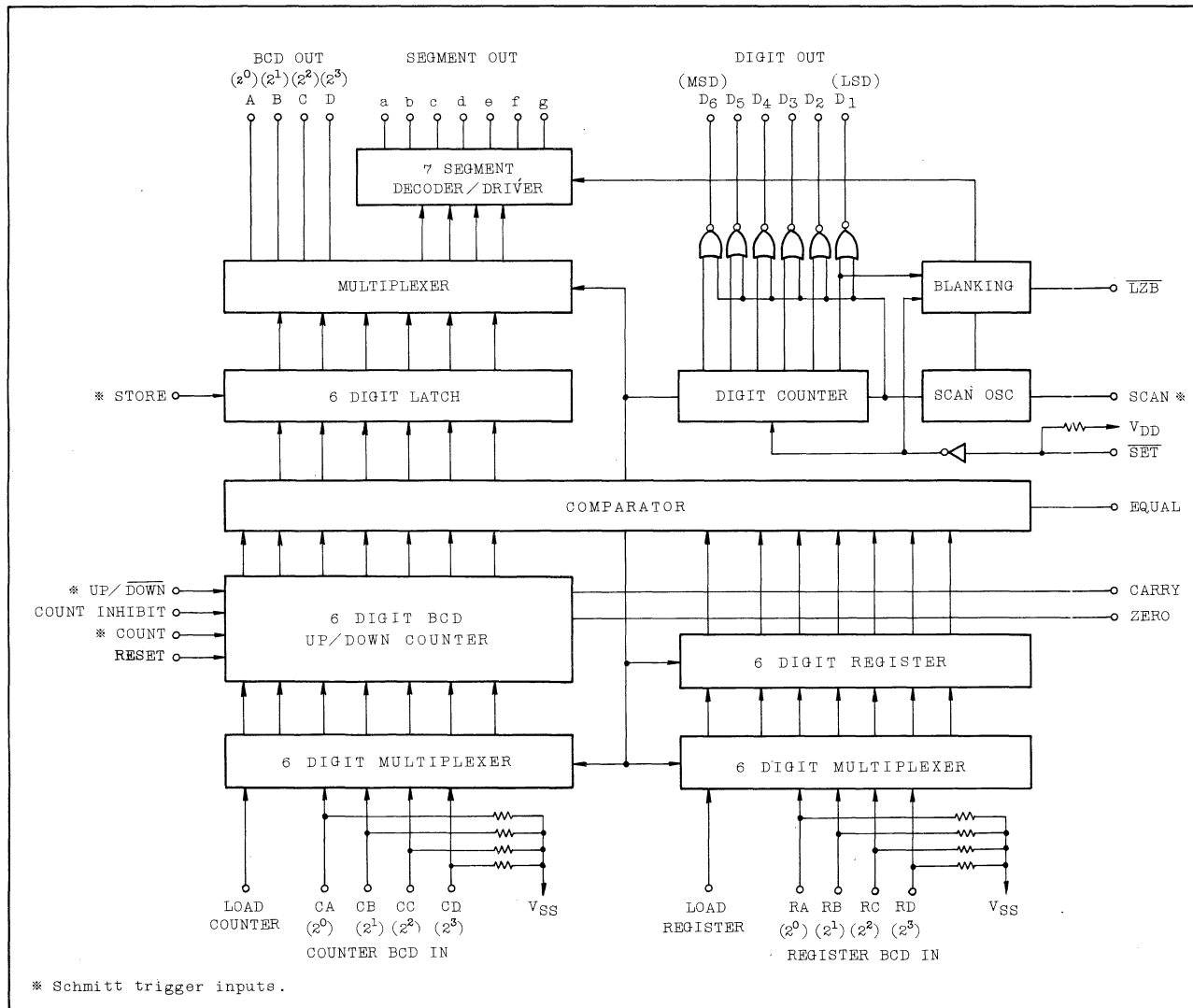
DIP 42 (6D42A-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +10	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

PIN ASSIGNMENT





TC5070P, TC5071P, TC5072P

DESCRIPTION OF PIN FUNCTION

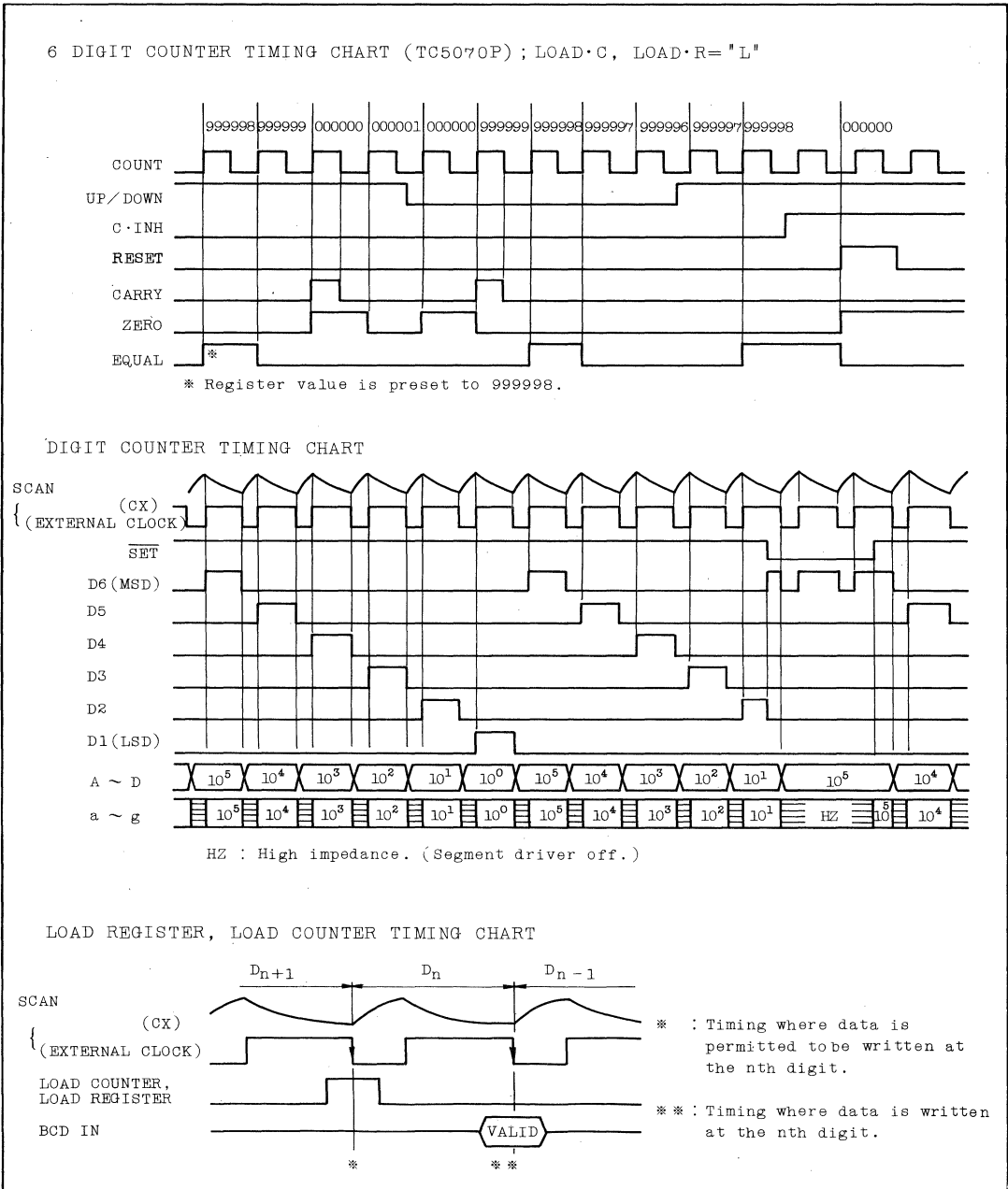
PIN No.	SYMBOL	FUNCTION	
1	NC	No connection	
2	V _{DD}	V _{DD} power supply (3-8V)	
3	$\overline{\text{SET}}$	At "L" level, the digit counter is reset, and D6 (MSD) only provide. The Segment-out changes to the blanking state. At "H" level, normal display operation.	
4	$\overline{\text{LZB}}$	"H"	No zero blanking
		"L"	Leading zero blanking in the higher order 5 digits.
5	a	Each pin is seven segment output of 6-digit counter. The output is synchronized with the digit-out and is provided stepwise from the most significant digit.	
6	b		
7	c		
8	d		
9	e		
10	f		
11	g		
12	A	Each pin is BCD output of 6-digit counter. The output is synchronized with the digit-out and is provided stepwise from the most significant digit. When $\overline{\text{SET}}$ input is at "L" level, the most significant digit data is provided.	
13	B		
14	C		
15	D		
16	STORE	"H"	At positive edge of the STORE input, the contents of the counter are latched.
		"L"	The contents of the counter are straight transferred to the multiplexer.
17	CD	BCD input at the time when data are preset to the 6-digit counter. (With the LOAD COUNTER input at "H" level.)	
18	CC		
19	CB		
20	CA		
21	RESET	At "H" level, the 6-digit counter is reset, and the contents of the counter become ALL "0". ZERO output become at "H" level.	
22	SCAN	Auto scan oscillator is operated by connecting a capacitor (2000-20000pF) between No.22 (SCAN) and No.23 (V _{SS}) terminals. External scan oscillator may also be used to drive the scan input.	
23	V _{SS}	GND (0V)	

DESCRIPTION OF PIN FUNCTION (Cont'd)

PIN No.	SYMBOL	FUNCTION	
24	EQUAL	When the contents of the 6-digit register set by the input of RA, RB, RC, and RD coincide with the contents of 6-digit counter, EQUAL output is provided at "H" level. Even if both the contents coincide each other during setting by the inputs of LOAD REGISTER and LOAD COUNTER, the output is inhibited and "L" level remains unchanged.	
25	D1 (LSD)	These are the outputs to display the digits of segment out and BCD-out. When SET input reaches "L" level, the digit counter is reset and D6 (MSD) only is provided. When SET input rises at "H" level, the output is provided in the order of D5, D4...in synchronization with the SCAN clock.	
26	D2		
27	D3		
28	D4		
29	D5		
30	D6 (MSD)		
31	LOAD REGISTER (LOAD·R)	"H"	RA ~ RD input is set to 6-digit register.
		"L"	Write operation to the register is inhibited.
32	LOAD COUNTER (LOAD·C)	"H"	CA ~ CD input is preset to the 6-digit counter.
		"L"	Write operation to the counter is inhibited.
33	RD	BCD input at the time when the data are set to the 6-digit register. (With the LOAD REGISTER input at "H" level.)	
34	RC		
35	RB		
36	RA		
37	COUNT			Clock input of 6-digit counter (Counting at the positive edge of clock)
38	COUNT INHIBIT (C·INH)	"H"	No counting
		"L"	Counting
39	CARRY	When the contents of counter have become "000000" at time of up-counting, CARRY output is provided at "H" level during this time from rise to fall of COUNT input. When the contents of counter have become "999999" (for TC5070P), "995959" (for TC5071P), and "595999" (for TC5072P) at time of down-counting, CARRY output is also provided at "H" level during this time from rise and fall of COUNT input.	
40	ZERO	When the contents of counter have become "00000", ZERO is provided at "H" level. During presetting by the LOAD COUNTER input, output operation is inhibited and "L" level remains unchanged.	
41	UP/DOWN	"H"	Up count.
		"L"	Down count.
42	NC	No connection.	

TC5070P, TC5071P, TC5072P

TIMING CHART



OPERATING CONSIDERATION

1. COUNTER OPERATION

Counting is stepped by the rise of clock when the clock is added to COUNT input at state of the inputs of LOAD·C, C·INH, and RESET at "L" level. At time of up-counting, CARRY and ZERO outputs are "H" level at "000000", and at time of down-counting, CARRY output is at "H" level at "999999" (for TC5070P), "995959" (for TC5071P), and "595999": (for TC5072P).

When CARRY output is at "H" level, CARRY output remain at "H" level until COUNT input falls, even if RESET and LOAD·C inputs are changed to "H" level.

For COUNT and UP/ $\overline{\text{DOWN}}$ inputs is shaped schmitt trigger, COUNT and UP/ $\overline{\text{DOWN}}$ inputs rarely miscounts if waveform is not sharp.

2. COMPARATOR OPERATION

EQUAL output is provided at "H" level, when the contents of the counter coincide with the comparator value set by LOAD·R input. However, even if they coincide each other during setting by LOAD·C and LOAD·R input, output operation is inhibited and "L" level remains unchanged.

3. LOAD COUNTER AND LOAD REGISTER OPERATIONS

When the data required to preset the counter or when the comparing value is required to set to the register, such operation is made by LOAD·C and LOAD·R input. The presetting of data to the counter is acquired by setting LOAD·C input to "H" level, synchronizing CA~CD input with the digit counter, and setting the digits one after another. For the purpose, the external circuits are required for timing of D6~D1 output with CA~CD input. The comparator value can be set to the register in the same way. Load register operation is independently of counting operation; therefore, even during setting of the data to the register, counting can be performed. (See an example of input setting circuits.)

(Note) that normal operation is not acquired when the data exceeding the maximum counting value (for each digit) shown on page 1 for the individual items are set to the counter and register.

4. LATCH OPERATION

At STORE input is at "L" level, the contents of counter are straight transferred to the multiplexer, and the output indicates the contents of counter.

At STORE input is at "H" level, the indicating output remains unchanged although the count varies for the contents of counter are latched at the positive edge of

TC5070P, TC5071P, TC5072P

OPERATING CONSIDERATION (Cont'd)

STORE input. When STORE is turned to "L" level, the contents of counter at that time are provided. STORE input shape schmitt trigger.

5. DISPLAY OPERATION

At $\overline{\text{LZB}}$ input is at "L" level, the higher order 5 digits of SEGMENT-OUT output are changed to the state of leading zero blanking.

At "H" level, the function of leading zero blanking is released.

At $\overline{\text{SET}}$ input is at "L" level, the SEGMENT-OUT output is changed to the state of blanking, and the digit counter is reset, and D6 (MSD) only is provided. At that time, the BCD-OUT output provided the data of the 6th digit. At "H" level, the DIGIT-OUT output provided in the order of D6, D5, D4, ... in synchronization with SCAN, and SEGMENT-OUT and CD-OUT output are also provided in synchronization.

Segment Display Format (Common Cathod type LED)

0	1	2	3	4	5	6	7	8	9	10~15
0	1	2	3	4	5	6	7	8	9	E

6. SCANNING OPERATION

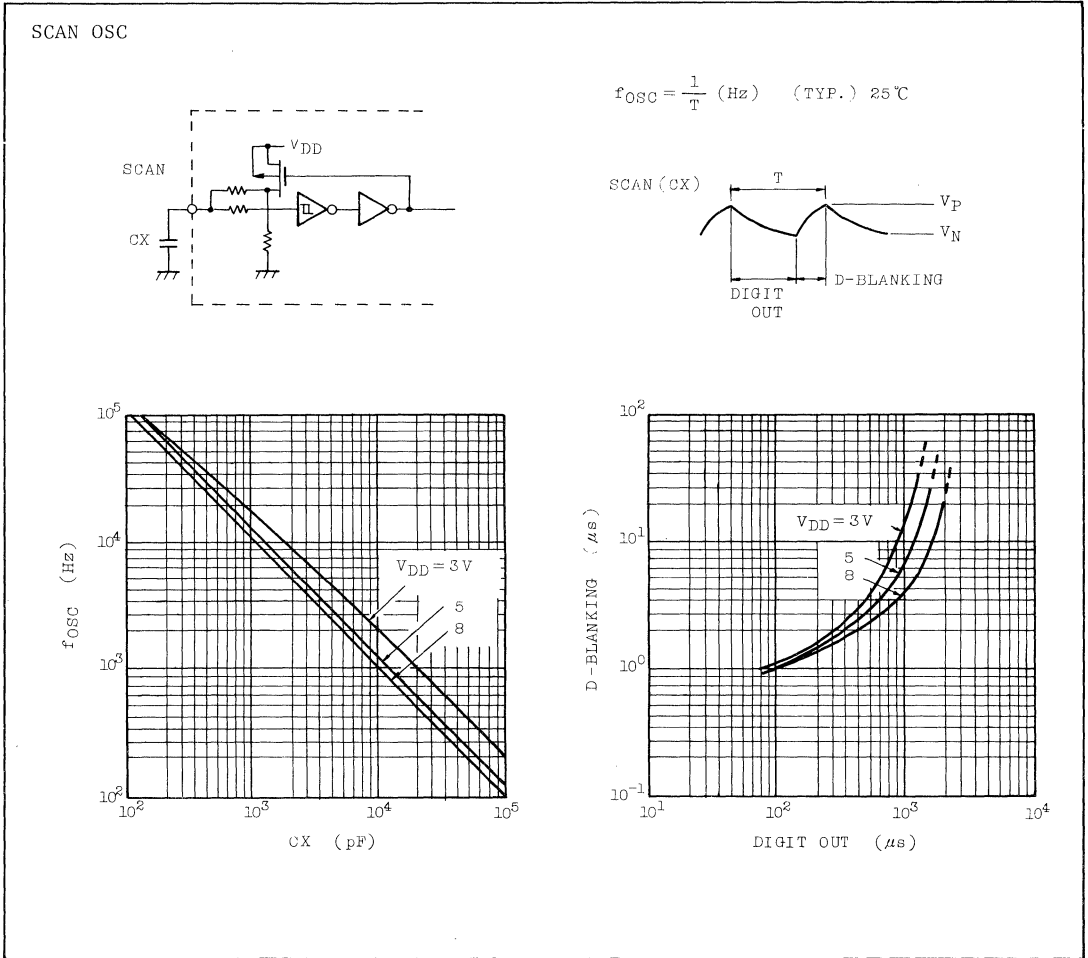
AUTO SCAN operation can be performed by inserting a capacitor between the terminal SCAN and the terminal VSS. By adding an external clock to the terminal SCAN, MANUAL SCAN operation can be performed.

SCAN OSC actuates the digit counter, and at the AUTO SCAN operation, the digit blanking is applied to each DIGIT OUT for the T/150 period of one cycle (T) of SCAN OSC, therefore, can be prevented overlap of each DIGIT OUT. One cycle of DIGIT OUT is equal to 6 cycles of SCAN OSC.

SCAN signal synchronize with data signal setting by the LOAD REGISTER and/or LOAD COUNTER inputs. An external capacitor of 2000 to 20000pF is required for SCAN (CX).

(Note) BCD-OUT output may involve some hazards at the change of COUNT input and DIGIT-OUT output; However, such hazards do not hinder operation because they occur during the blanking hours for DIGIT-OUT and SEGMENT-OUT output.

OPERATING CONSIDERATION (Cont'd)



RECOMMENDED OPERATING CONDITIONS ($V_{SS}=0V$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V_{DD}		3	-	8	V
Input Voltage	V_{IN}		0	-	V_{DD}	V
Operating Temperature Range	T_{opr}		-40	-	85	$^\circ\text{C}$

TC5070P, TC5071P, TC5072P

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High-Level Output Voltage (Except SEGMENT OUTPUT)	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
Low-Level Output Voltage (Except SEGMENT OUTPUT)	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	
High-Level Output Voltage (SEGMENT OUTPUT)	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.0	-	4.0	4.5	-	4.0	-	
Output High Current (A ~ D, EQ, CA, ZE OUTPUT)	I _{OH}	V _{OH} =4.6V V _{IN} =V _{SS} , V _{DD}	5	-0.2	-	-0.16	-0.8	-	-0.12	-	mA
Output High Current (D1 ~ D6 OUTPUT)	I _{OH}	V _{OH} =4.2V V _{IN} =V _{SS} , V _{DD}	5	-0.75	-	-0.7	-1.5	-	-0.6	-	
Output Low Current (Except SEGMENT OUTPUT)	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	5	0.52	-	0.44	1.2	-	0.36	-	
Output High Current (SEGMENT OUTPUT)	I _{OH}	V _{OH} =3.5V V _{IN} =V _{SS} , V _{DD}	5	-25	-	-25	-50	-	-20	-	V
Input Low Voltage (Except Schmitt Trigger Input)	V _{IH}	V _{OH} =4.0V V _{OL} =0.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	
Input High Voltage (Except Schmitt Trigger Input)	V _{IL}	V _{OH} =4.0V V _{OL} =0.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.15	1.5	-	1.5	
High-Level Input Current (Except Pull Up/Down Resistance Input)	I _{IH}	V _{IH} =8V	8	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA

STATIC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYM-BOL	TEST CONDITION	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Low-Level Input Current (Except Pull Up/ Down Resistance Input)	I _{IL}	V _{IL} =0V	8	-	-0.3	-	10 ⁻⁵	-0.3	-	-1.0	μA
High-Level Input Current (SET IN)	I _{IH}	V _{IH} =8V	8	-	5.0	-	-	5.0	-	5.0	
Low-Level Input Current (SET IN)	I _{IL}	V _{IL} =0V	8	-	-180	-	-70	-160	-	-140	
High-Level Input Current (CA ~ CD, RA ~ RD, SCAN IN)	I _{IH}	V _{IH} =8V	8	-	180	-	80	160	-	140	
Low-Level Input Current (CA ~ CD, RA ~ RD IN)	I _{IL}	V _{IL} =0V	8	-	-5.0	-	-	-5.0	-	-5.0	
Low-Level Input Current (SCAN IN)	I _{IL}	V _{IL} =0V	5	-	-2.3	-	-1.0	-2.0	-	-1.8		mA
			8	-	-3.6	-	-1.6	-3.2	-	-2.8	
Output Leakage Current (SEGMENT OUT)	I _{DL}	V _{OL} =0V	8	-	-3.0	-	-10 ⁻⁴	-3.0	-	-1.5	μA
Quiescent Device Current	I _{DD}	SCAN=V _{DD}	5	-	750	-	180	500	-	1000	μA
		SET, CA ~ CD, RA ~ RD OPEN	8	-	1500	-	250	1000	-	2000	

TC5070P, TC5071P, TC5072P

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{DD}=5.0V, V_{SS}=0V, C_L=50pF)

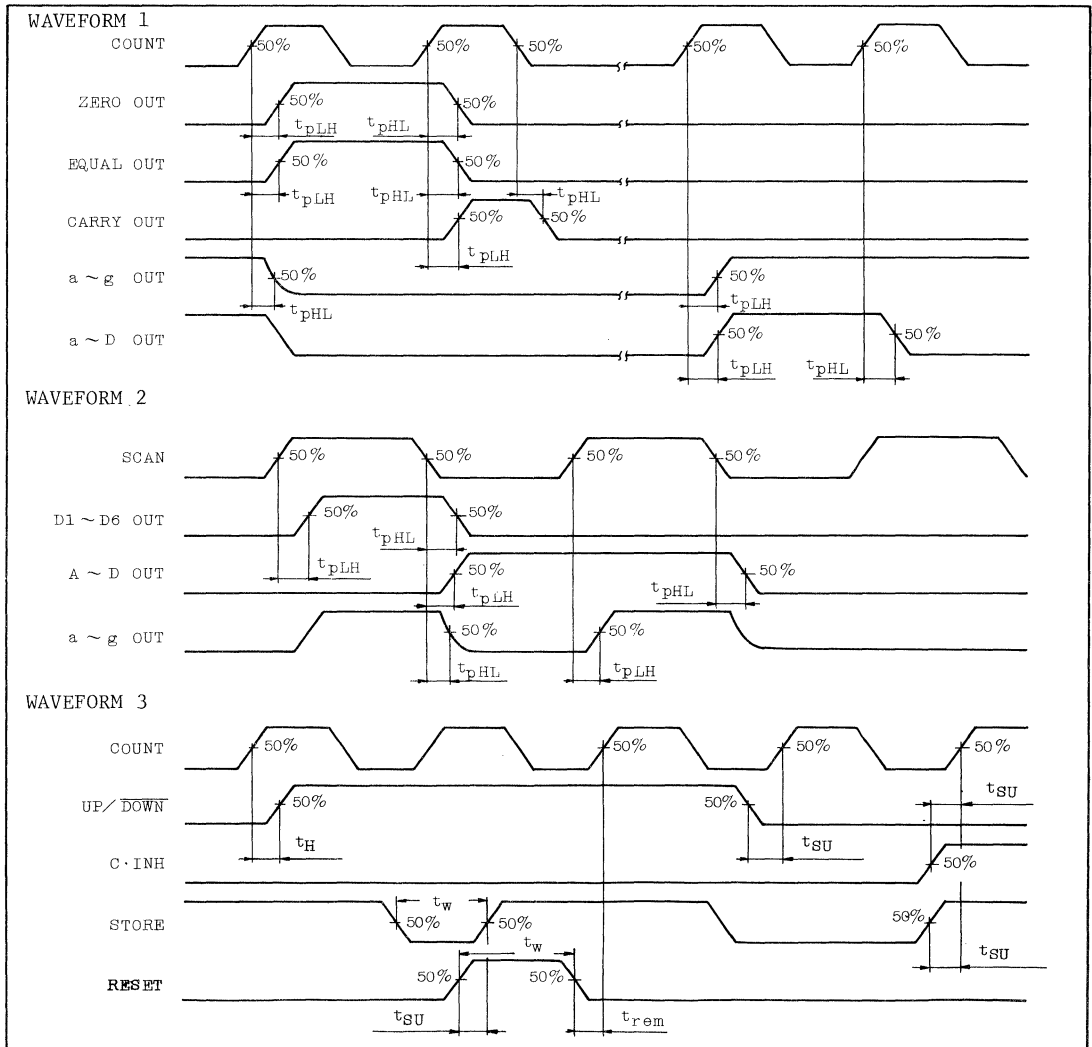
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t _{TLH}	SEGMENT OUT (R _L =1kΩ)	-	70	200	
	t _{TLH}	OTHER OUT	-	100	400	
Output Transition Time (High to Low)	t _{THL}	Except SEGMENT OUT	-	70	200	
Propagation Delay Time	t _{pLH} , t _{pHL}	COUNT-BCD, SEGMENT OUT (R _L =1kΩ)	-	750	1500	ns
	t _{pLH} , t _{pHL}	COUNT-CARRY OUT	-	150	400	
	t _{pLH} , t _{pHL}	COUNT-ZERO OUT	-	200	400	
	t _{pLH} , t _{pHL}	COUNT-EQUAL OUT	-	270	500	
	t _{pLH} , t _{pHL}	SCAN-DIGIT OUT	-	250	500	
	t _{pLH} , t _{pHL}	SCAN-BCD OUT	-	750	1500	
Propagation Delay Time	t _{pLH}	SCAN-SEGMENT OUT (R _L =1kΩ)	-	500	1000	
	t _{pHL}	SCAN-SEGMENT OUT (R _L =1kΩ)	-	300	700	
Max. Clock Frequency	f _{CL-1}	COUNT IN *	2.0	4.0	-	MHz
	f _{CL-2}		1.0	1.6	-	
	f _{CL}	SCAN IN	0.5	1.0	-	
Min. Pulse Width	t _w	RESET IN	-	250	500	
	t _w	STORE IN	-	80	160	
Min. Set-up Time	t _{SU}	COUNT-STORE	-	70	150	ns
	t _{SU}	COUNT-UP/ <u>DOWN</u>	-	230	500	
	t _{SU}	STORE-CLEAR	-	130	300	
	t _{SU}	COUNT-C·IN	-	0	100	
	t _{SU}	SCAN IN-LOAD·C, LOAD·R	-	-40	50	
	t _{SU}	SCAN IN-BCDIN	-	200	450	
Min. Hold Time	t _H	COUNT-UP/ <u>DOWN</u>	-	40	150	
	t _H	SCAN IN-LOAD·C, LOAD·R	-	70	200	
	t _H	SCAN IN-BCDIN	-	140	300	
Min. Removal Time	t _{rem}	COUNT-RESET	-	60	150	
Max. Input Rise/Fall Time	t _{rCL}	Except Schmitt Trigger Input	20	-	-	μs
	t _{rCL}	Except Schmitt Trigger Input	20	-	-	
Positive Trigger Threshold Voltage	V _P		-	3.0	4.0	V
Negative Trigger Threshold Voltage	V _N		1.0	1.8	-	
Hysteresis Voltage	V _H		0.5	1.2	-	

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta=25°C, VDD=5.0V, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Device Current (CX=2000~20000pF)	I _{DD}	COUNT IN = H & L	-	250	-	μA
		COUNT IN = 1 MHz	-	650	-	
Input Capacitance	C _{IN}	Except SCAN IN	-	5.0	7.5	pF

* The count operation can respond as far as f_{CL}-1, and CARRY, EQUAL, and ZERO outputs can respond as far as f_{CL}-2.

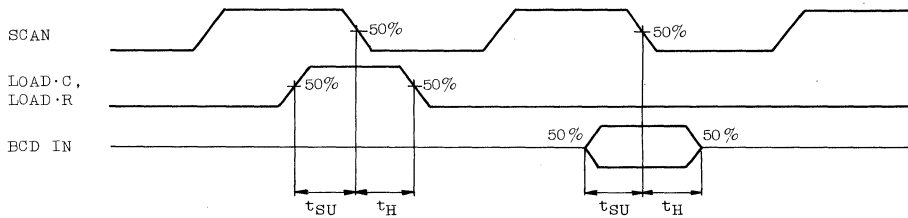
WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



TC5070P, TC5071P, TC5072P

WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS

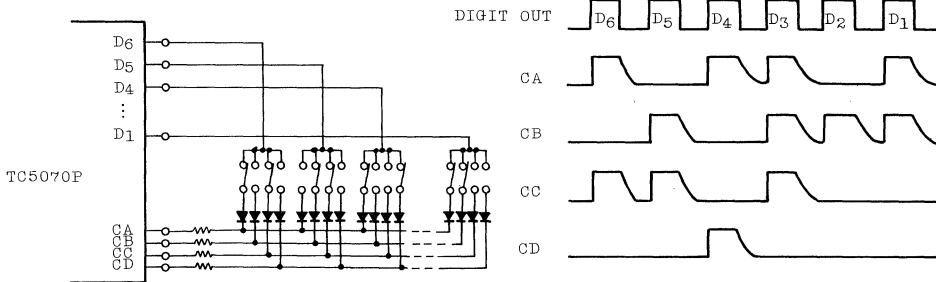
WAVEFORM 4



* Output t_r and t_f : note the output change time during 10~90% of V_{out} .

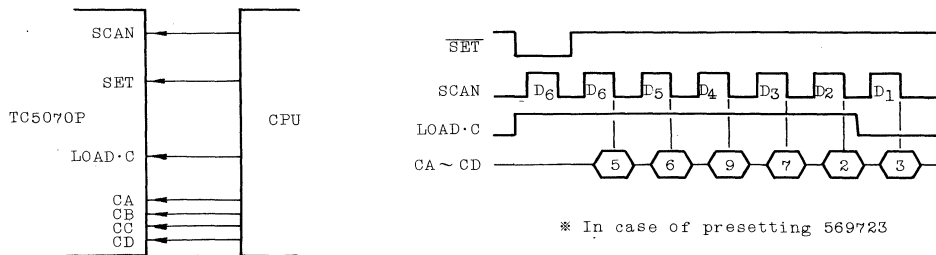
TYPICAL INPUT SELECT CIRCUIT

(1) IN CASE OF DATA PRESETTING WITH DIGITAL SWITCH, ETC.



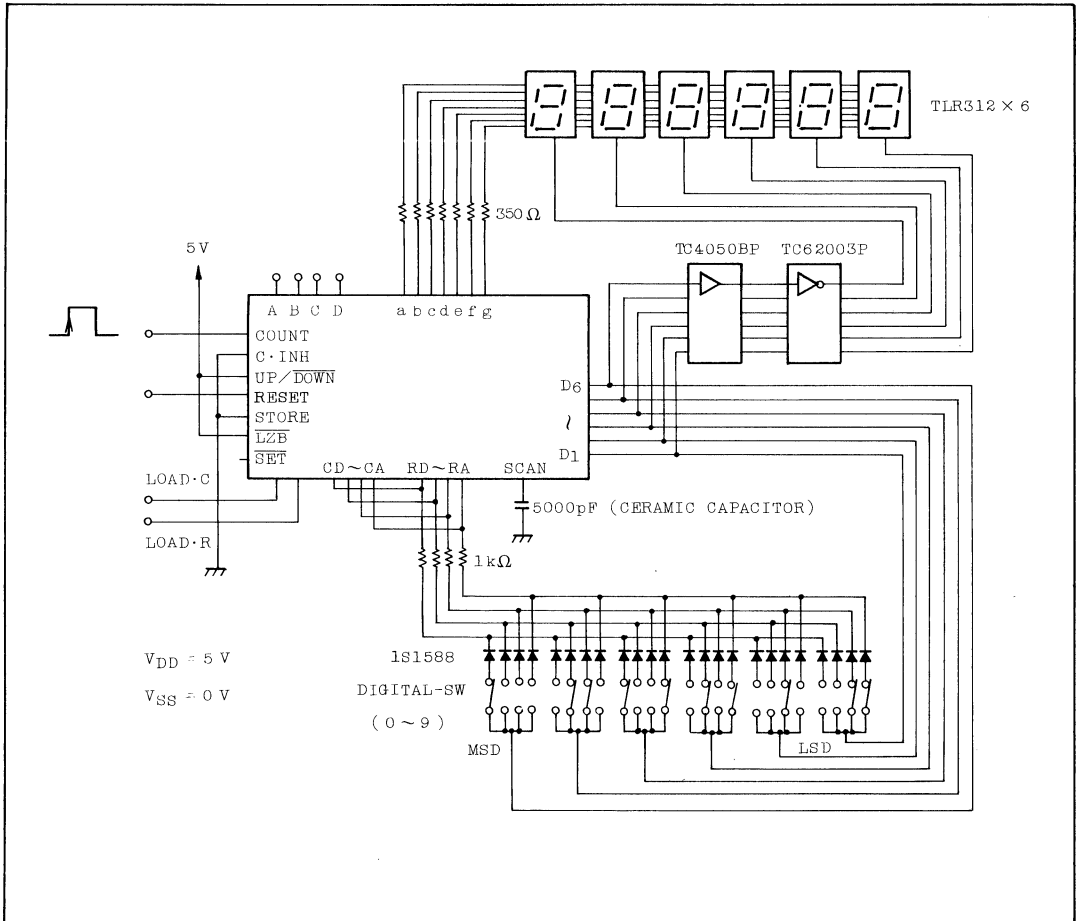
* In case of presetting 569723

(2) IN CASE OF DATA PRESETTING WITH MICRO-COMPUTER, ETC.



* In case of presetting 569723

APPLICATION CIRCUIT

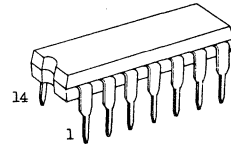


TC7400BP

CMOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC7400BP QUAD 2-INPUT POSITIVE NAND GATE

TC7400BP is two input positive logic NAND gate. Since all the outputs of this gate are equipped with buffers which consist of inverters, the input/output transmission characteristic has been improved and the variation of transmission time caused by increase of load capacity has been kept minimum.



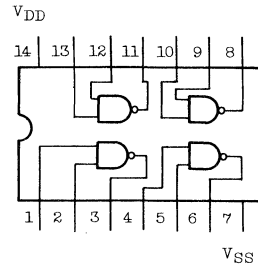
DIP 14 (3D14A-P)

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C · 10sec	

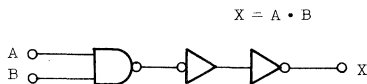
PIN ASSIGNMENT

TC7400BP



LOGIC DIAGRAM

1/4 TC7400BP



RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
"H" Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} = V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
"L" Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} = V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
"H" Level Output Current	I _{OH}	V _{OH} = 4.6V V _{OH} = 9.5V V _{OH} = 13.5V V _{IN} = V _{SS} , V _{DD}	5	-0.2	-	-0.16	-0.5	-	-0.12	-	mA	
			10	-0.5	-	-0.4	-1.2	-	-0.3	-		
			15	-1.4	-	-1.2	-6.0	-	-1.0	-		
"L" Level Output Current	I _{OL}	V _{OL} = 0.4V V _{OL} = 0.5V V _{OL} = 1.5V V _{IN} = V _{DD}	5	0.52	-	0.44	1.5	-	0.36	-	mA	
			10	1.3	-	1.0	3.5	-	0.9	-		
			15	3.6	-	3.0	15	-	2.4	-		
"H" Level Input Voltage	V _{IH}	V _{OUT} =0.5V, 4.5V V _{OUT} =1.0V, 9.0V V _{OUT} =1.5V, 13.5V |I _{OUT}| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
"L" Level Input Voltage	V _{IL}	V _{OUT} = 4.5V V _{OUT} = 9.0V V _{OUT} = 13.5V |I _{OUT}| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	I _{IH}	V _{IH} = 18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	I _{IL}	V _{IL} = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	I _{DD}	V _{IN} = V _{SS} , V _{DD} *	5	-	1.0	-	0.001	1.0	-	7.5	μA	
			10	-	2.0	-	0.001	2.0	-	15		
			15	-	4.0	-	0.002	4.0	-	30		

* All valid input combinations

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

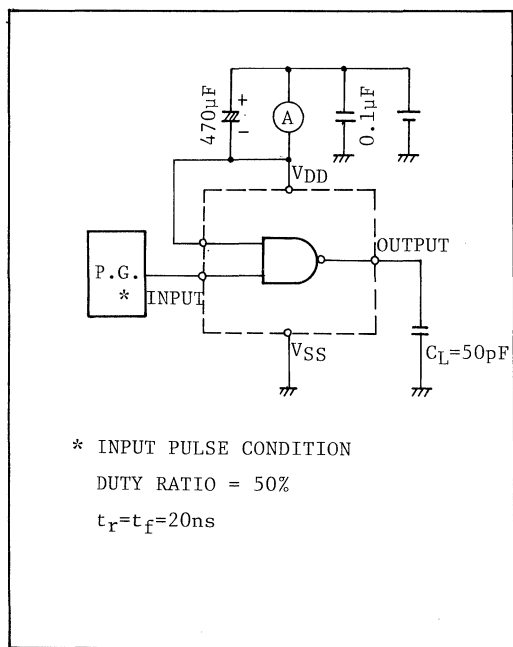
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

TC7400BP

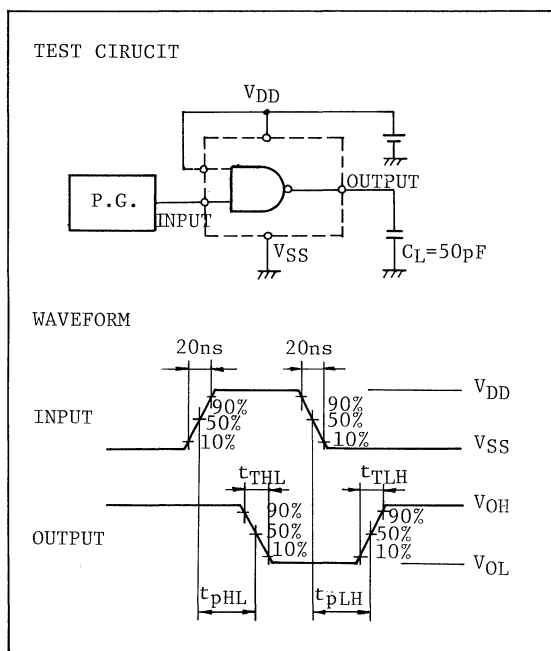
SWITCHING CHARACTERISTICS ($T_a=25^\circ\text{C}$, $V_{SS}=0\text{V}$, $C_L=50\text{pF}$)

CHARACTERISTIC		SYMBOL	TEST CONDITIONS	V_{DD} (V)	MIN.	TYP.	MAX.	UNIT
TC7400BP	(Low=High) Propagation Delay Time	t_{pLH}		5	-	140	300	ns
				10	-	60	150	
				15	-	50	125	
	(High=Low) Propagation Delay Time	t_{pHL}		5	-	180	300	
				10	-	80	150	
				15	-	60	125	
Input Capacitance		C_{IN}			-	5	7.5	pF

I_T TEST CIRCUIT

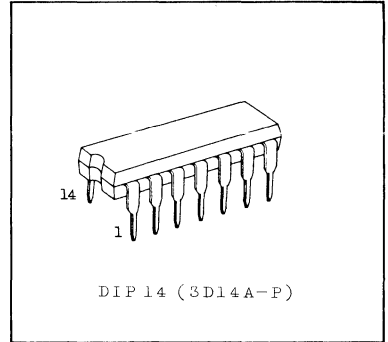


SWITCHING TIME TEST CIRCUIT AND WAVEFORM



TC7404UBP HEX INVERTING BUFFER

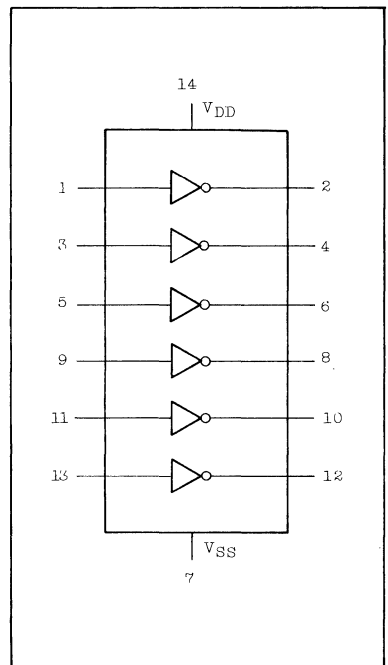
TC7404UBP contains six circuits of inverter type buffers. This has pin to pin compatibility with TC4069UBP and its large output current enables to directly drive one TTL with 5 volt power supply. In addition to its original application as inverters, this can be used as clock drivers and for TTL interface circuits.



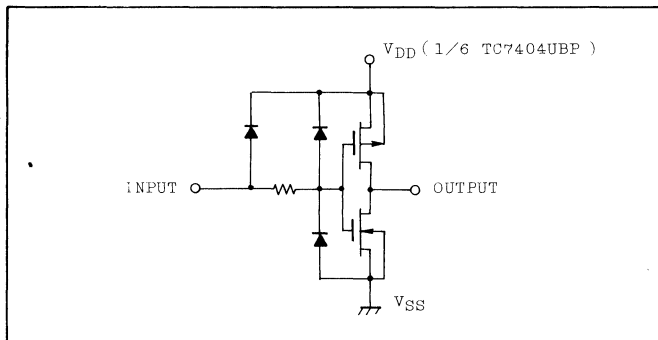
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V _{DD}	V _{SS} -0.5 ~ V _{SS} +20	V
Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	±10	mA
Power Dissipation	P _D	300	mW
Storage Temperature Range	T _{stg}	-65 ~ 150	°C
Lead Temp./Time	T _{sol}	260°C . 10sec	

PIN ASSIGNMENT



CIRCUIT DIAGRAM



RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
DC Supply Voltage	V _{DD}	3	-	18	V
Input Voltage	V _{IN}	0	-	V _{DD}	V
Operating Temperature Range	T _{opr}	-40	-	85	°C

TC7404UBP

ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS}	5	4.95	-	4.95	5.00	-	4.95	-	V
			10	9.95	-	9.95	10.00	-	9.95	-	
			15	14.95	-	14.95	15.00	-	14.95	-	
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	V
			10	-	0.05	-	0.00	0.05	-	0.05	
			15	-	0.05	-	0.00	0.05	-	0.05	
High Level Output Current	I _{OH}	V _{OH} =2.5V V _{OH} =9.5V V _{OH} =13.5V	5	-1.40	-	-1.25	-	-	-1.0	-	mA
			10	-1.40	-	-1.25	-	-	-1.0	-	
			15	-4.00	-	-3.75	-	-	-3.0	-	
		V _{IN} =V _{SS}									
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{OL} =0.5V V _{OL} =1.5V	5	3.5	-	3.2	-	-	2.5	-	mA
			10	6.0	-	5.0	-	-	3.6	-	
			15	26.0	-	24.0	-	-	18.0	-	
		V _{IN} =V _{DD}									
High Level Input Voltage	V _{IH}	V _{OUT} =0.5V V _{OUT} =1.0V V _{OUT} =1.5V	5	4.0	-	4.0	3.0	-	4.0	-	V
			10	8.0	-	8.0	6.5	-	8.0	-	
			15	12.0	-	12.0	9.5	-	12.0	-	
		|I _{OUT}| < 1μA									
Low Level Input Voltage	V _{IL}	V _{OUT} =4.5V V _{OUT} =9.0V V _{OUT} =13.5V	5	-	1.0	-	2.0	1.0	-	1.0	V
			10	-	2.0	-	2.5	2.0	-	2.0	
			15	-	2.5	-	3.0	2.5	-	2.5	
		|I _{OUT}| < 1μA									
H.Level Input Current	I _{IH}	V _{IH} =18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
L.Level Input Current	I _{IL}	V _{IL} =0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	μA
Quiescent Current Consumption	I _{DD}	V _{IN} =V _{SS} , V _{DD} *	5	-	4.0	-	0.002	4.0	-	30	μA
			10	-	8.0	-	0.004	8.0	-	60	
			15	-	16.0	-	0.008	16.0	-	120	

* All valid input combination

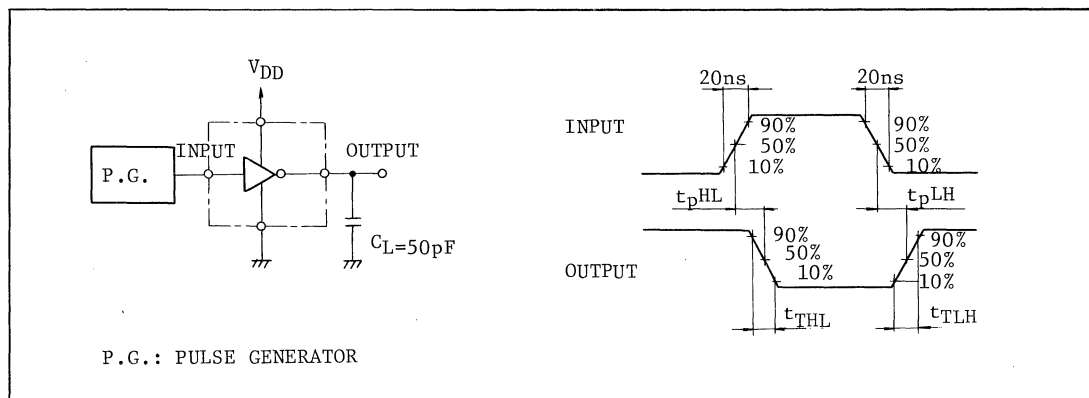
SWITCHING CHARACTERISTICS (T_a=25°C, V_{SS}=0V, C_L=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	t _{THL}		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	MIN.	TYP.	MAX.	UNIT
(Low-High) Propagation Delay Time	t _{pLH}		5	-	80	150	ns
			10	-	40	100	
			15	-	35	80	
(High-Low) Propagation Delay Time	t _{pHL}		5	-	50	150	ns
			10	-	30	100	
			15	-	25	80	
Input Capacity	C _{IN}			-	15	-	pF

SWITCHING TIME TEST CIRCUIT AND WAVEFORM



TC7476BP

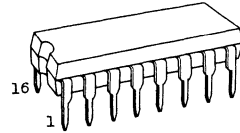
C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC7476BP DUAL J-K MASTER-SLAVE FLIP-FLOP

TC7476BP is J-K master-slave flip-flop having $\overline{\text{RESET}}$ and $\overline{\text{SET}}$ functions.

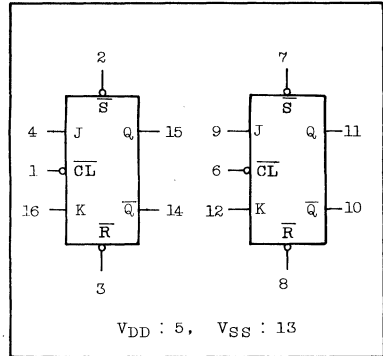
J-K Mode ; When clock input is applied with $\overline{\text{RESET}}$ and $\overline{\text{SET}}$ kept at "H", the output varies depending on the conditions of J and K at the falling edge of $\overline{\text{CLOCK}}$ input.

R-S Mode ; When $\overline{\text{RESET}}$ is set to "L", output Q becomes "L" regardless of other inputs, and when $\overline{\text{SET}}$ is set "L" and $\overline{\text{RESET}}$ is set "H", Q becomes "H" regardless of other inputs.



DIP 16 (3D16A-P)

PIN ASSIGNMENT

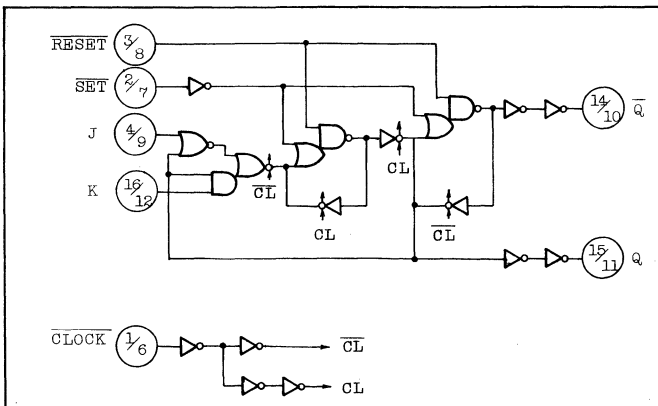


$V_{DD} : 5, V_{SS} : 13$

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+20$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$
Lead Temp./Time	T_{sol}	$260^{\circ}\text{C} \cdot 10\text{sec}$	

LOGIC DIAGRAM



TRUTH TABLE

INPUTS					OUTPUT	
$\overline{\text{R}}$	$\overline{\text{S}}$	J	K	$\overline{\text{CL}} \wedge$	Q_{n+1}	\overline{Q}_{n+1}
H	L	*	*	*	H	L
L	H	*	*	*	L	H
L	L	*	*	*	L	H
H	H	L	L	\downarrow	Q_n	\overline{Q}_n
H	H	L	H	\downarrow	L	H
H	H	H	L	\downarrow	H	L
H	H	H	H	\downarrow	\overline{Q}_n	Q_n
H	H	*	*	\uparrow	Q_n	\overline{Q}_n

* Don't care
 \wedge Level change
 \downarrow No change
 \uparrow Change

RECOMMENDED OPERATING CONDITIONS (VSS=0V)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VDD	3	-	18	V
Input Voltage	VIN	0	-	VDD	V
Operating Temp.	Topr	-40	-	85	°C

ELECTRICAL CHARACTERISTICS (VSS=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
"H" Level Output Voltage	VOH	|IOUT| < 1μA VIN = VSS, VDD	5	4.95	-	4.95	5.00	-	4.95	-	V	
			10	9.95	-	9.95	10.00	-	9.95	-		
			15	14.95	-	14.95	15.00	-	14.95	-		
"L" Level Output Voltage	VOL	|IOUT| < 1μA VIN = VSS, VDD	5	-	0.05	-	0.00	0.05	-	0.05	V	
			10	-	0.05	-	0.00	0.05	-	0.05		
			15	-	0.05	-	0.00	0.05	-	0.05		
"H" Level Output Current	IOH	VOH = 4.6V VOH = 9.5V VOH = 13.5V VIN = VSS, VDD	5	-0.2	-	-0.16	-	-	-0.12	-	mA	
			10	-0.5	-	-0.4	-	-	-0.3	-		
			15	-1.4	-	-1.2	-	-	-1.0	-		
"L" Level Output Current	IOL	VOL = 0.4V VOL = 0.5V VOL = 1.5V VIN = VSS, VDD	5	0.52	-	0.44	-	-	0.36	-	mA	
			10	1.3	-	1.1	-	-	0.9	-		
			15	3.6	-	3.0	-	-	2.4	-		
"H" Level Input Voltage	VIH	VOUT=0.5V, 4.5V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |IOUT| < 1μA	5	3.5	-	3.5	2.75	-	3.5	-	V	
			10	7.0	-	7.0	5.5	-	7.0	-		
			15	11.0	-	11.0	8.25	-	11.0	-		
"L" Level Input Voltage	VIL	VOUT=0.5V, 4.5V VOUT=1.0V, 9.0V VOUT=1.5V, 13.5V |IOUT| < 1μA	5	-	1.5	-	2.25	1.5	-	1.5	V	
			10	-	3.0	-	4.5	3.0	-	3.0		
			15	-	4.0	-	6.75	4.0	-	4.0		
Input Current	"H" Level	IIH	VIH = 18V	18	-	0.3	-	10 ⁻⁵	0.3	-	1.0	μA
	"L" Level	IIL	VIL = 0V	18	-	-0.3	-	-10 ⁻⁵	-0.3	-	-1.0	
Quiescent Supply Current	IDD	VIN = VSS, VDD *	5	-	4.0	-	0.002	4.0	-	30	μA	
			10	-	8.0	-	0.004	8.0	-	60		
			15	-	16.0	-	0.008	16.0	-	120		

* All valid input combinations

SWITCHING CHARACTERISTICS (Ta=25°C, VSS=0V, CL=50pF)

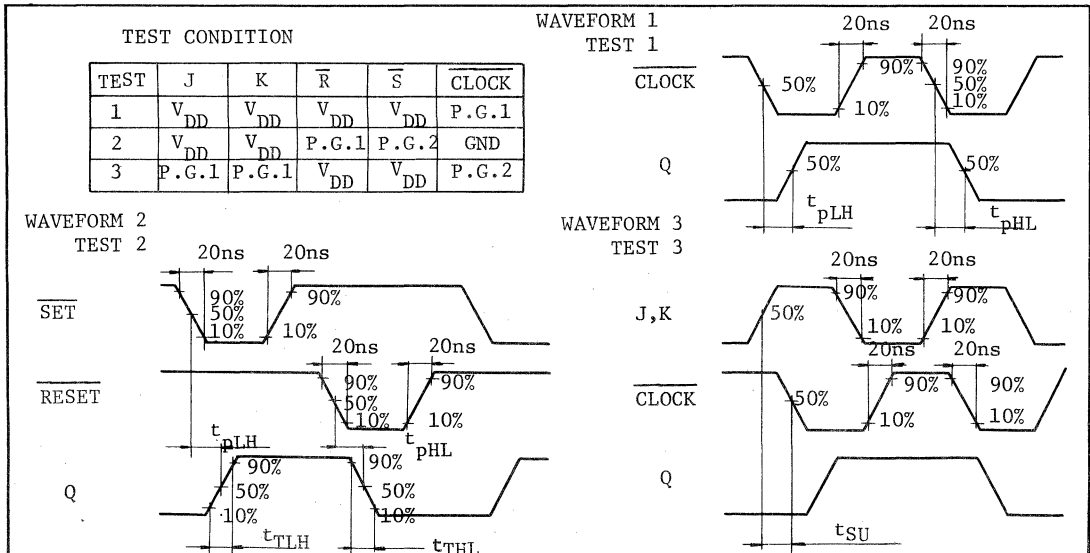
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	VDD (V)	MIN.	TYP.	MAX.	UNIT
Output Rise Time	tTLH		5	-	130	400	ns
			10	-	65	200	
			15	-	50	160	
Output Fall Time	tTHL		5	-	100	200	ns
			10	-	50	100	
			15	-	40	80	

TC7476BP

SWITCHING CHARACTERISTICS (Ta=25°C, V_{SS}=0V, C_L=50 pF)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	V _{DD} (V)	MIN.	TYP.	MAX.	UNIT
(Low-High) Propagation Delay Time (CLOCK - Q, Q̄)	t _{pLH}	Waveform 1	5	-		550	ns
			10	-		350	
			15	-		300	
(High-Low) Propagation Delay Time (CLOCK - Q, Q̄)	t _{pHL}	Waveform 1	5	-		500	ns
			10	-		300	
			15	-		260	
(Low-High) Propagation Delay Time (CL, PR - Q, Q̄)	t _{pLH}	Waveform 2	5	-		600	ns
			10	-		300	
			15	-		260	
(High-Low) Propagation Delay Time (CL, PR - Q, Q̄)	t _{pHL}	Waveform 2	5	-		600	ns
			10	-		300	
			15	-		260	
Max. Clock Frequency	f _{CL}	Waveform 1	5	1.0		-	MHz
			10	3.0		-	
			15	3.5		-	
Max. Clock Rise Time Max. Clock Fall Time	t _{rCL} t _{fCL}	Waveform 1	5	20	-	-	μs
			10	2.5	-	-	
			15	1.0	-	-	
Min. Pulse Width (SET, RESET)	t _w	Waveform 2	5	-		500	ns
			10	-		250	
			15	-		200	
Min. Set-up Time	t _{SU}	Waveform 3	5	-		250	ns
			10	-		125	
			15	-		100	
Input Capacitance	C _{IN}				5	7.5	pF

SWITCHING TIME TEST WAVEFORMS



TC5090AP PENTAPHASIC INTEGRATION 8-BIT A/D CONVERTER

The TC5090AP is a pentaphase integration 8-bit A/D converter of high precision and low power consumption, which is mounted in a compact 16-pin standard package. The 8-bit output data can be taken out in the form of time-shared higher order 4 bits and lower order 4 bits on four 3-state data outputs.

This output system is designed specifically considering interface to 4-bit CPU.

The features of low power consumption and compact outline are applicable to battery-driven small-sized instruments.

FEATURES:

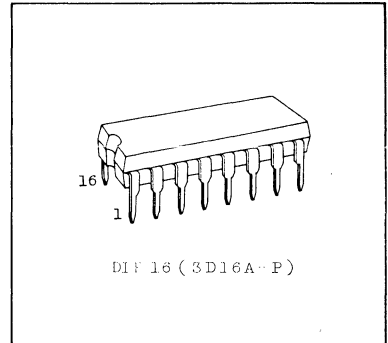
- High precision : ± 1 LSB MAX.
- Low power consumption: 10mW(Typ.) @ ($V_{DD}=5V$, $f_{OSC}=1MHz$)
- Single power supply : $V_{DD}=5\pm 1.5V$
- High-speed conversion: 2mS(Max.) @ $f_{OSC}=1.5MHz$
- Reference clock oscillation circuit contained (CR oscillation)
- 3-state output with output latch
- TTL/CMOS compatible digital Input/Output
- Offset automatic correction

APPLICATIONS:

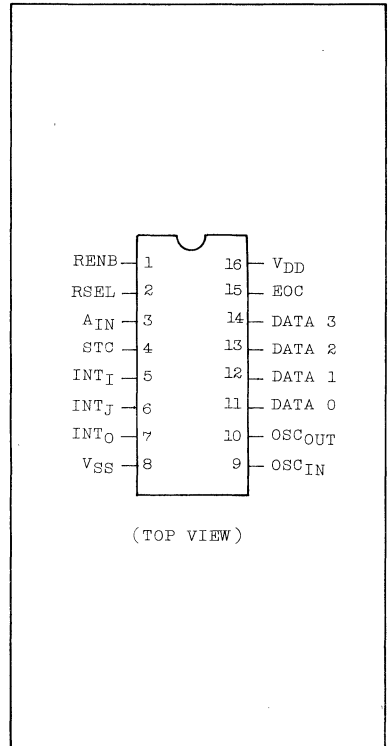
- Various control instruments (for temperature, humidity, pressure, etc.)
- Home electric appliances
- Electric wiring apparatuses
- Battery-driven instruments

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+8$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_d	300	mW
Operating Temperature Range	T_{opr}	-40 ~ 85	°C
Storage Temperature Range	T_{stg}	-65 ~ 150	°C

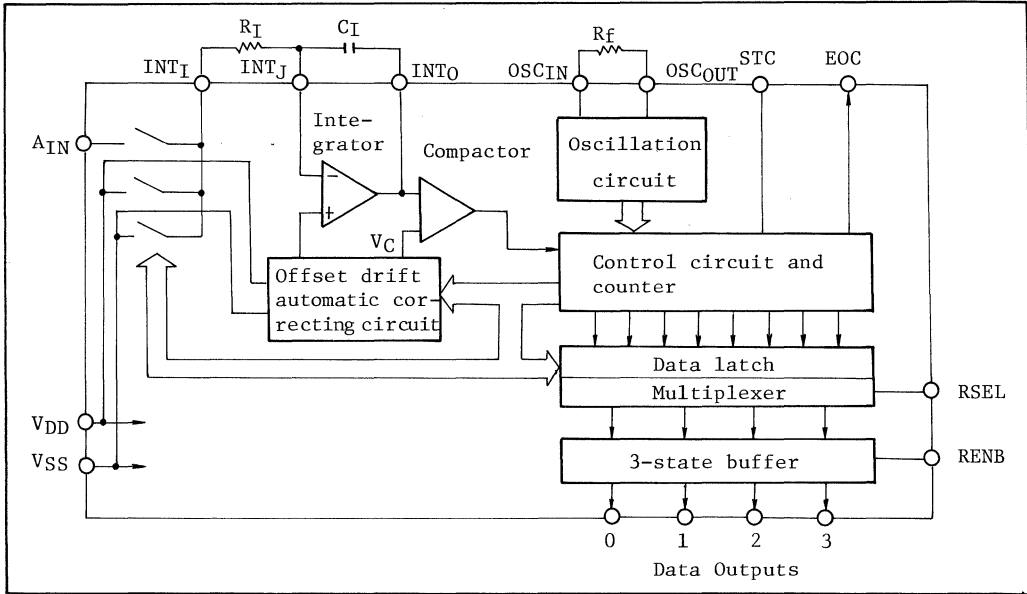


PIN ASSIGNMENT

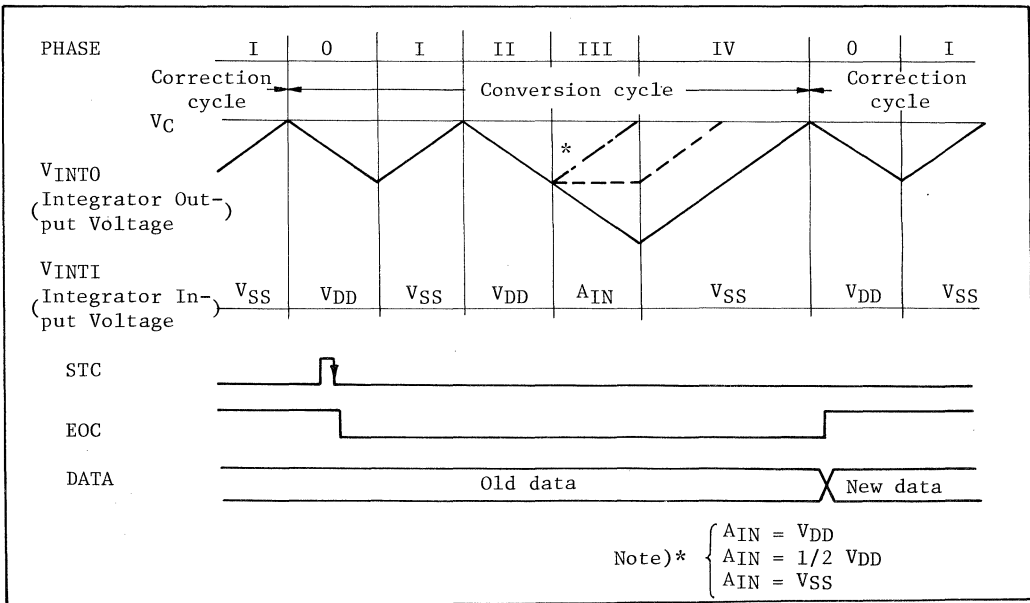


TC5090AP

BLOCK DIAGRAM



TIMING DIAGRAM



FUNCTION OF EACH PIN

PIN NO.	SYMBOL	NAME & FUNCTION	PIN NO.	SYMBOL	NAME & FUNCTION
1	RENB	(Read Enable) Data read signal. "H": The data 0~3 can be output. "L": The output above is at high impedance.	9	OSC IN	I/O for reference clock oscillation. Clock oscillation can be made by means of external resistance. Clock can be supplied from outside through input of OSC IN.
			10	OSC OUT	
2	RSEL	(Read Select) Input to select the higher order 4 bits or the lower order 4 bits to 4-bit data output. "H": Output of the higher order 4 bits. "L": Output of the lower order 4 bits.	11	DATA 0	(3-state Parallel Data Outputs) Conversion data output. The data 0 is LSB, and the data 3 is MSB.
			12	DATA 1	
			13	DATA 2	
			14	DATA 3	
3	AIN	(Analog Input) Analog input terminals. Input voltage range is $V_{DD} \sim V_{SS}$.	15	EOC	(End of Conversion) Conversion ending signal. EOC goes to "L" level at the fall of STC, and returns to "H" level at the end of conversion.
4	STC	(Start Conversion) Conversion starting signal. Conversion starts at the falling edge.			
5	INT I	(Integrator Input, Integrator Junction, Integrator Output) Integrator consists of external resistor R_I and external capacitor C_I .	16	V_{DD}	(Power Supply) $5V \pm 1.5V$
6	INT J				
7	INT O				
8	V_{SS}	(Ground) Normally 0V			

FUNCTIONAL DESCRIPTION

(1) System Description (Pentaphasic Integration)

The operation of the TC5090AP is composed of the correction cycle and the conversion cycle as shown in the timing chart. While the power is switched on, the repetition of correction cycle and conversion cycle enables the TC5090AP to make A/D conversion under the optimum conditions at all times. The operation flowchart is shown in Fig. 1.

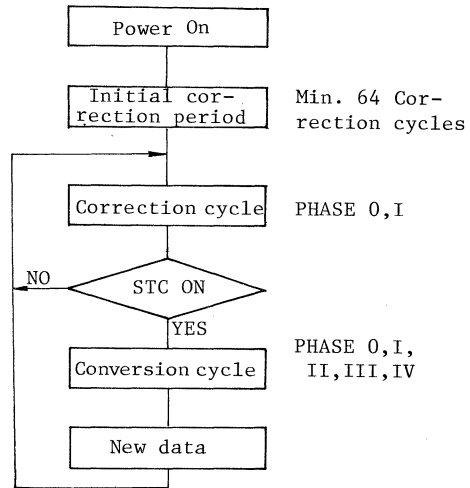


Fig. 1 Operation Flowchart

(a) Initial correction period

The internal state of this LSI is reasonably unsettled at the time when the power is switched on;

therefore, the initial correction cycle is required before stable converting operation becomes possible.

The correction cycle automatically corrects conversion error caused by offset voltage of the integrator or the like, and is composed of the period (PHASE 0) for which V_{DD} is integrated and the period (PHASE I) for which V_{SS} is integrated.

Since system correction is performed in steps at the end of this PHASE I, 64 correction cycles ($64 \times 1024 \cdot T_{OSC}$) are required as the initial correction period. (TOSC denotes one clock cycle.)

(b) Conversion cycle

If the initial correction cycle period is completed, normal conversion becomes possible.

When STC input is given, (although the correction cycle in PHASE 0 or PHASE 1 is in operation at this time), the correction operation stops, and the conversion cycle starts.

In other words, even if STC input is given, this LSI performs the same operation as the correction cycle until PHASE I is completed; but it does not perform the correction at the time of completion of PHASE I, and shifts to PHASE II. Therefore, attention should be given to the fact that PHASE I prior to PHASE II does not act as correction cycle.

When STC input is given, the LSI integrates analog input in PHASE III through PHASE I and PHASE II, performing digital conversion in PHASE IV. When the LSI completes digital conversion in PHASE IV, the output is turned to the new data and the LSI returns to the correction cycle.

(c) Correction cycle

When the next STC input is given between completion of arbitrary conversion cycle (at the time of completion of PHASE IV) and completion of one correction cycle ($1024 \cdot T_{OSC}$), no correction is substantially made. Therefore, in case the STC input is consecutively given, another STC should be given after the lapse of one correction cycle at the earliest from completion of PHASE IV. When the STC input is given during conversion (while EOC is at "L" level), the STC cannot be accepted.

(d) Constant of integration

The R_I and C_I composing the integrator should be selected to satisfy the following equation.

$$R_I C_I = (0.9 \sim 2.5) \cdot \frac{10^3}{f_{OSC}} \quad [S]$$

Attention should be paid to the fact that, when the external R oscillation is used, f_{OSC} has $\pm 30\%$ variations in regard to the typ. value in Fig. 5 due to variations in sample and temperature characteristic.

In other words, if the typ. value in Fig. 5 is denoted by f_{R-TYP} , the R_I and C_I should be selected according to the following equation.

$$R_I C_I = (1.2 \sim 1.75) \cdot \frac{10^3}{f_{R-TYP}} \quad [S]$$

(2) Output Data Mode

TRUTH TABLE

RENB	ANALOG INPUT	DIGITAL OUTPUTS							
		RSEL = "L"				RSEL = "H"			
		DATA 0	DATA 1	DATA 2	DATA 3	DATA 0	DATA 1	DATA 2	DATA 3
L	Don't care	High Impedance							
H	$< \frac{1}{2} \text{ LSB}$	L	L	L	L	L	L	L	L
H	$-\frac{1}{2} \text{ LSB} \sim \frac{1}{2} \text{ LSB}$	L	L	L	L	L	L	L	L
H	$\frac{1}{2} \text{ LSB} \sim \frac{3}{2} \text{ LSB}$	H	L	L	L	L	L	L	L
H	.....	Straight Binary							
H	"FS" $-\frac{5}{2} \text{ LSB} \sim \text{"FS"}-\frac{3}{2} \text{ LSB}$	L	H	H	H	H	H	H	H
H	"FS" $-\frac{3}{2} \text{ LSB} \sim \text{"FS"}-\frac{1}{2} \text{ LSB}$	H	H	H	H	H	H	H	H
H	"FS" $-\frac{1}{2} \text{ LSB} <$	H	H	H	H	H	H	H	H

Note : $V_{SS} = 0V$

1 LSB = $V_{DD}/256$

"FS" Full Scale (V_{DD})

8-bit digital data is output on four data lines after having been divided into the higher order 4 bits and the lower order 4 bits. Either the higher order bits or the lower order bits can be selected by RSEL.

(3) System Clock Oscillation Circuit

For oscillating reference clock the oscillation circuit is composed of external resistors as shown in Fig. 2.

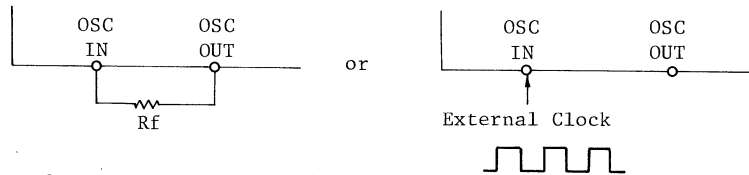


Fig.2 Clock Supplying Methods

(4) Timings for STC-EOC and EOC-DATA

- o Time (t_{SE}) from the fall of STC to the fall of EOC.

$$t_{SE} = \frac{1}{2} T_{OSC} \sim \frac{3}{2} T_{OSC}$$

- o Time (t_{DE}) from the out of DATA output to the rise of EOC

$$t_{DE} = \frac{1}{2} T_{OSC}$$

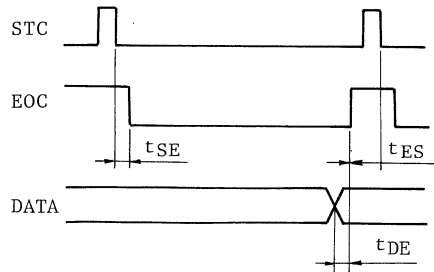


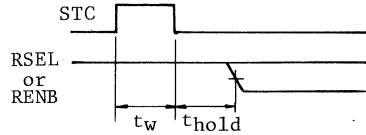
Fig.3 Timing chart of STC/EOC

- o Min. time (t_{ES}) from the rise of EOC to the acceptance of another STC.

$$t_{ES} = \frac{1}{2} T_{OSC} \sim \frac{3}{2} T_{OSC}$$

(5) Timings for STC Input and RSEL/RENB Input

STC signal is taken in synchronously with the internal clock; therefore, if T_{OSC} denotes one clock cycle of OSC terminal, the pulse width of more than $(2 \cdot T_{OSC})$ is required.



Either RSEL input or RENB input is required to be set to "H" level at the falling time of STC by reason of internal structure.

Fig.4 Timing chart of Control Input

Further, the hold time of $(T_{OSC} + 50ns)$ or more after the falling time of STC at least for "H" level time of RSEL or REMB is required.

NOTE : $t_w > 2 \cdot T_{OSC}$, $t_{hold} > T_{OSC} + 50ns$

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V)

ITEM	SYMBOL		MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		3.5	5	6.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Integral Resistor	R _I		0.4	-	2	MΩ
Integral Capacitor	C _I		Note			
Oscillatory Resistance	R _f	V _{DD} = 5V	10	-	-	kΩ

Note: Refer to Function Description (1) for determining the values of R_I and C_I, respectively.

ELECTRICAL CHARACTERISTICS (V_{SS} = 0V)

ITEM	SYM-BOL	TEST CONDITIONS	V _{DD} [V]	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Input High Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	4.95	-	4.95	5.00	-	4.95	-	V
Output Low Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	I _{OH}	V _{OH} =4.0V * V _{IN} =V _{SS} , V _{DD}	5	-1.2	-	-1.0	-2.0	-	-0.7	-	mA
Output Low Current	I _{OL}	V _{OL} =0.4V * V _{IN} =V _{SS} , V _{DD}	5	2.4	-	2.0	4.0	-	1.6	-	
Input High Voltage	V _{IH}	*	5	2.4	-	2.4	-	-	2.4	-	V
Input Low Voltage	V _{IL}	*	5	-	0.8	-	-	0.8	-	0.8	
Output Disable Current	I _{DH} I _{DL}	V _{OH} =6.5V * V _{OL} =0V	6.5	-	±0.5	-	±10 ⁻⁴	±0.5	-	±5	μA
Input Current	I _{IH} I _{IL}	V _{IH} =6.5V * V _{IL} =0V	6.5	-	±0.3	-	±10 ⁻⁵	±0.3	-	±1	
Analog Switch Off-Leak Current	I _{OFF}	V _{IH} =6.5V * V _{IL} =0V	6.5	-	±0.3	-	±10 ⁻⁵	±0.3	-	±1	
Operating Consumption Current	I _{DD} (opr)	f _{OSC} = 1 MHz	5	-	-	-	2.0	3	-	-	mA

* Applicable to digital input/output. Not applicable to analog input/output and OSC_{IN}/OSC_{OUT}.

TC5090AP

SWITCHING CHARACTERISTICS (V_{DD} = 5V, V_{SS} = 0V, T_a = 25°C, C_L = 50 pF)

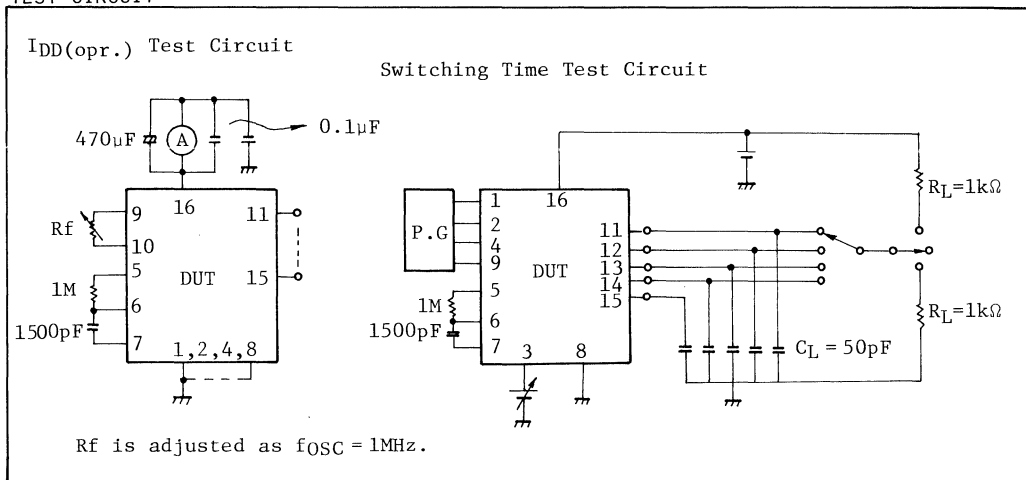
ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		-	50	100	ns
Output Fall Time	t _{THL}		-	40	100	
(Low-High) Propagation Delay Time	t _{pLH}	RSEL("L"→"H")-DATA OUT	-	180	400	
(High-Low) Propagation Delay Time	t _{pHL}		-	150	400	
(Low-High) Propagation Delay Time	t _{pLH}	RSEL("H"→"L")-DATA OUT	-	380	700	
(High-Low) Propagation Delay Time	t _{pHL}		-	300	700	
Output Enable Time	t _{ZL} t _{ZH}	RENB-DATA OUT	-	80	250	
Output Disable Time	t _{LZ} t _{HZ}		-	280	500	
Max. Clock Frequency	f _{MAX} ∅	OSC Input	1.5	3.0	-	MHz
Min. Clock Frequency	f _{MIN} ∅	OSC Input	-	-	100	kHz
Input Capacity	C _{IN}	Digital Inputs	-	4	-	pF
Analog Input Capacity	C _{IN}		-	7	-	pF
3-State Output Capacity	C _{OUT}		-	8	-	pF

SYSTEM CHARACTERISTICS (T_a = -40 ~ 85°C)

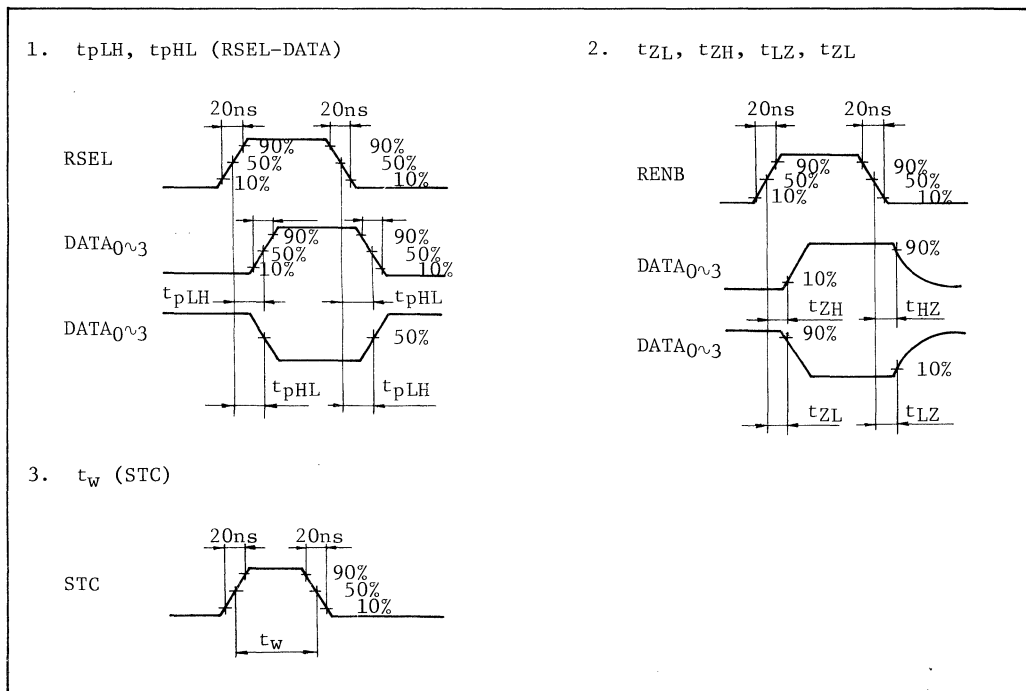
ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZP}	V _{DD} =5V, V _{SS} =0V	-	± 1/4	± 1/2	LSB
Full Scale Error	E _{FS}		-	± 1/4	± 1	
Nonlinearity			-	± 1/4	± 1	
STC Min. Pulse Width	t _w	*	-	-	2 / f _{OSC}	s
Conversion Time	t _{conv.}	A _{IN} = 0 ~ FS *	10 ³ / f _{OSC}	-	3.1x10 ³ / f _{OSC}	s

* f_{OSC} : OSC terminal clock frequency [Hz], FS : Full Scale voltage, V_{DD} level

TEST CIRCUIT



SWITCHING CHARACTERISTICS TEST WAVEFORMS



STANDARD CHARACTERISTICS CHARTS

Fig. 1 $V_{DD} - I_{DD(opr)}$

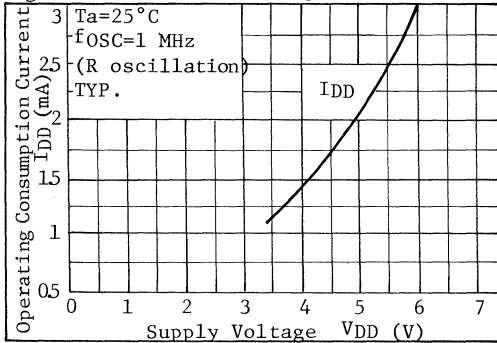


Fig. 2 $I_{DD(opr)} - f_{OSC}$

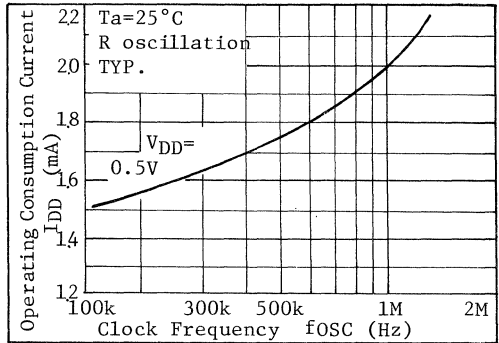


Fig. 3 P-channel Output Buffer Drain Current Characteristics

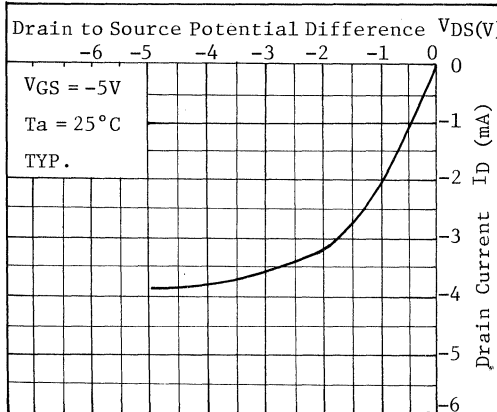


Fig. 4 N-channel Output Buffer Drain Current Characteristics

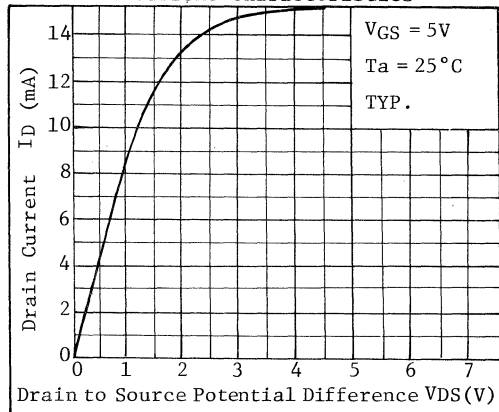


Fig. 5 $R_f - f_{OSC}$

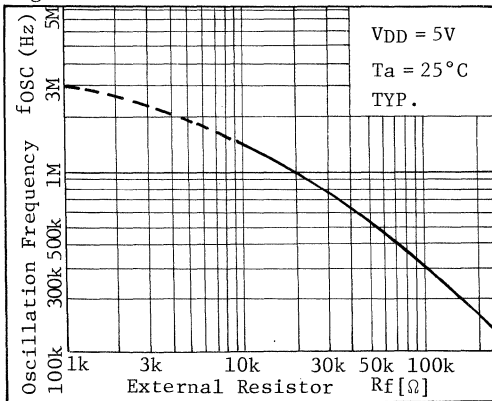


Fig. 6 $f_{OSC} - V_{DD}$

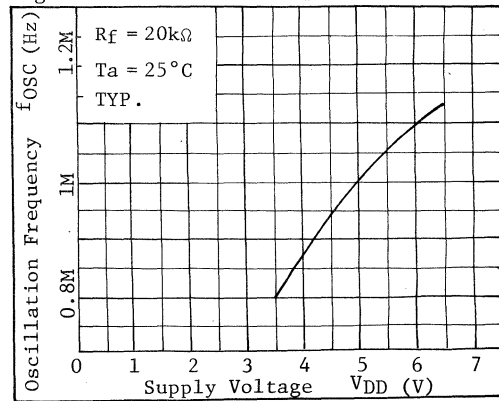


Fig. 7 $t_{pd} - V_{DD}$ (PENB-DATA)

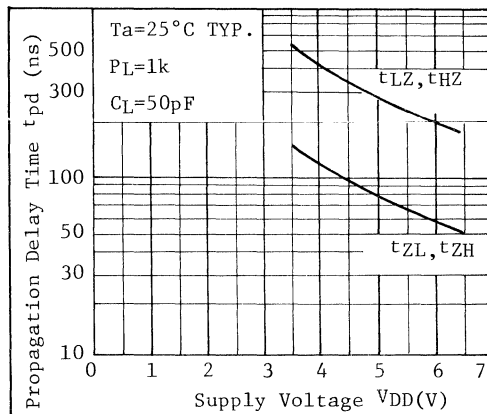


Fig. 8 $t_{pd} - V_{DD}$ (RSEL (L→H)-DATA)

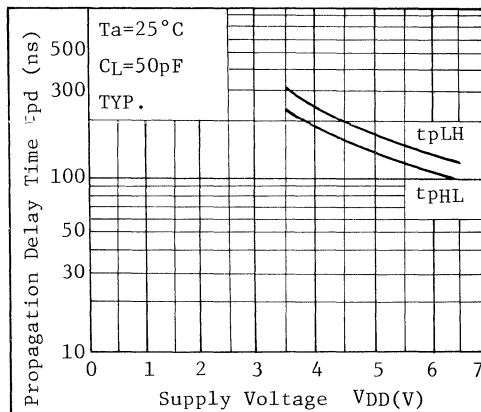


Fig. 9 $t_{pd} - V_{DD}$ (RSEL(H→L)-DATA)

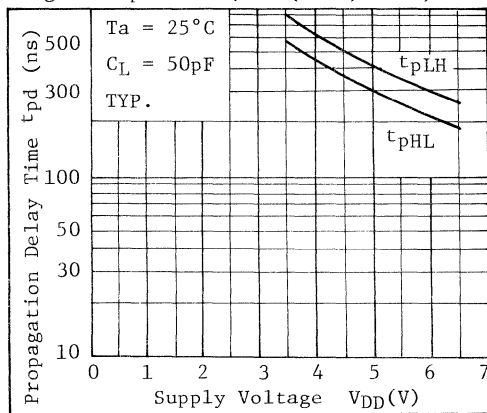
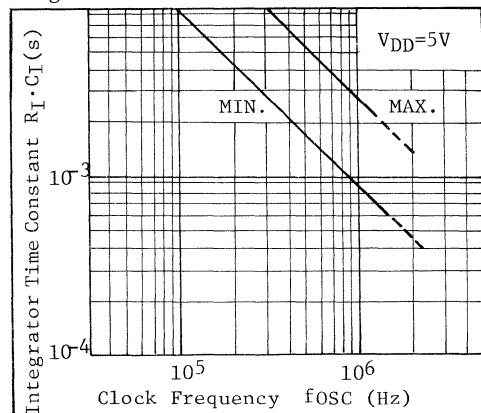


Fig.10 $R_I \cdot C_I - f_{OSC}$



(Note) The characteristics at Fig. 10 have been prepared for reference at the time of determination of an integrator time constant, according to the equation of

$$(R_I \cdot C_I = (0.9 \sim 2.5) \frac{10^3}{f_{osc}} [\text{Sec}]) \quad \text{for determining } R_I \cdot C_I.$$

In case of the determination of R_I and C_I , the product, or the value, of R_I and C_I is required to be within the range of MIN. to MAX. as shown in Fig. 10 after due consideration of dispersion.

TC5091AP

CMOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5091AP PENTAPHASIC INTEGRATION 8-BIT A/D CONVERTER

The TC5091AP is a pentaphasic integration 8-bit A/D converter of high precision and low power consumption. The 8-bit output data can be taken out in the form of time-shared higher order 4 bits and lower order 4 bits on four 3-state data output. Either the higher order bits or the lower order bits can be selected by RSEL input. This output system is designed specifically considering interface to 4-bit CPU.

Further, since this converter has an analog multiplexer capable of selecting the input data up to six channels, an over-range flag, and a serial clock output function, it is used for a variety of applications.

FEATURES:

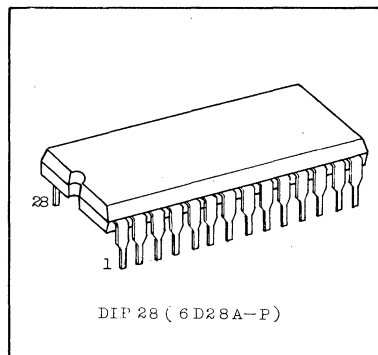
- High precision : $\pm 1\text{LSB}(\text{Max.})$
- Low power consumption: 10mW(Typ.) @ ($V_{DD}=5\text{V}$
 $f_{OSC}=1\text{MHz}$)
- Single power supply : $V_{DD}=5\pm 1.5\text{V}$
- High-speed conversion: 2ms(Max.) @ $f_{OSC}=1.5\text{MHz}$
- 6-channel analog multiplexer contained
- Reference clock oscillation circuit contained (CR oscillation)
- 3-state output with output latch
- TTL/CMOS compatible digital Input/Output
- Offset automatic correction

APPLICATIONS:

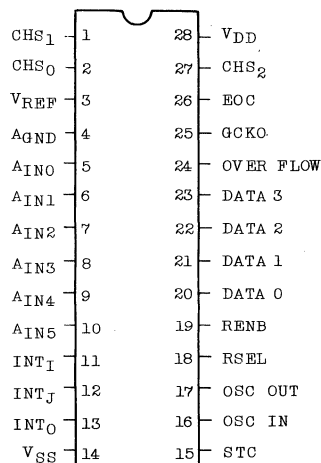
- Various control instruments (for temperature, humidity, pressure, etc.)
- Home electric appliances
- Electrical wiring apparatuses
- Battery-driven instruments

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	V_{DD}	$V_{SS}-0.5 \sim V_{SS}+8$	V
Input Voltage	V_{IN}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Output Voltage	V_{OUT}	$V_{SS}-0.5 \sim V_{DD}+0.5$	V
Reference Supply Voltage	V_{REF}	$V_{AGND} \sim V_{DD}+0.5$	V
Analog Ground Voltage	V_{AGND}	$V_{SS}-0.5 \sim V_{REF}$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_d	300	mW
Operating Temperature Range	T_{opr}	$-40 \sim 85$	$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	$-65 \sim 150$	$^{\circ}\text{C}$

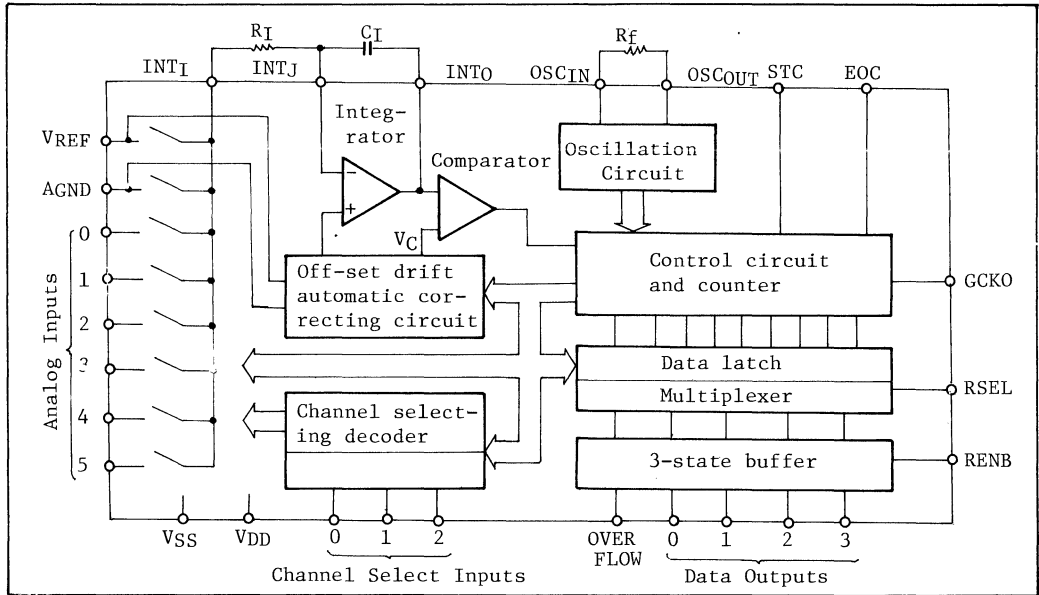


PIN ASSIGNMENT

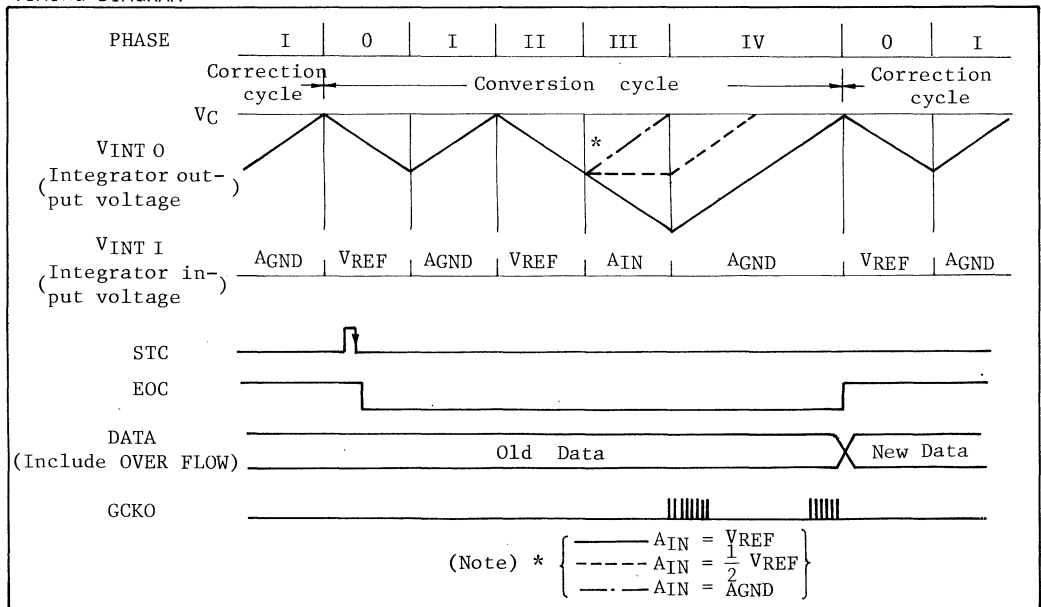


(TOP VIEW)

BLOCK DIAGRAM



TIMING DIAGRAM



FUNCTION OF EACH PIN

PIN No.	SYMBOL	NAME & FUNCTION	PIN No.	SYMBOL	NAME & FUNCTION																																				
1	CHS 1	(Channel Select Inputs) Address inputs to select analog inputs, which consist of three terminals of CHS0 [~] 2.	16	OSC IN	I/O for reference clock oscillation. Clock oscillation can be made by means of external resistance. Clock can be supplied from outside through input of OSC IN.																																				
		17	OSC OUT																																						
		These select inputs are taken into the internal latch by the falling edge of STC inputs. Test mode should not be used.	18	RSEL	(Read Select) Input to select the higher order 4 bits or the lower order 4 bits to 4-bit data output. "H": Output of the higher order 4 bits. "L": Output of the lower order 4 bits.																																				
TRUTH TABLE OF MULTIPLEXER	19	RENB			(Read Enable) Data read signal. "H": The data 0 [~] 3 and overflow can be output. "L": The output above is at high impedance.																																				
2			CHS 0	<table border="1"> <thead> <tr> <th>CHS2</th> <th>CHS1</th> <th>CHS0</th> <th>ON channel</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>L</td> <td>VREF*</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>AGND*</td> </tr> <tr> <td>L</td> <td>H</td> <td>L</td> <td>AIN₀</td> </tr> <tr> <td>L</td> <td>H</td> <td>H</td> <td>AIN₁</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> <td>AIN₂</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>AIN₃</td> </tr> <tr> <td>H</td> <td>H</td> <td>L</td> <td>AIN₄</td> </tr> <tr> <td>H</td> <td>H</td> <td>H</td> <td>AIN₅</td> </tr> </tbody> </table>	CHS2	CHS1	CHS0	ON channel	L	L	L	VREF*	L	L	H	AGND*	L	H	L	AIN ₀	L	H	H	AIN ₁	H	L	L	AIN ₂	H	L	H	AIN ₃	H	H	L	AIN ₄	H	H	H	AIN ₅	20
	CHS2	CHS1		CHS0	ON channel																																				
	L	L		L	VREF*																																				
	L	L		H	AGND*																																				
	L	H		L	AIN ₀																																				
	L	H		H	AIN ₁																																				
	H	L		L	AIN ₂																																				
	H	L		H	AIN ₃																																				
	H	H		L	AIN ₄																																				
	H	H		H	AIN ₅																																				
* Test Conditions	21	DATA 1																																							
	22	DATA 2																																							
	23	DATA 3																																							
3	VREF	(Reference Voltage) Reference voltage supplying terminal, which performs as full-scale voltage of AIN.	24	OVERFLOW	In case of overrange or underrange, "H" level is output and the output is 3-state output.																																				
4	AGND	(Analog Ground) Electrical potential to determine "zero point" of AIN.																																							
5	AIN 0	(Analog Input) Analog input terminals, by which AIN selected by CHS inputs are integrated. Input voltage range is AGND [~] VREF.	25	GCKO	(Gated Clock Output) Pulses of number equivalent to the conversion data are output during conversion (356 pulses at full scale)																																				
6	AIN 1																																								
7	AIN 2																																								
8	AIN 3																																								
9	AIN 4																																								
10	AIN 5																																								
11	INT I	(Integrator Input, Integrator Junction, Integrator Output) Integrator consists of external resistor R _I and external capacitor C _I .	26	EOC	(End of Conversion) Conversion endig signal. EOC goes to "L" level at the fall of STC, and returns to "H" level at the end of conversion.																																				
12	INT J																																								
13	INT O																																								
14	VSS	(Digital Ground) Normally 0V	27	CHS 2	(Channel Select Input) Refer to Pins 1 and 2.																																				
15	STC	(Start Conversion) Conversion starting signal. Conversion starts at the falling edge.	28	VDD	(Power Supply) 5V ± 1.5V																																				

FUNCTIONAL DESCRIPTION

(1) System Description (Pentaphasic Integration)

The operation of the TC5091AP is composed of the correction cycle and the conversion cycle as shown in the timing chart. While the power is switched on, the repetition of correction cycle and conversion cycle enables the TC5091AP at make A/D conversion under the optimum conditions at all times. The operation flowchart is shown in Fig. 1.

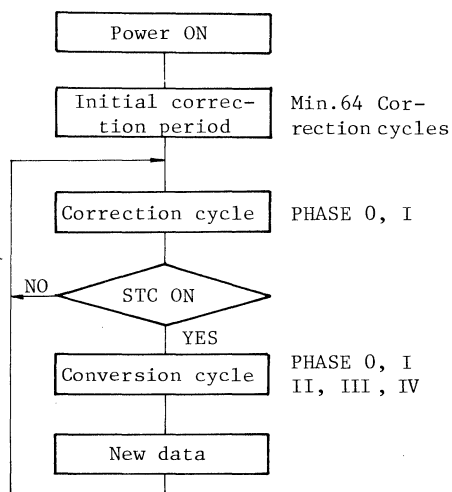


Fig. 1 Operation Flowchart

(a) Initial correction period

The internal state of this LSI is reasonably unsettled at the time when the power is switched on; therefore, the initial correction cycle is required before stable converting operation becomes possible.

The correction cycle automatically corrects conversion error caused by offset voltage of the integrator or the like, and is composed of the period (PHASE 0) for which V_{REF} is integrated and the period (PHASE I) for which AGND is integrated.

Since system correction is performed in steps at the end of this PHASE I, 64 correction cycles ($64 \times 1024 \cdot T_{OSC}$) are required as the initial correction period. (T_{OSC} denotes one clock cycle.)

(b) Conversion cycle

If the initial correction cycle period is completed, normal conversion becomes possible.

When STC input is given, (although the correction cycle in PHASE 0 or PHASE I is in operation at this time), the correction operation stops, and the conversion cycle starts.

In other words, even if STC input is given, this LSI performs the same operation as the correction cycle until PHASE I is completed; but it does not perform the correction at the time of completion of PHASE I, and shifts to PHASE II. Therefore, attention should be given to the fact that PHASE I prior to PHASE II does not act as correction cycle.

When STC input is given, the LSI integrates analog input in PHASE III through PHASE I and PHASE II, performing digital conversion in PHASE IV. When the LSI completes digital conversion in PHASE IV, the output is turned to the new data and the LSI returns to the correction cycle.

(c) Correction cycle

When the next STC input is given between completion of arbitrary conversion cycle (at the time of completion of PHASE IV) and completion of one correction cycle ($1024 \cdot T_{OSC}$), no correction is substantially made. Therefore, in case the STC input is consecutively given, another STC should be given after the lapse of one correction cycle at the earliest from completion of PHASE IV. When the STC input is given during conversion (While EOC is at "L" level), the STC cannot be accepted.

(d) Constant of integration

The R_I and C_I composing the integrator should be selected to satisfy the following equation.

$$R_I C_I = (0.9 \sim 2.5) \cdot \frac{V_{REF}}{V_{DD}} \cdot \frac{10^3}{f_{OSC}} \text{ [S]}$$

Attention should be paid to the fact that, when the external R oscillation is used, f_{OSC} has $\pm 30\%$ variations in regard to the typ. value in Fig. 5 due to variations in sample and temperature characteristic.

In other words, if the typ. value in Fig. 5 is denoted by $f_{R \cdot TYP}$, the R_I and C_I should be selected according to the following equation.

$$R_I C_I = (1.2 \sim 1.75) \cdot \frac{V_{REF}}{V_{DD}} \cdot \frac{10^3}{f_{R \cdot TYP}} \text{ [S]}$$

(2) Output Data Mode

TRUTH TABLE

RENB	ANALOG INPUT	DIGITAL OUTPUTS								OVER FLOW
		RSEL = "L"				RSEL = "H"				
		DATA 0	DATA 1	DATA 2	DATA 3	DATA 0	DATA 1	DATA 2	DATA 3	
L	Don't Care	High Impedance								
H	$\sim \frac{1}{2} \text{LSB}$	L	L	L	L	L	L	L	H	H
H	$\frac{1}{2} \text{LSB} \sim \frac{1}{2} \text{LSB}$	L	L	L	L	L	L	L	L	L
H	$\frac{1}{2} \text{LSB} \sim \frac{3}{2} \text{LSB}$	H	L	L	L	L	L	L	L	L
H	.....	Straight Binary								
H	"FS" $-\frac{5}{2} \text{LSB} \sim \text{"FS"} - \frac{3}{2} \text{LSB}$	L	H	H	H	H	H	H	H	L
H	"FS" $-\frac{3}{2} \text{LSB} \sim \text{"FS"} - \frac{1}{2} \text{LSB}$	H	H	H	H	H	H	H	H	L
H	"FS" $-\frac{1}{2} \text{LSB} \sim$	H	H	H	H	H	H	H	H	H

Note : • AGND = 0V • 1LSB = "FS"/256
 • "FS" Full Scale (=VREF)

8-bit digital data is output on four data lines after having been divided into the higher order 4 bits and the lower order 4 bits. Either the higher order bits or the lower order bits can be selected by RSEL.

(3) System Clock Oscillation Circuit

For oscillating reference clock the oscillation circuit is composed of external resistors as shown in Fig. 2.

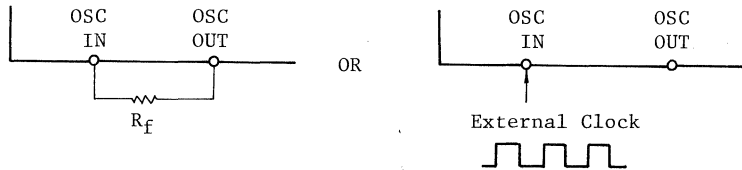


Fig. 2 Clock Supplying Methods

(4) Timings for STC-EOC and EOC-DATA

- o Time (t_{SE}) from the fall of STC to the fall of EOC.

$$t_{SE} = \frac{1}{2} T_{OSC} \sim \frac{3}{2} T_{OSC}$$

- o Time (t_{DE}) from the out of DATA output to the rise of EOC

$$t_{DE} = \frac{1}{2} T_{OSC}$$

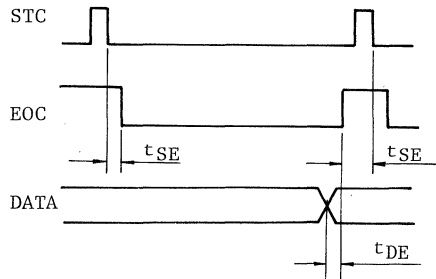


Fig. 3 Timing Chart of STC, EOC

- o Min. time (t_{ES}) from the rise of EOC to the acceptance of another STC.

$$t_{ES} = \frac{1}{2} T_{OSC} \sim \frac{3}{2} T_{OSC}$$

(5) GCKO Output (Gated Clock Output)

During the conversion (PHASE IV), the pulses of number equivalent to the values of digital data can be obtained on GCKO output.

The output pulse has the frequency corresponding to four times of reference clock as shown in Fig. 4, and is synchronized with the rising edge of OSC OUT.

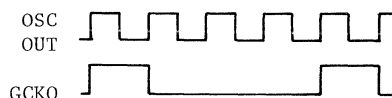


Fig. 4 Timing Chart of GCKO Output

(6) Timing for STC Input and CHS Input

STC signal is taken in synchronously with the internal clock. Therefore, if T_{OSC} denotes one clock cycle of OSC terminal, the pulse width of more than $(2 \cdot T_{OSC})$ is required.

Since the data of $CHS_{0 \sim 2}$ are also latched in synchronously with the internal clock, the CHS signal at least requires the hold time of $(T_{OSC} + 50ns)$ or more after the fall of STC.

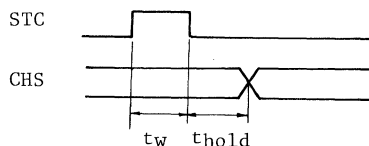


Fig.5 Timing Chart of Control Input

NOTE :

$t_w > 2 \cdot T_{OSC}, \quad t_{hold} > T_{OSC} + 50ns$
--

TC5091AP

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V)

ITEM	SYMBOL		MIN.	TYP.	MAX.	Unit
Supply Voltage	VDD		3.5	5	6.5	V
Input Voltage	VIN		0	-	VDD	V
Reference Voltage	VREF		3	-	VDD	V
Analog Ground Voltage	VAGND		0	0	1	V
Integral Resistor	RI		0.4	-	2	MΩ
Integral Capacitor	CI	(Note)	-	-	-	-
Oscillatory Resistance	RF	VDD = 5V	10	-	-	MΩ

Note: Refer to the operating consideration (1) for determining the values of RI and CI respectively.

The ripples of VDD and VREF should be held down to less than 1/256 of the respective absolute values in view of precision.

ELECTRICAL CHARACTERISTICS (V_{SS} = 0V)

ITEM	SYM-BOL	TEST CONDITION	VDD (V)	-40°C		25°C			85°C		UNIT
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
Output High Voltage	VOH	|I _{OUT}| < 1 μA VIN = VSS, VDD	5	4.95	-	4.95	5.00	-	4.95	-	V
Output Low Voltage	VOL	|I _{OUT}| < 1 μA VIN = VSS, VDD	5	-	0.05	-	0.00	0.05	-	0.05	
Output High Current	IOH	VOH = 4.0V VIN = VSS, VDD *	5	-1.2	-	-1.0	-2.0	-	-0.7	-	mA
Output Low Current	IOL	VOL = 0.4V VIN = VSS, VDD *	5	2.4	-	2.0	4.0	-	1.6	-	
Input High Voltage	VIH		* 5	2.4	-	2.4	-	-	2.4	-	V
Input Low Voltage	VIL		* 5	-	0.8	-	-	0.8	-	0.8	
Output Disable Current	IDH IDL	VOH = 6.5V VOL = 0V	* 6.5	-	±0.5	-	±10 ⁻⁴	±0.5	-	±5	μA
Input Current	I _{IH} I _{IL}	VIH = 6.5V VIL = 0V	* 6.5	-	±0.3	-	±10 ⁻⁵	±0.3	-	±1	
Analog Switch Input Leak Current	I _{OFF}	VIH = 6.5V VIL = 0V	6.5	-	±0.3	-	±10 ⁻⁵	±0.3	-	±1	
Operating Consumption Current	IDD (opr)	f _{OSC} = 1 MHz	5	-	-	-	1.8	3	-	-	mA
Reference Supply Consumption Current	I _{REF}	VREF = 5V AGND = 0V	5	-	-	-	0.3	0.6	-	-	

* Applicable to digital input/output. Not applicable to analog input/output and OSC_{IN}/OSC_{OUT}.

SWITCHING CHARACTERISTICS (V_{DD} = 5V, V_{SS} = 0V, T_a = 25°C, C_L = 50pF)

ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}		-	50	100	ns
Output Fall Time	t _{THL}		-	40	100	
(Low-High) Propagation Delay Time	t _{pLH}	OSC _{OUT} -GCKO	-	200	400	
(High-Low) Propagation Delay Time	t _{pHL}		-	150	400	
(Low-High) Propagation Delay Time	t _{pLH}	RSEL("L"→"H")-DATA OUT	-	180	400	
(High-Low) Propagation Delay Time	t _{pHL}		-	150	400	
(Low-High) Propagation Delay Time	t _{pLH}	RSEL("H"→"L")-DATA OUT	-	380	700	
(High-Low) Propagation Delay Time	t _{pHL}		-	300	700	
Output Enable Time	t _{ZL} t _{ZH}		-	80	250	
Output Disable Time	t _{LZ} t _{HZ}		-	280	500	
Max. Clock Frequency	f _{MAZ} ∅	OSC Input	1.5	3.0	-		MHz
Min. Clock Frequency	f _{MIN} ∅	OSC Input	-	-	100	kHz
Input Capacity	C _{IN}	Digital Input	-	4	-	pF
Analog Input Capacity	C _{IN}	A ₀ ~ A ₅	-	7	-	pF
3-State Output Capacity	C _{OUT}		-	8	-	pF

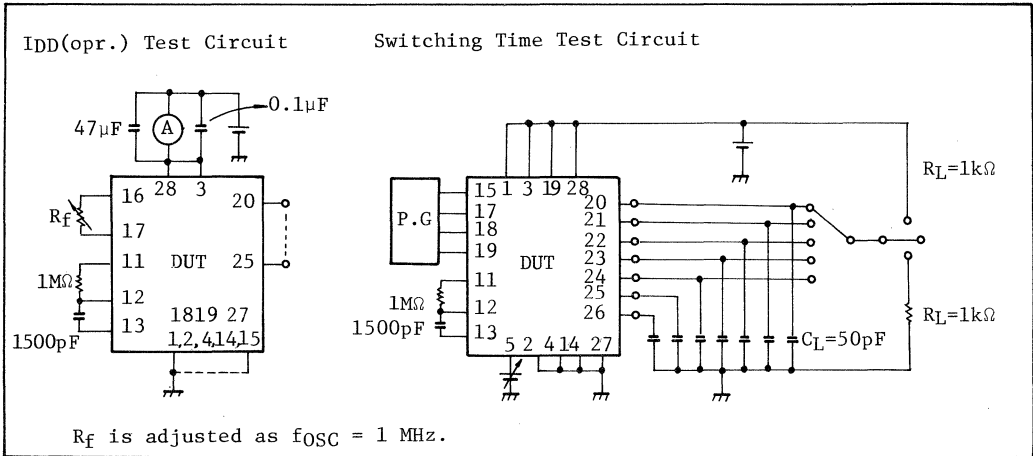
SYSTEM CHARACTERISTICS (T_a = -40 ~ 85°C)

ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZP}	V _{REF} = V _{DD} = 5V V _{AGND} = 0V	-	± 1/4	± 1/2	LSB
Full Scale Error	E _{FS}		-	± 1/4	± 1	
Nonlinearity			-	± 1/4	± 1	
STC Min. Pulse Width	t _w		-	-	2 / f _{OSC}	s
CHS Min. Hold Time	t _{hold}	STC = CHS ₀ ~2	-	-	10 / f _{OSC} + 50	ns
Conversion Time	t _{conv.}	A _{IN} = 0 ~ FS	10 ³ / f _{OSC}	-	3.1x10 ³ / f _{OSC}	s

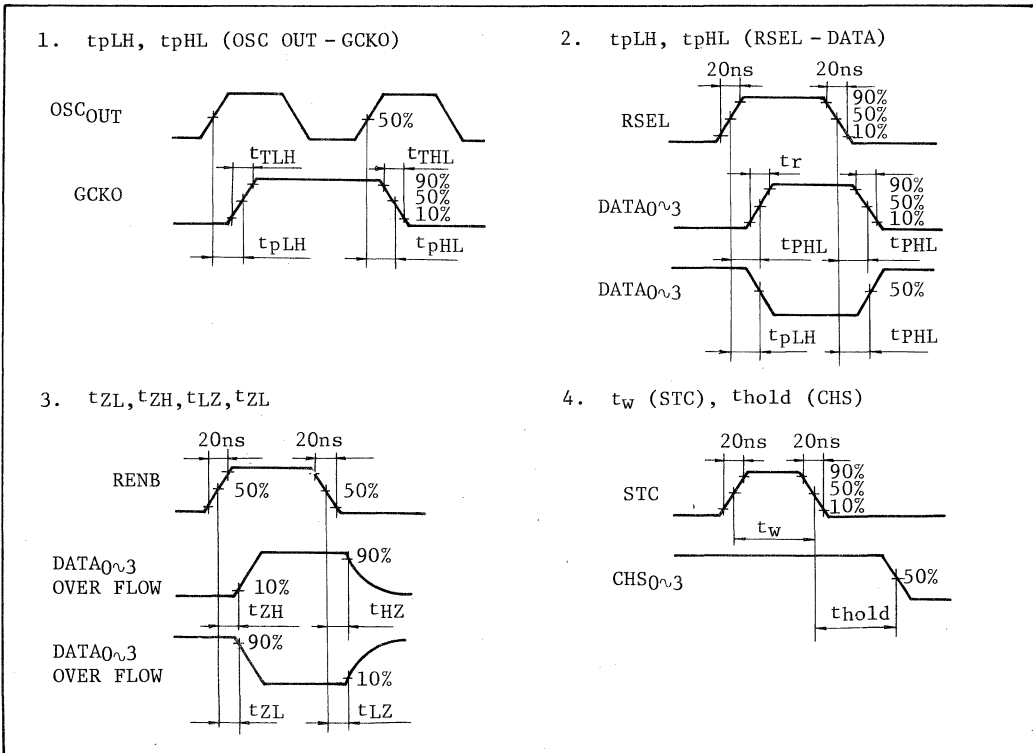
* f_{OSC} : OSC terminal clock frequency [Hz], FS : Full Scale voltage, V_{DD} level

TC5091AP

TEST CIRCUIT



SWITCHING CHARACTERISTICS TEST WAVEFORMS



STANDARD CHARACTERISTICS CHARTS

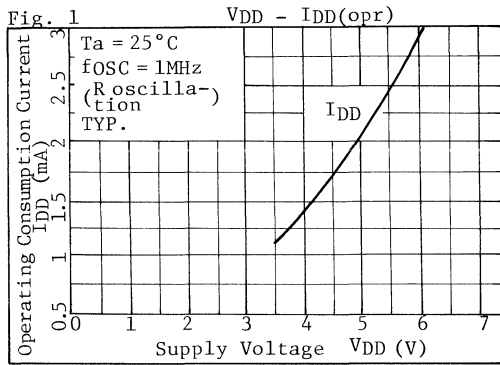


Fig. 3 P-channel Output Buffer Drain Current Characteristics

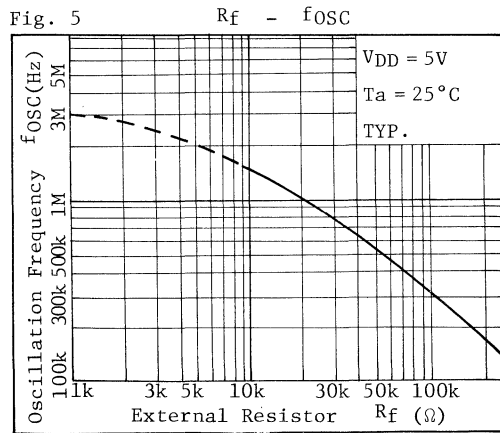
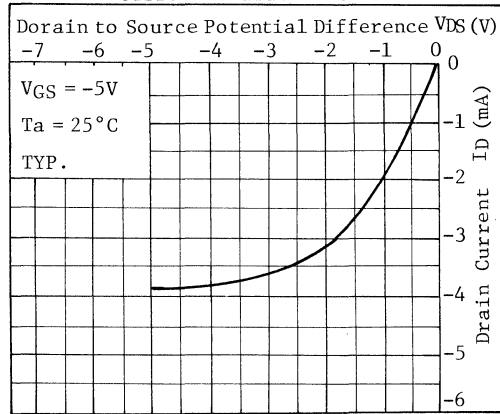


Fig. 3 P-channel Output Buffer Drain Current Characteristics

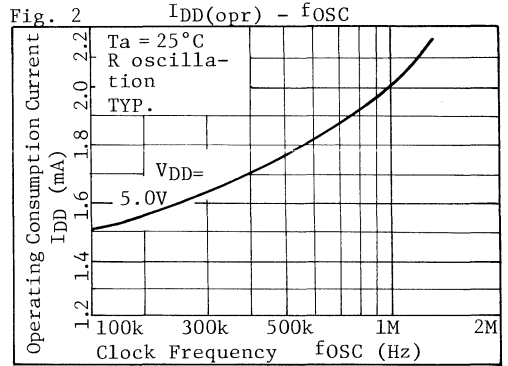


Fig. 4 N-channel Output Buffer Drain Current Characteristics

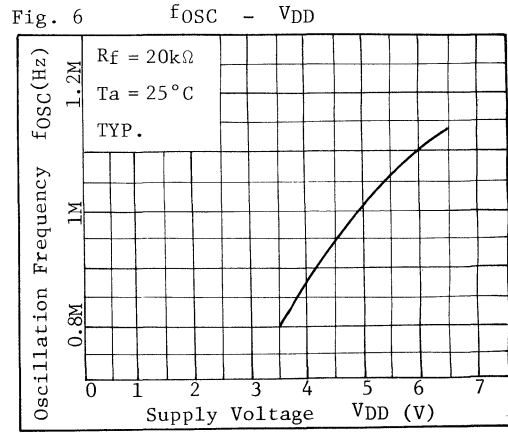
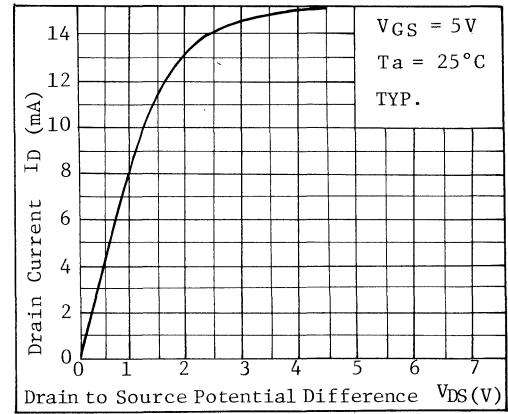


Fig. 6 $f_{OSC} - V_{DD}$

Fig. 7 $t_{pd} - V_{DD}$ (RENB-DATA)

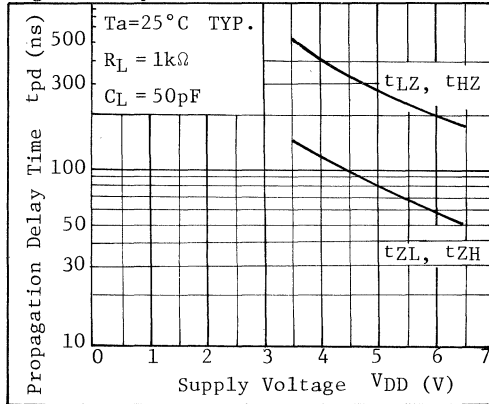


Fig. 8 $t_{pd} - V_{DD}$ (RSEL (L→H)-DATA)

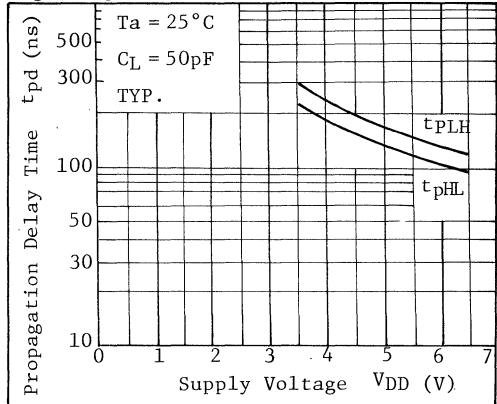


Fig. 9 $t_{pd} - V_{DD}$ (RSEL (H→L)-DATA)

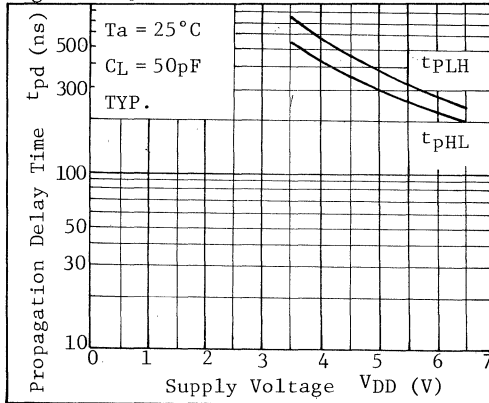


Fig. 10 $t_{pd} - V_{DD}$ (OSCOU - GCKO)

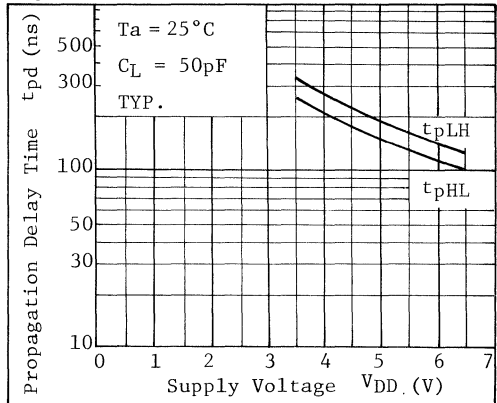
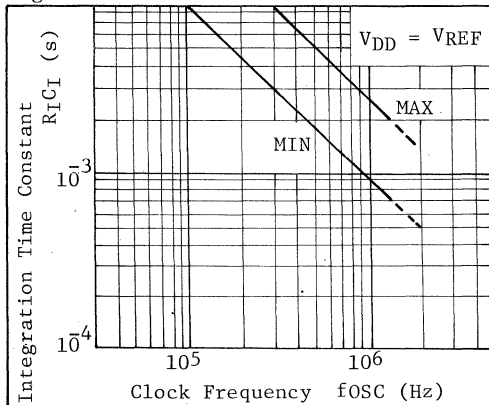


Fig. 11 $R_I C_I - f_{OSC}$



(Note)

The characteristics at left have been prepared for reference at the time of determination of an integrator time constant according to the equation of

$$(R_I C_I = (0.9 \sim 2.5) \cdot \frac{V_{REF}}{V_{DD}} \cdot \frac{103}{f_{OSC}} \text{ (s)})$$

for determining $R_I \cdot C_I$.

In case of the determination of R_I and C_I , the product, or the value, of R_I and C_I is required to be within the range of MIN. to MAX. as shown in left figure after due consideration of dispersion.

TC5092AP C²MOS 13-BIT A/D CONVERTER

GENERAL DESCRIPTION

The TC5092AP is an integration 13-bit A/D converter of high precision and low power consumption.

The 13-bit, 3-state data output is capable of independent enable in 4 bits so as to be connected directly to 4-bit/8-bit/12-bit data bus. (LSB is common to lower order 4 bits.)

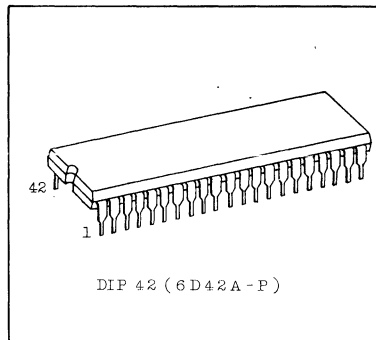
Further, since this converter has an 8-channel analog multiplexer, and a serial clock output function, it is most suitable as data collection unit of various industrial control instruments.

FEATURES:

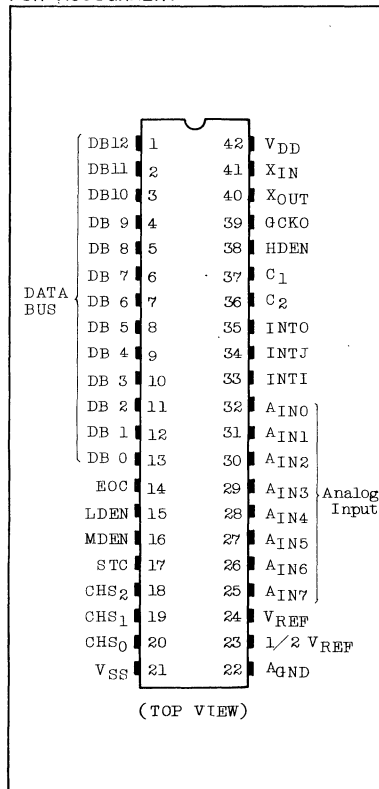
- . High precision..... ± 1 LSB(Typ.)
- . Low power consumption.....10mW(Typ.)
- . Single power supply.....VDD=5V \pm 0.5V
- . High-speed conversion.....fCP Max.=5MHz
- . 8-channel analog multiplexer contained
- . TTL/CMOS compatible digital Input/Output
- . Capable of direct connection to 4-/8-/12-bit bus

APPLICATIONS:

- . Various industrial control instruments
- . Data collection modules



PIN ASSIGNMENT

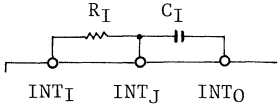


ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
DC Supply Voltage	VDD	VSS-0.5 ~ VSS+7	V
Input Voltage	VIN	VSS-0.5 ~ VDD+0.5	V
Reference Supply Voltage	VREF	VAGND ~ VDD+0.5	V
Analog Ground Voltage	VAGND	VSS-0.5 ~ VREF	V
Output Voltage	VOUT	VSS-0.5 ~ VDD+0.5	V
DC Input Current	IIN	± 10	mA
Power Dissipation	PD	300	mW
Operating Temperature Range	T _{opr}	-40 ~ 85	°C
Storage Temperature Range	T _{stg}	-65 ~ 150	°C

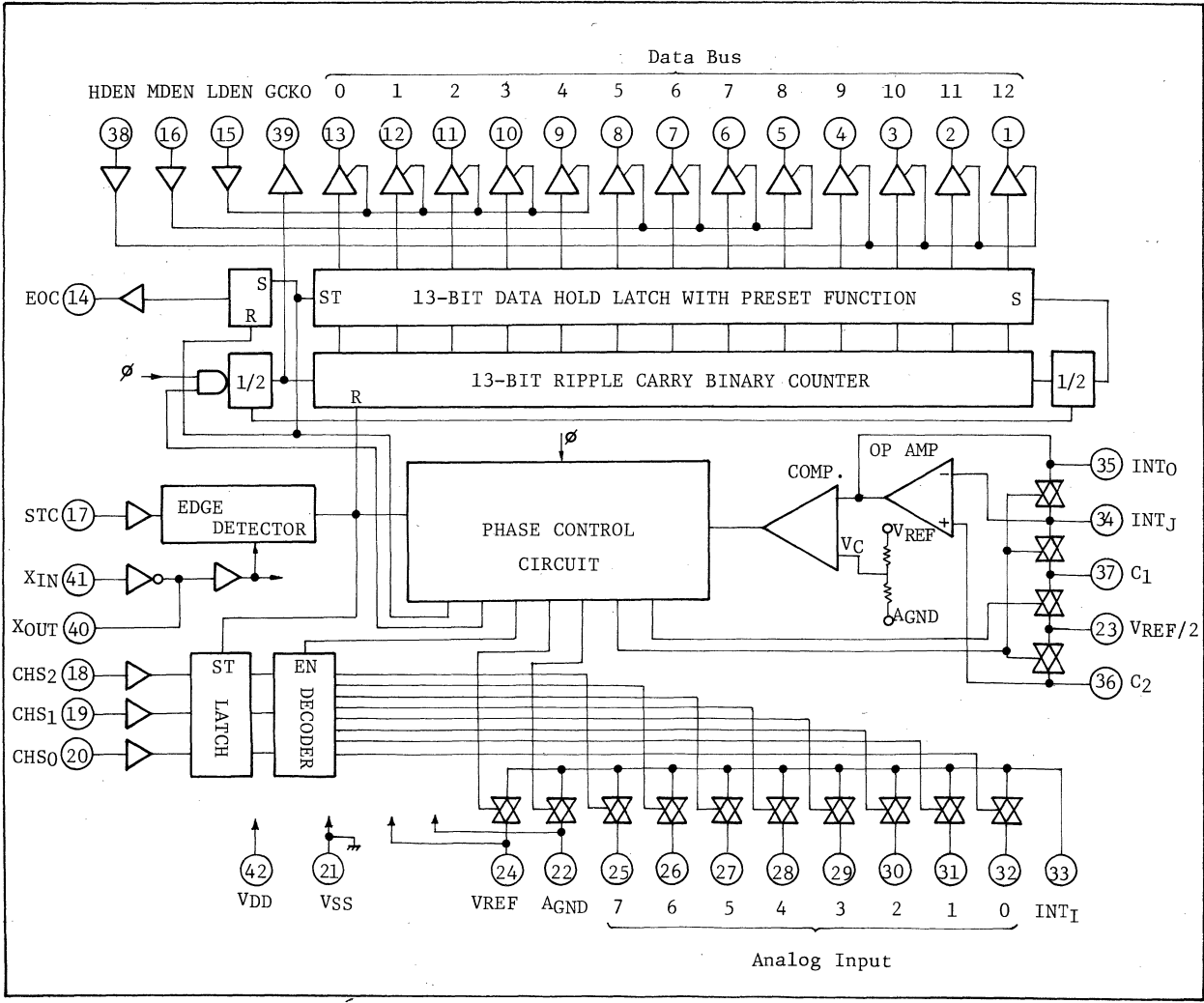
TC5092AP

FUNCTION OF EACH PIN

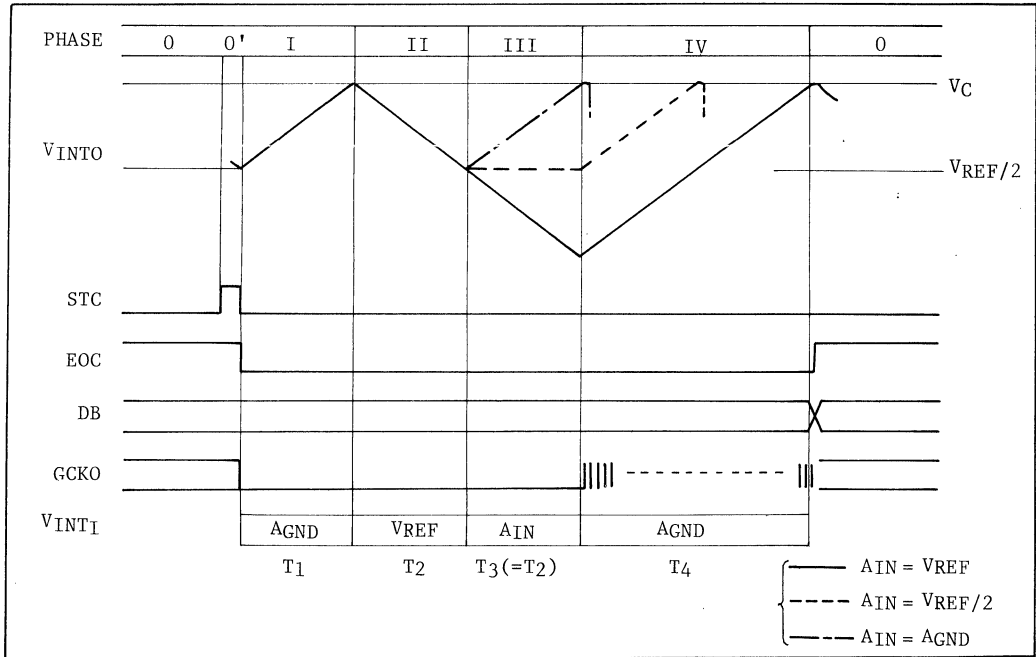
PIN NO.	Symbol	NAME & FUNCTION	PIN NO.	Symbol	NAME & FUNCTION																																				
1	DB12	3-State Parallel Data Outputs DB12 : MSB DB 0 : LSB	23	$V_{REF/2}$	Reference voltage supply terminal, which supplies the voltage of $\frac{V_{REF} - AGND}{2}$																																				
2	DB11																																								
3	DB10																																								
4	DB 9																																								
5	DB 8																																								
6	DB 7																																								
7	DB 6																																								
8	DB 5																																								
9	DB 4																																								
10	DB 3																																								
11	DB 2																																								
12	DB 1																																								
13	DB 0																																								
14	EOC	End of Conversion EOC goes to "L" level at the fall of STC signal, and returns to "H" level at the end of conversion.	30	AIN2	<table border="1"> <thead> <tr> <th>CHS0</th> <th>CHS1</th> <th>CHS2</th> <th>A_{IN}</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>L</td> <td>A_{IN0}</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> <td>A_{IN1}</td> </tr> <tr> <td>L</td> <td>H</td> <td>L</td> <td>A_{IN2}</td> </tr> <tr> <td>H</td> <td>H</td> <td>L</td> <td>A_{IN3}</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>A_{IN4}</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>A_{IN5}</td> </tr> <tr> <td>L</td> <td>H</td> <td>H</td> <td>A_{IN6}</td> </tr> <tr> <td>H</td> <td>H</td> <td>H</td> <td>A_{IN7}</td> </tr> </tbody> </table>	CHS0	CHS1	CHS2	A _{IN}	L	L	L	A _{IN0}	H	L	L	A _{IN1}	L	H	L	A _{IN2}	H	H	L	A _{IN3}	L	L	H	A _{IN4}	H	L	H	A _{IN5}	L	H	H	A _{IN6}	H	H	H	A _{IN7}
CHS0	CHS1	CHS2	A _{IN}																																						
L	L	L	A _{IN0}																																						
H	L	L	A _{IN1}																																						
L	H	L	A _{IN2}																																						
H	H	L	A _{IN3}																																						
L	L	H	A _{IN4}																																						
H	L	H	A _{IN5}																																						
L	H	H	A _{IN6}																																						
H	H	H	A _{IN7}																																						
15	LDEN	Low Data Enable DB ₀ ~ DB ₄ are read by "H" level input.	31	AIN1																																					
16	MDEN	Medium Data Enable DB ₅ ~ DB ₈ are read by "H" level input.	32	AIN0																																					
17	STC	Start Conversion Conversion starts at the fall time, if pulse input at "H" level is provided. "L" level should be kept during conversion.	33	INT _I	Integrator Input Integrator Junction Integrator Output The integrator consists of these three terminals. 																																				
18	CHS ₂	Channel Select Inputs These pins are address inputs for selecting eight analog inputs of A _{IN0} ~ A _{IN7} , and are taken into the internal latch	34	INT _J																																					
19	CHS ₁		35	INT _O																																					
20	CHS ₀																																								
21	VSS	Digital Ground	36	C ₂	Capacitors connection terminals for offset calibration.																																				
22	AGND	Analog Ground																																							

FUNCTION OF EACH PIN

PIN NO.	Symbol	NAME & FUNCTION
37	C ₁	0.1 μ F is connected between C ₂ and C ₁ , and 0.01 μ F C ₁ and VSS, respectively.
38	HDEN	High Data Enable DB ₉ ~ DB ₁₂ are read by "H" level input.
39	GCKO	Gated Clock Output Pulses of number equivalent to conversion data are output during conversion.
40	X _{OUT}	Terminals for system clock oscillation.
41	X _{IN}	Crystal oscillators are connected to both the ends of terminals.
42	VDD	Supply Voltage 5V \pm 0.5V



TIMING CHART



FUNCTIONAL DESCRIPTION

(1) Conversion cycle

In the state of PHASE 0', the operation of LSI is at a stop and the integrating amplifier performs as voltage follower. Under this condition the external capacitor (0.1 μ F across C_1 and C_2)

When STC is given, the offset voltage charged into external capacitors is applied to non-inversion of the integrator, thus cancelling the offset voltage equivalently. In PHASE I, the integrator continues to integrate AGND until its output reaches V_C .

In PHASE III the integrator integrates the analog input for the same period of time as T_2 after it has integrated V_{REF} for a fixed period of time (T_2) in PHASE II.

Finally, in PHASE IV the integrator continues to integrate AGND until its output reaches V_C .

FUNCTIONAL DESCRIPTION

Let the time in PHASE IV be T_4 . Then the following equation is made (formed) by omitting error factors such as offset drift.

$$V_{AIN} = \frac{T_4}{2T_2} V_{REF} \quad (AGND=0V) \dots (1)$$

In case of this LSI, T_2 is designed by $4096 \times 2 \cdot T_{OSC}$ (T_{OSC} denotes reference clock synchronization). Therefore, the above formula letting $2 \cdot T_{OSC}$ be T is changed as follows:

$$\frac{V_{AIN}}{V_{REF}} = \frac{T_4}{8192T} \dots (2)$$

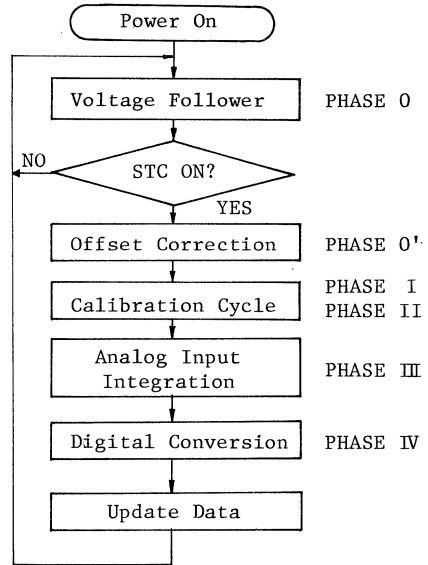
That is, 13-bit resolution A/D conversion of FS (full scale) = 8192 can be made by counting the period of T_4 by use of a clock having T frequency.

However, it is recommended that R_I and C_I composing the integrator be set to the values close to $13000/f_{OSC}$ as possible after having satisfied the following formula.

$$R_I C_I > 13000 / f_{OSC}, \quad R_I = 1 \sim 2M\Omega \text{ is used.} \dots (3)$$

(2) Output data format

13-bit output data are output to 13 independent 3-state data buses $DB_0 \sim DB_{12}$. Since 13-bit outputs can be independently placed on 3-state every group of High, Medium and Low of 4 bits/4 bits/5 bits from the higher order, it is easy to connect the microcomputer to buses of 4, 8, 12 bits.



FUNCTIONAL DESCRIPTION

TRUTH TABLE

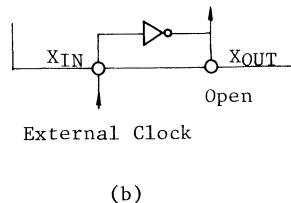
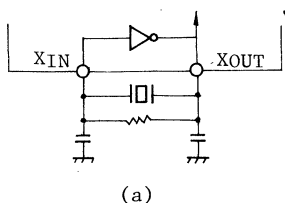
LDEN	MDEN	HDEN	Analog Input	DATA OUTPUTS (DB)												
				0	1	2	3	4	5	6	7	8	9	10	11	12
L	L	L	Don't Care	Z				Z				Z				
H	L	L		D	D	D	D	D	Z				Z			
L	H	L		Z				D	D	D	D	Z				
H	H	L		D	D	D	D	D	D	D	D	Z				
L	L	H		Z				Z				D	D	D	D	
H	L	H		D	D	D	D	D	Z				D	D	D	D
L	H	H		Z				D	D	D	D	D	D	D	D	
H	H	H	<1/2LSB	L	L	L	L	L	L	L	L	L	L	L	L	
			1/2LSB ~ 3/2LSB	H	L	L	L	L	L	L	L	L	L	L	L	
			.....	Straight Binary											
			"FS"-5/2LSB ~ "FS"-3/2LSB	L	H	H	H	H	H	H	H	H	H	H	H	H
			"FS"-3/2 LSB <	H	H	H	H	H	H	H	H	H	H	H		

Note : FS Full Scale, 1 LSB = (VREF-AGND)/8192, Z ... High Impedance
 D ... "H" or "L" Level

(3) Basic clock

Since this LSI operates on the basis of the frequency given to XIN input, a stable clock ($\Delta f < 0.005\%$) must be used for the clock to be given to XIN.

Therefore, it is proper that the oscillation circuit is configured as shown in the following figure (a) by the use of externally mounted crystal because the LSI has a built-in inverter for crystal oscillation.



FUNCTIONAL DESCRIPTION

(4) How to give STC input, Conversion time, and Sampling cycle

STC input is taken in with the reference clock of LSI, but the positive pulse having the pulse width for at least two cycles is required for internal starting.

The conversion time of from the fall of STC input to the rise of EOC output. Letting this time be $T_{c\text{ MAX}}$ (Maximum conversion time), then the following equation is obtained.

$$T_{c\text{ MAX}} = 41000 \times T_{\text{OSC}} \text{ [S]} \dots\dots\dots (4)$$

(where T_{OSC} is oscillation cycle of basic clock.)

For example, when $f_{\text{CP}}=5\text{MHz}$, $T_{c\text{ MAX}}=8.2\text{ms}$. For one-time sampling, an accurate output can be obtained from the falling edge of STC input after the lapse of $T_{c\text{ MAX}}$.

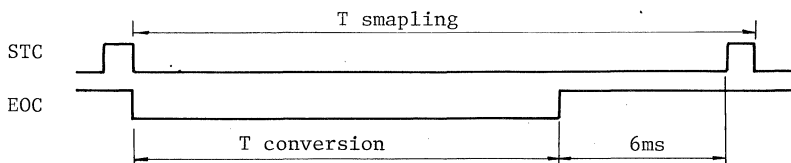
For consecutive sampling, however, STC input must be given after the lapse of a given period of time (6ms) from the rise of EOC. This period (6ms) is the time required for the recovery of LSI to normal state.

Therefore, the minimum sampling cycle $T_{s\text{ MIN}}$ is as follows:

$$T_{s\text{ MIN}} = 41000 \times T_{\text{OSC}} + 0.006 + t_w(\text{STC}) \text{ [S]} \dots\dots\dots (5)$$

Note: When power is set ON, following start-up procedure is required due to indefinite state of internal circuitry.

1. Applying clock, STC is to be set high over 10ms.
2. Complete at least one cycle as a dummy conversion cycle.

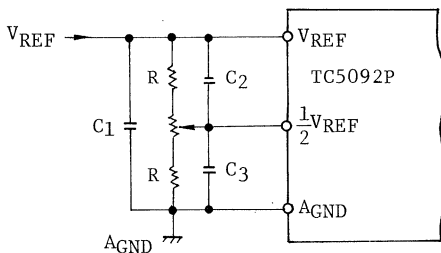


(5) Reference voltage

This LSI has three reference input voltage terminals of A_{GND} , $\frac{1}{2} V_{\text{REF}}$, and V_{REF} . Since analog input signal is quantized to 1/8192 in the range of $A_{\text{GND}} \sim A_{\text{REF}}$ for digitization, stable voltages must be supplied to $\frac{1}{2} V_{\text{REF}}$ and V_{REF} .

FUNCTIONAL DESCRIPTION

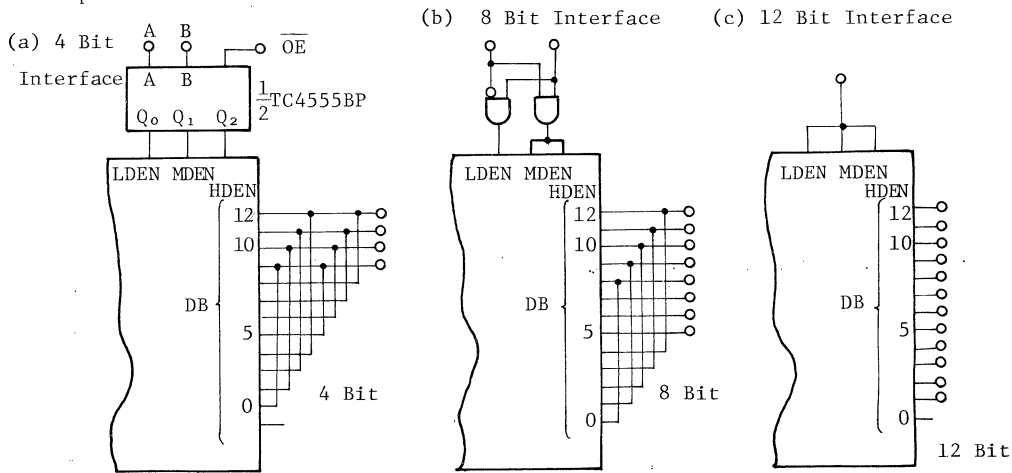
Espacially the value of $\frac{1}{2} V_{REF}$ voltage has direct effects upon conversion accuracy; therefore, it is recommended that adjustment be made so as to agree output data with analog input by actually making A/D convert by use of input voltage at FS (full scale) or 1/2FS level.



The left figure shows an example of reference voltage supplying circuit. $C_1 \sim C_3$ are filter capacitors for preventing reference voltage variations to be caused by ripple or induction noise. Generally the value of capacitor is about $0.01 \sim 0.1 \mu F$, though it varies with the system.

(6) BUS Interface

For connecting a microcomputer to BUS line, three independent enable terminals are used. These three enable terminals permit the processing in the unit of 4 bits (5 bits for the low order digit only). The microcomputer can be directly connected to the BUS of 4 ~ 12 bits easily by allocating proper address of microcomputer to the TC5092AP.



TC5092AP

RECOMMENDED OPERATING CONDITION

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VDD	4.5	5.0	5.5	V
Digital Input Voltage	VIN	0	-	VDD	V
Analog Input Voltage	VAIN	AGND	-	VREF	-
Reference Supply Voltage	VREF	4.0	-	VDD	V
Analog Ground Voltage	VAGND	0	0	0.5	V

ELECTRICAL CHARACTERISTICS (VDD = 5V ± 10%, VSS = 0V, Ta = -40 ~ 85°C)

ITEM	SYMBOL	TEST CONDITION	VDD	MIN.	TYP.	MAX.	UNIT
			(V)				
Output High Voltage	VOH	IOH = -1μA, Digital output	5	4.9	5.0	-	V
Output Low Voltage	VOL	IOL = 1μA, Digital output	5	-	0.0	0.1	
Input High Voltage	VIH	Digital Input except XIN	5	2.4	-	-	V
		XIN	5	4.5	-	-	
Input Low Voltage	VIL	Digital Input except XIN	5	-	-	0.8	
		XIN	5	-	-	0.5	
Output High Current	IOH	VOH = 2.4V Digital output except XOUT	4.75	-1.0	-	-	mA
Output Low Current	IOL	VOL = 0.4V Digital output except XOUT	4.75	1.6	-	-	mA
Output Disable Current	IDH	VOH = 5.5V, DB0 ~ DB12	5.5	-	10 ⁻³	5	μA
	IDL	VOL = 0.0V, DB0 ~ DB12	5.5	-	-10 ⁻³	-5	
Input Current	I _{IH}	VIN = 5.5V, Digital input	5.5	-	10 ⁻⁵	1.0	μA
	I _{IL}	VIL = 0.0V, Digital input	5.5	-	-10 ⁻⁵	-1.0	
Analog Switch Off-Leak	I _{OFF}	Analog input/output	5.5	-	±10 ⁻⁴	-	μA
Analog Switch On Resistor	RON	RL = 10kΩ	5	-	-	-	Ω
Operating Consumption Current	IDD	VREF = VDD Digital output open	fCP = 5MHz	5	-	2	mA
		Digital input GND	fCP = 1MHz	5	-	1	

SWITCHING CHARACTERISTICS (V_{DD} = 5V±10%, V_{SS} = 0V, T_a = 25°C, C_L = 50pF)

ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Rise Time	t _{TLH}	Digital output	-	50	150	ns
Output Fall Time	t _{THL}	Digital output	-	40	150	
Output Enable Time	t _{ZL} t _{ZH}	LDEN } MDEN } HDEN } -DB Output	-	80	250	ns
Output Disable Time	t _{LZ} t _{HZ}		-	280	500	
Max. Clock Frequency	f _{MAX} ∅	X _{IN} Duty 40~60%	5.0	-	-	
Min. Clock Frequency	f _{MIN} ∅	X _{IN} Duty 40~60%	-	-	-	MHz
Input Capacity	C _{IN}	Digital input	-	5	-	pF
	C _{IN}	Analog input	-	-	-	
3-State Output Capacity	C _{OUT}	DB Output	-	8	-	

 SYSTEM CHARACTERISTICS (V_{DD} = 5V±10%, V_{SS} = 0V, T_a = 25°C)

ITEM	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Resolution	n		-	13	-	Bit
Conversion Time	T _c	f _{CP} = 5 MHz	-	-	8.2	ms
		f _{CP} = 1 MHz	-	-	41	
Sampling Cycle	T _{SPL}	f _{CP} = 5 MHz	14.2	-	-	ms
		f _{CP} = 1 MHz	47	-	-	
Nonlinearity		V _{DD} = V _{REF}	-	±1		LSB
Zero Scale Error	EZP		-	±2		
Full Scale Error	EFS		-	±1		
STC Min. Pulse Width	t _w		-	-	2/f _{OSC}	S

TC5093AP

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC5093AP 8 BIT ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

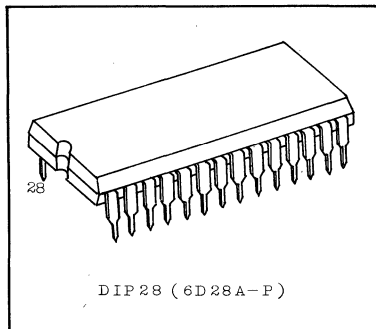
The TC5093AP is a monolithic CMOS 8 bit successive approximation A/D converter with 8 channel multiplex inputs. After an analog input channel is selected with channel select input (CH0 ~2) and channel latch input (CHL), when STC is set high EOC goes low at the leading edge of STC and the conversion starts.

After the conversion is completed, EOC returns high and the new data replace the previous data at DB0 ~DB7.

The TC5093AP has features of high speed, high accuracy and very low power consumption which make the device well suited to a broad application field such as process and machine control and automotive equipment.

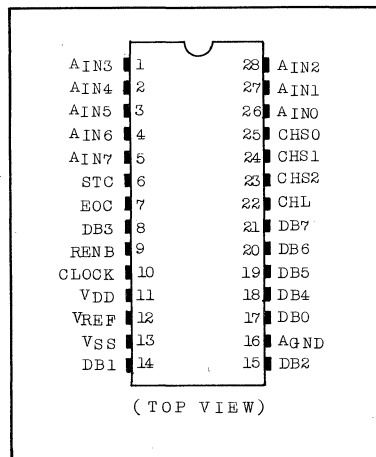
FEATURES

- High accuracy $\pm \frac{1}{2}$ LSB TYP
- High speed conversion 100 μ sec TYP @ $f_{cp}=640$ kHz
- Single power supply 5V \pm 10%
- Low power consumption 9mW MAX @ $T_a=25^\circ\text{C}$
- 8 channel analog multiplex input
- Easy interface to all microprocessors
- Zero or full scale adjustment free
- Latched 3-state output



DIP28 (6D28A-P)

PIN ASSIGNMENT

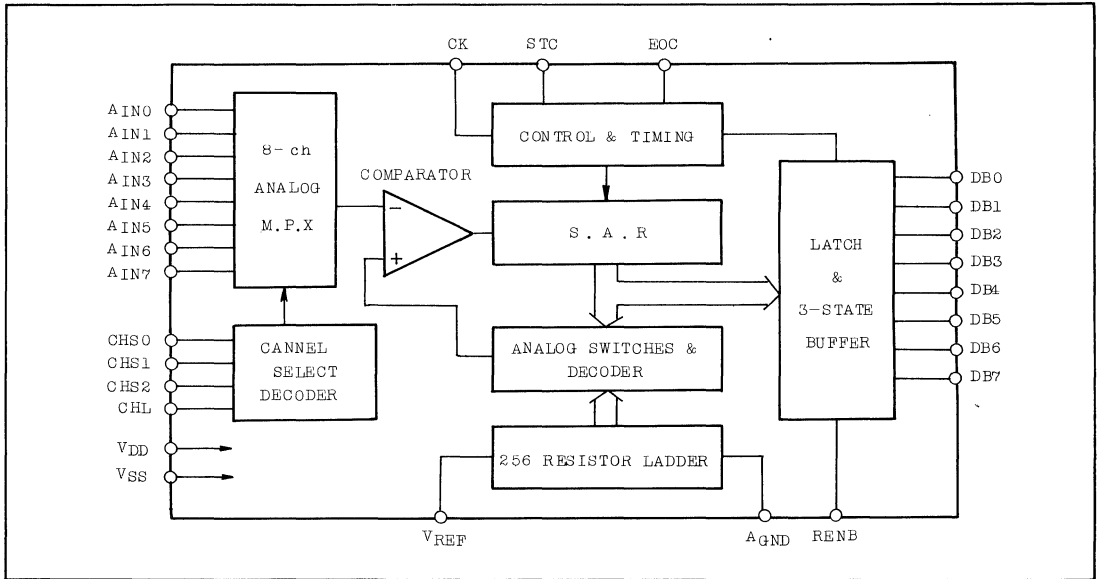


(TOP VIEW)

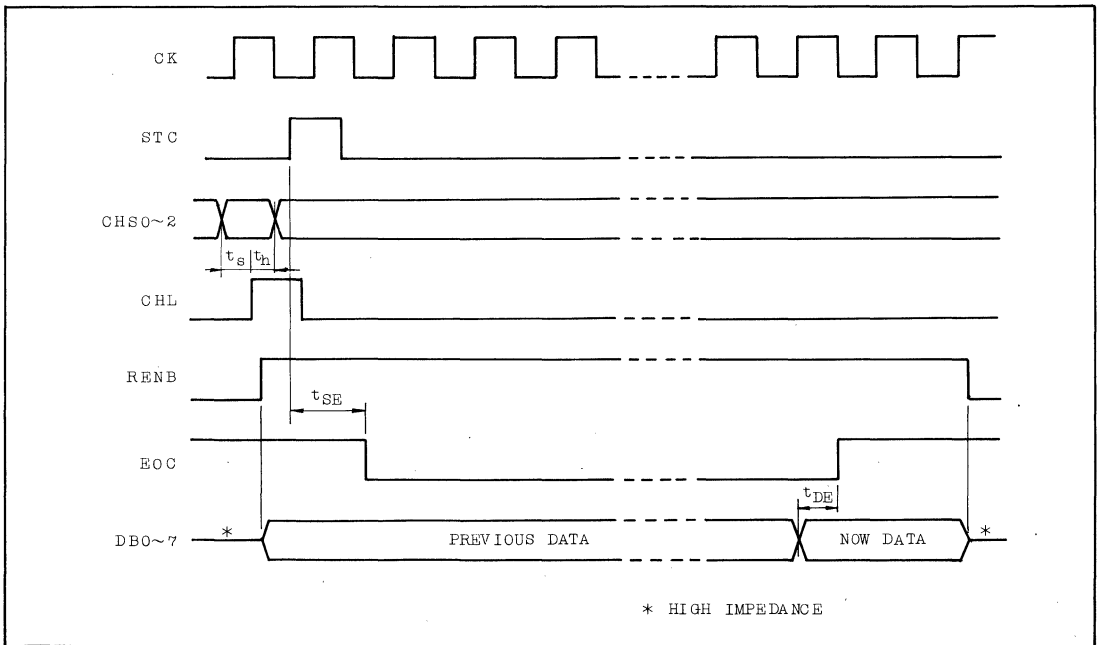
ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5~V _{SS} + 7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} + 0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} + 0.5	V
Reference Voltage	V _{REF}	V _{SS} -0.5~V _{DD} + 0.5	V
Analog Ground Voltage	AGND	V _{SS} -0.5~V _{DD} + 0.5	V
DC Input Current	I _{IN}	± 10	mA
Power Dissipation	P _D	300	mW
Storage Temperature	T _{STG}	-65 ~ 150	$^\circ\text{C}$
Lead Temperature 10 sec.	T _L	300	$^\circ\text{C}$

BLOCK DIAGRAM



TIMING CHART



TC5093AP

PIN & FUNCTION

PIN NO.	SYMBOL	PIN NAME & FUNCTION	PIN NO.	SYMBOL	PIN NAME & FUNCTION																																				
1	A _{IN3}	[ANALOG INPUT]	15	DB2	3-STATE PARALLEL DATA OUTPUT																																				
2	A _{IN4}	The analog input voltage applied to the selected channel is converted. Full range of input signal is to be from AGND to V _{REF} .	16	AGND	[ANALOG GROUND] AGND defines the zero level of A _{IN} .																																				
3	A _{IN5}		17	DB0	3-STATE PARALLEL DATA OUTPUT DB0 : LSB DB7 : MSB																																				
4	A _{IN6}		18	DB4																																					
5	A _{IN7}		19	DB5																																					
6	STC	[START CONVERSION] Conversion starts at the falling edge of STC.	20	DB6																																					
7	EOC	[END OF CONVERSION] EOC becomes low level at the rising edge of STC. And when the conversion is completed EOC returns to high level.	21	DB7																																					
8	DB3	3-STATE PARALLEL DATA OUTPUT	22	CHL	[CHANNEL LATCH INPUT] The channel select signals CHS0 ~2 are latched at the rising edge of CHL.																																				
9	RENB	[READ ENABLE] Output enable signal "H" = DB0 ~7 enable "L" = DB0 ~7 high impedance	23	CHS2	[CHANNEL SELECT INPUT] One of A _{IN0} ~ A _{IN7} is selected according to the status of CH0 ~ CH2.																																				
10	CLOCK	[CLOCK INPUT] Basic system clock	24	CHS2																																					
11	V _{DD}	[SYSTEM POWER SUPPLY] V _{DD} =5V ±10%	25	CHS0	<table border="1"> <thead> <tr> <th>CHS2</th> <th>CHS1</th> <th>CHS0</th> <th>ON CHANNEL</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>L</td> <td>A_{IN0}</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>A_{IN1}</td> </tr> <tr> <td>L</td> <td>H</td> <td>L</td> <td>A_{IN2}</td> </tr> <tr> <td>L</td> <td>H</td> <td>H</td> <td>A_{IN3}</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> <td>A_{IN4}</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>A_{IN5}</td> </tr> <tr> <td>H</td> <td>H</td> <td>L</td> <td>A_{IN6}</td> </tr> <tr> <td>H</td> <td>H</td> <td>H</td> <td>A_{IN7}</td> </tr> </tbody> </table>	CHS2	CHS1	CHS0	ON CHANNEL	L	L	L	A _{IN0}	L	L	H	A _{IN1}	L	H	L	A _{IN2}	L	H	H	A _{IN3}	H	L	L	A _{IN4}	H	L	H	A _{IN5}	H	H	L	A _{IN6}	H	H	H	A _{IN7}
CHS2	CHS1	CHS0			ON CHANNEL																																				
L	L	L			A _{IN0}																																				
L	L	H	A _{IN1}																																						
L	H	L	A _{IN2}																																						
L	H	H	A _{IN3}																																						
H	L	L	A _{IN4}																																						
H	L	H	A _{IN5}																																						
H	H	L	A _{IN6}																																						
H	H	H	A _{IN7}																																						
12	V _{REF}	[REFERENCE VOLTAGE] V _{REF} defines the full scale of A _{IN} .	26	A _{IN0}	[ANALOG INPUT]																																				
13	V _{SS}	[SYSTEM GROUND] V _{SS} =0V	27	A _{IN1}																																					
14	DB1	3-STATE PARALLEL DATA OUTPUT	28	A _{IN2}																																					

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Reference Voltage	V _{REF}	V _{DD} =5V, AGND=0V	3.5	V _{DD}	V _{DD}	V
Analog Ground Voltage	AGND	V _{DD} =5V, V _{REF} =5V	0.0	0.0	3.0	V
Voltage Between V _{REF} and AGND		V _{DD} =5V ± 10%	2.0	V _{DD}	V _{DD}	V
Clock Frequency	f _{CP}	V _{DD} =5V ± 10% Duty Cycle=50%	10	640	1280	kHz
Operating Temperature	T _{opr}		-40	-	+85	°C

DC ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

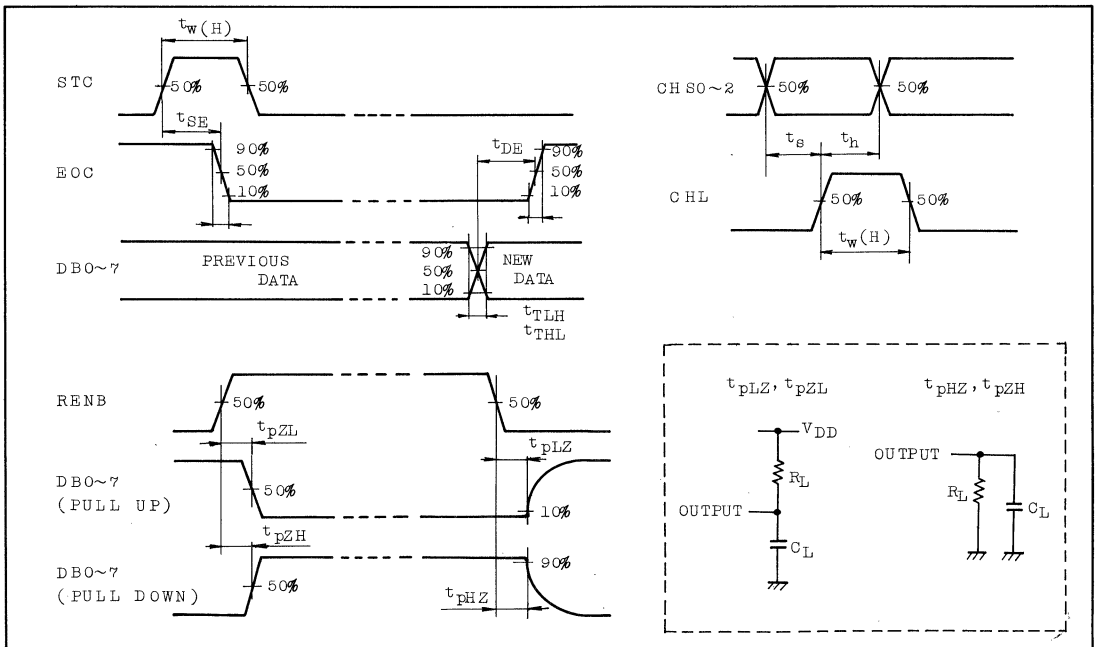
PARAMETER	SYMBOL	TEST CONDITION	-40°C			25°C			85°C		UNIT
			V _{DD}	MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5.0	4.95	-	4.95	5.00	-	4.95	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	5.0	-	0.05	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =4.6V V _{IN} =V _{SS} , V _{DD}	5.0	-1.2	-	-	-	-	-0.7	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	5.0	2.4	-	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, 4.5V	5.0	3.5	-	3.5	-	-	3.5	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, 4.5V	5.0	-	1.5	-	-	1.5	-	1.5	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =5.5V or V _{OL} =0.0V	5.5	-	±0.5	-	-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =5.5V or V _{IL} =0.0V	5.5	-	±0.3	-	-	±0.3	-	±1	μA
On Channel Input Current	I _{ON}	V _{IH} =5.5V or V _{IL} =0.0V f _{CP} = kHz	5.5	-	±2	-	-	±2	-	±5	μA
OFF Channel Input Current	I _{OFF}	V _{IH} =5.5V or V _{IL} =0.0V	5.5	-	±0.2	-	-	±0.2	-	±1	μA
Operating Current	I _{DD}	f _{CP} =1 MHz	5.0	-	2.0	-	-	1.8	-	2.0	mA
Reference Resistance	R _{REF}		-	4.0	1.7	4.3	7.5	17	4.3	19	kΩ

TC5093AP

SWITCHING CHARACTERISTICS (V_{DD}=5.0V, T_a=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-	50	100	nS
Propagation Delay Time (STC - EOC)	t _{SE}	C _L =50pF	10	1/2 CLOCK + 200	1/2 CLOCK + 600	
Data-EOC Time	t _{DE}	C _L =50pF	1 CLOCK - 300	1 CLOCK - 70	1 CLOCK	
3-State Output Enable Time	t _{pZH}	C _L =50pF R _L =1k	-	85	200	
	t _{pZL}					
3-State Output Disable Time	t _{pLZ}						85	200
				65	200	
Minimum Pulse Width (STC, CHL)	t _{w(H)}	C _L =50pF	-	40	100	
Minimum Set-up Time (CHSO ~2)	t _s	C _L =50pF	-	2	50	
Minimum Hold Time (CHSO ~2)	t _h	C _L =50pF	-	0	50	
Input Capacitance	C _{IN1}	Digital Input	-	5	-	pF
Input Capacitance	C _{IN2}	Analog In(ON)	-	-	-	
Input Capacitance	C _{IN3}	Analog In(OFF)	-	-	-	
Output Capacitance	C _{OUT}	3-State Out	-	10	-	

SWITCHING CHARACTERISTICS TEST WAVEFORM



SYSTEM CHARACTERISTICS (T_a=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.0V V _{REF} =5.000V t _{CP} =1 MHz	-	± $\frac{1}{4}$	±1	LSB
Full Scale Error	E _{FS}		-	± $\frac{1}{2}$	±1	
Nonlinearity Error	E _{LI}		-	± $\frac{1}{2}$	±1	
Conversion Time	T _C	f _{CP} =640 kHz	-	100		μs
		f _{CP} =1280 kHz	-	50		

TC35094P

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC35094P 8 BIT ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35094P is a monolithic CMOS 8 bit successive approximation A/D converter. The TC35094P consists of a high speed chopper stabilized comparator, a 256 resistor ladder with analog switches, 3 state latched buffers and a microprocessor compatible control logic.

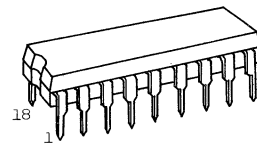
When STC is set high, EOC goes to low level and the conversion starts.

After the conversion is completed the new data replace the previous data at DB0~DB7 and EOC returns to high level.

The TC35094P has features of high speed, high accuracy and very low power consumption which make the device well suited to a broad application field such as data communication, process and machine control and automotive equipment.

FEATURES

- High accuracy $\pm\frac{3}{4}$ LSB MAX
- High speed conversion 19 μ sec MAX @ $f_{cp}=2$ MHz
- Single power supply 5V \pm 10%
- Low power consumption 7.5mW MAX @ $T_a=25^\circ$ C
- Zero or full scale adjustment free
- Easy interface to all microprocessors
- Latched 3-state output
- LSTTL and CMOS compatible output

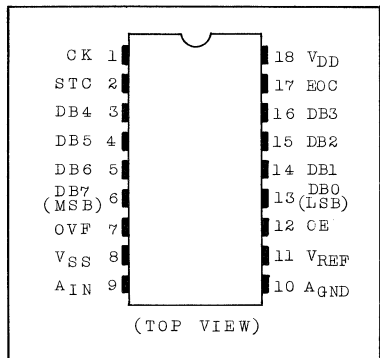


DIP18(3D18A-P)

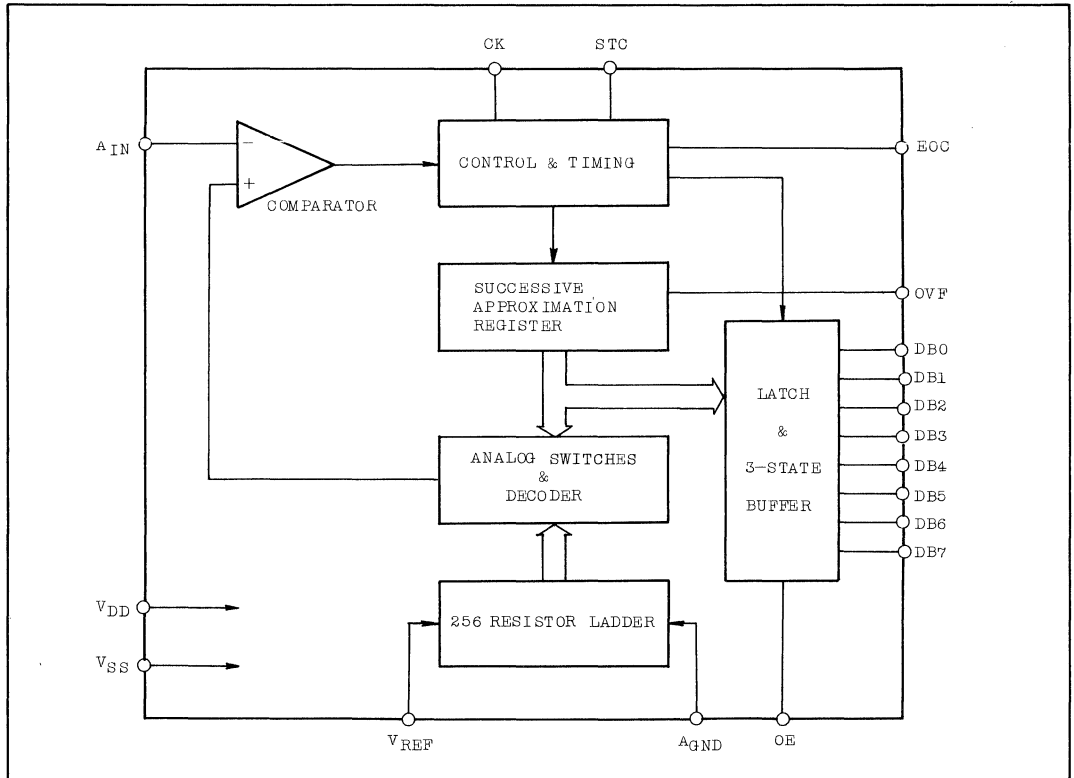
ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply voltage Range	V_{DD}	$V_{SS}-0.5\sim V_{SS}+7$	V
DC Input Voltage	V_{IN}	$V_{SS}-0.5\sim V_{DD}+0.5$	V
DC Output Voltage	V_{OUT}	$V_{SS}-0.5\sim V_{DD}+0.5$	V
Reference Voltage	V_{REF}	$V_{SS}-0.5\sim V_{DD}+0.5$	V
Analog Ground Voltage	A_{GND}	$V_{SS}-0.5\sim V_{DD}+0.5$	V
DC Input Current	I_{IN}	± 10	mA
Power Dissipation	P_D	300	mW
Storage Temperature	T_{stg}	-65 ~ 150	$^\circ$ C
Lead Temperature 10sec.	T_L	300	$^\circ$ C

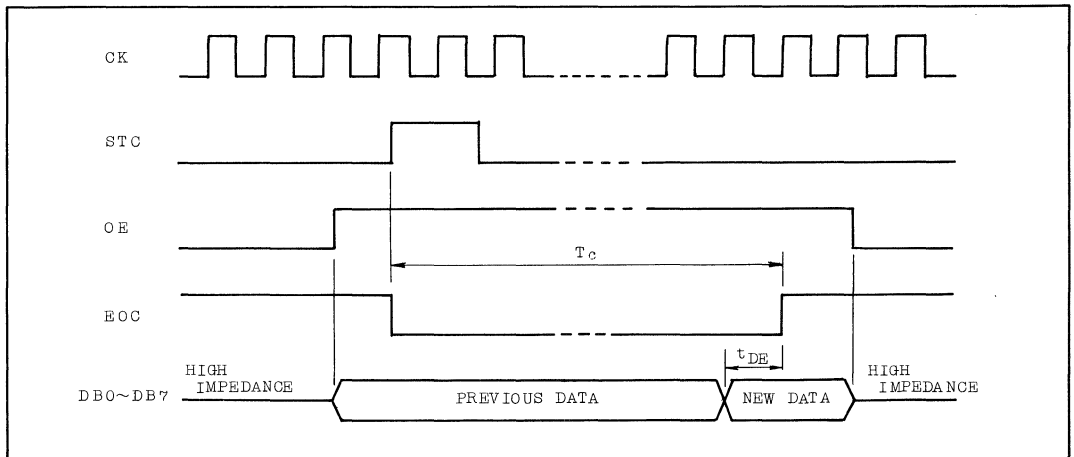
PIN ASSIGNMENT



BLOCK DIAGRAM



TIMING CHART



TC35094P

PIN & FUNCTION

PIN NO.	SYMBOL	PIN NAME & FUNCTION	PIN NO.	SYMBOL	PIN NAME & FUNCTION		
1	CK	[CLOCK INPUT] Basic system clock	10	A _{GND}	[ANALOG GROUND] A _{GND} defines the zero level of A _{IN} .		
2	STC	[START CONVERSION] Command for starting conversion. Conversion starts at the rising edge of STC.	11	V _{REF}	[REFERENCE VOLTAGE] V _{REF} defines the full scale of A _{IN} .		
3	DB4	[3-STATE PARALLEL] DATA OUTPUT The new data replaces the previous data one clock cycle before the rising edge of EOC. DB0 : LSB DB7 : MSB	12	OE	[OUTPUT ENABLE] Data DB0~DB7 are enabled when OE is set high, and data output DB0~DB7 become high impedance when OE is set low level.		
4	DB5						
5	DB6						
6	DB7						
7	OVF	[OVER FLOW] OVF goes to high level in case that the input analog signal exceeds the full scale.	13	DB0	[3-STATE PARALLEL] DATA OUTPUT		
					14	DB1	The new data replaces the previous data one clock before the rising edge of EOC.
							15	DB2	DB0 : LSB DB7 : MSB
16	DB3						
		8	V _{SS}	[SYSTEM GROUND] V _{SS} = 0V	17	EOC	[END OF CONVERSION] EOC becomes low level at the rising edge of STC. And when the conversion is completed EOC returns to high level.
9	A _{IN}	[ANALOG INPUT] Full range of input signal is to be from A _{GND} to V _{REF} .	18	V _{DD}			[SYSTEM POWER SUPPLY] V _{DD} = 5V ± 10%

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Reference Voltage	V _{REF}	V _{DD} =5V, A _{GND} =0V	2.0	V _{DD}	V _{DD}	V
Analog Ground Voltage	A _{GND}	V _{DD} =5V, V _{REF} =5V	0.0	0.0	3.0	V
Voltage Between V _{REF} and A _{GND}		V _{DD} =5V±10%	2.0	V _{DD}	V _{DD}	V
Clock Frequency	f _{CP}	V _{DD} =5V±10%	10	1500	2000	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V±10%	250	333	-	nS
Operating Temperature	Topr		-40	-	+85	°C

 DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V ± 10%, V_{SS}=0V)

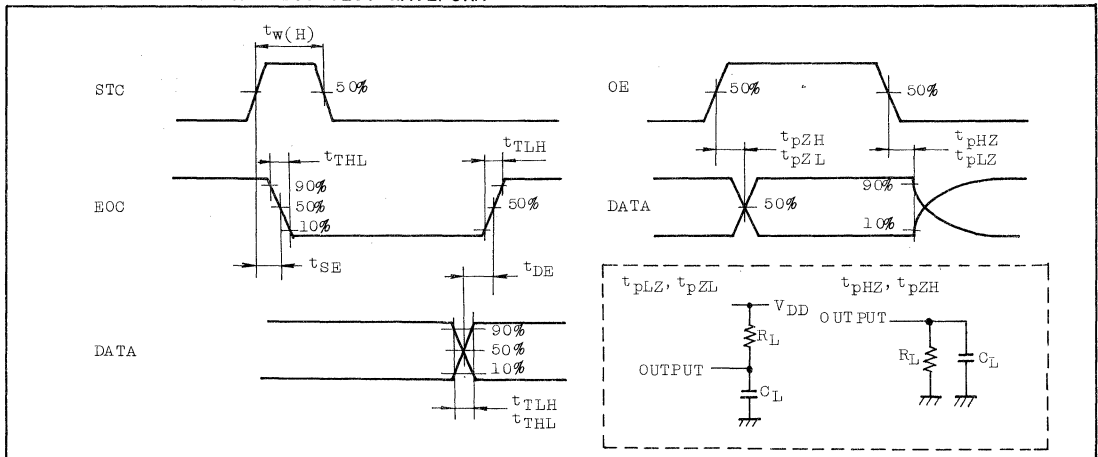
PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 ~ 85°C		UNIT
			MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} - 0.05	V _{DD}	-	V _{DD} - 0.05	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 ×V _{DD}	-	-	0.7 ×V _{DD}	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V		-	0.3 ×V _{DD}		0.3 ×V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V		-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.3	-	±1	μA
Analog Input Current	I _{AIN}	Conversion Cycle =10KHz V _{IH} =V _{REF} or V _{IL} =0.0V	-	-	±3	-	±6	μA
Operating Current	I _{DD}	f _{CP} =2MHz	-	-	1.7	-	2.1	mA
Reference Resistance	R _{REF}		2.5	5.1	8.2	2.3	9.0	kΩ

TC35094P

SWITCHING CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V, T_a=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-	-	100	nS
3-State Output Enable Time	t _{pZH} t _{pZL}	C _L =50pF	-	-	200	
3-State Output Disable Time	t _{pHZ} t _{pLZ}	R _L =1k	-	-	200	
Minimum Pulse Width (STC)	t _{w(H)}	C _L =50pF	-	-	150	
Propagation Delay Time (STC-EOC)	t _{SE}	C _L =50pF	-	-	150	
Data-EOC Time	t _{DE}	C _L =50pF	-	-1 clock	0	-
Input Capacitance	C _{IN1}	Digital Input	-	5	-	pF
Input Capacitance	C _{IN2}	Analog Input	-			
Output Capacitance	C _{OUT}	3-State Out	-	10	-	

SWITCHING CHARACTERISTICS TEST WAVEFORM



SYSTEM CHARACTERISTICS (T_a=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.0V V _{REF} =5.000V f _{cp} =2MHz	-	±1/4	±1/2	LSB
Full Scale Error	E _{FS}		-	±1/4	±1/2	
Nonlinearity Error	E _{LI}		-	±1/4	-	
Total Error	E _T		-	±1/4	±3/4	
Conversion Time	TC	f _{cp} =1MHz		38		μS
		f _{cp} =2MHz		19		

TC35095P 8 BIT 8-CH SERIAL I/O ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35095P is a monolithic CMOS 8 bit successive approximation A/D converter with serial I/O and 8 channel multiplex inputs.

Conversion start when \overline{CS} is set low and start bit ("L" level) and channel select bit (three bits) are given to serial input DI.

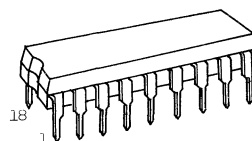
In case that \overline{SE} is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

In case that \overline{SE} is low, after the conversion is completed a start bit, 8 bit conversion data (LSB first) and a stop bit appear at DO.

The TC35095P has features of high speed, high accuracy and microprocessor compatible I/O which make the device well suited to a broad application field such as process and machine control and automotive equipment.

FEATURES

- High accuracy $\pm \frac{3}{4}$ LSB MAX
- High speed conversion 35 μ sec MAX @ f_{cp} =400kHz
- Single Power supply 5V \pm 10%
- Low Power consumption 5mW MAX @ T_a =25°C
- Serial I/O
- 8 channel analog multiplex input
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free

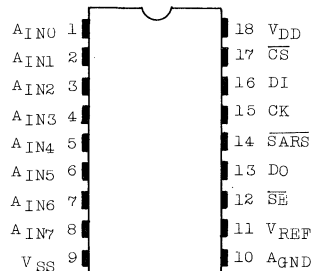


DIP18(3D18A-P)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5~V _{SS} +7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
Reference Voltage	V _{REF}	V _{SS} -0.5~V _{DD} +0.5	V
Analog Ground Voltage	A _{GND}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	\pm 10	mA
Power Dissipation	P _D	300	mW
Storage Temperature	T _{stg}	-65 ~ 150	°C
Lead Temperature 10sec.	T _L	300	°C

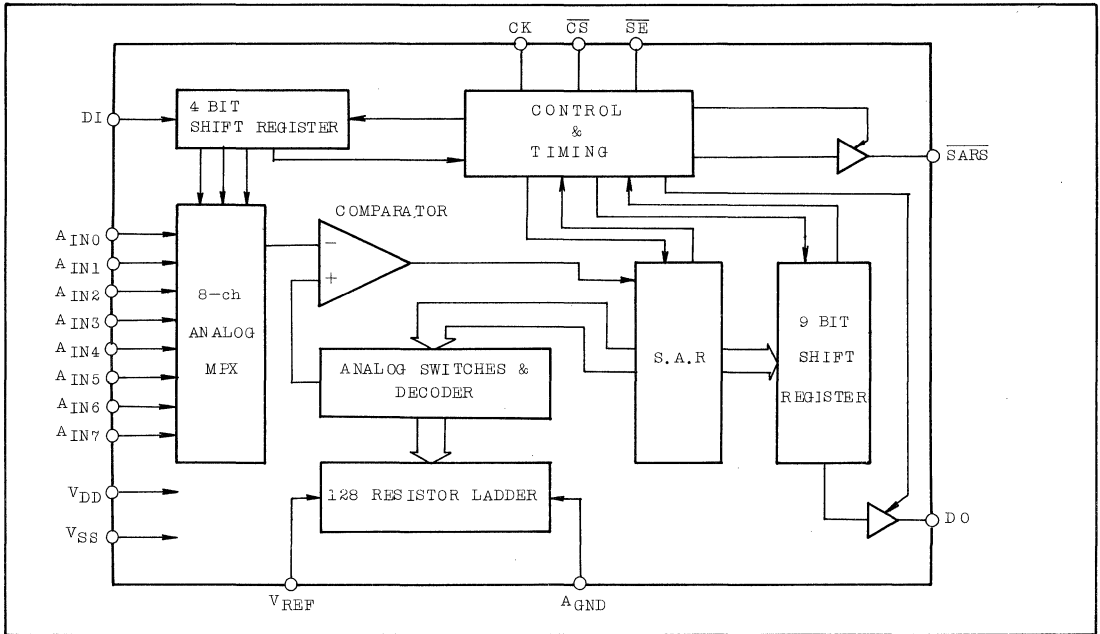
PIN ASSIGNMENT



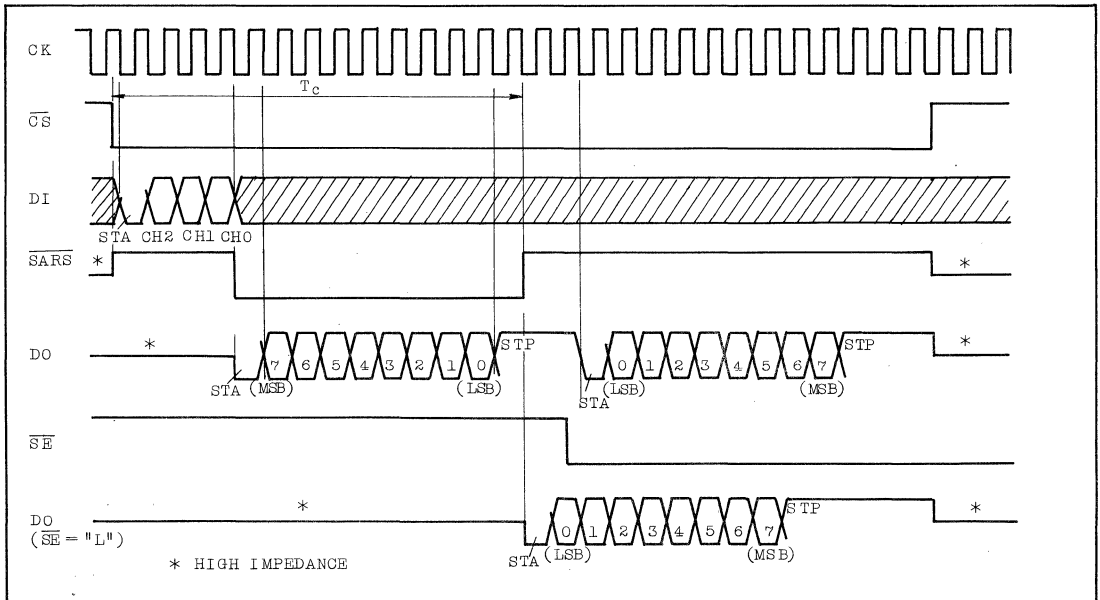
(TOP VIEW)

TC35095P

BLOCK DIAGRAM



TIMING CHART



PIN & FUNCTION

PIN NO.	SYMBOL	PIN NAME & FUNCTION	PIN NO.	SYMBOL	PIN NAME & FUNCTION																																							
1	A _{IN0}	<p>[ANALOG INPUT]</p> <p>One of A_{IN0} ~ A_{IN7} is selected according to the serial channel select bit applied on DI input. Full range of input signal is to be from A_{GND} to V_{REF}.</p> <table border="1"> <thead> <tr> <th rowspan="2">ON Channel</th> <th colspan="3">DI Serial Data</th> </tr> <tr> <th>CH2</th> <th>CH1</th> <th>CH0</th> </tr> </thead> <tbody> <tr> <td>A_{IN0}</td> <td>L</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN1}</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>A_{IN2}</td> <td>L</td> <td>H</td> <td>L</td> </tr> <tr> <td>A_{IN3}</td> <td>L</td> <td>H</td> <td>H</td> </tr> <tr> <td>A_{IN4}</td> <td>H</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN5}</td> <td>H</td> <td>L</td> <td>H</td> </tr> <tr> <td>A_{IN6}</td> <td>H</td> <td>H</td> <td>L</td> </tr> <tr> <td>A_{IN7}</td> <td>H</td> <td>H</td> <td>H</td> </tr> </tbody> </table>	ON Channel	DI Serial Data			CH2	CH1	CH0	A _{IN0}	L	L	L	A _{IN1}	L	L	H	A _{IN2}	L	H	L	A _{IN3}	L	H	H	A _{IN4}	H	L	L	A _{IN5}	H	L	H	A _{IN6}	H	H	L	A _{IN7}	H	H	H	10	A _{GND}	[ANALOG GROUND] A _{GND} defines the zero level of A _{IN} .
ON Channel	DI Serial Data																																											
	CH2		CH1	CH0																																								
A _{IN0}	L		L	L																																								
A _{IN1}	L		L	H																																								
A _{IN2}	L		H	L																																								
A _{IN3}	L		H	H																																								
A _{IN4}	H		L	L																																								
A _{IN5}	H	L	H																																									
A _{IN6}	H	H	L																																									
A _{IN7}	H	H	H																																									
2	A _{IN1}	11	V _{REF}	[REFERENCE VOLTAGE] V _{REF} defines the full scale of A _{IN} .																																								
3	A _{IN2}	12	\overline{SE}	[SELECT INPUT] \overline{SE} determines the order of output data. \overline{SE} ="L" LSB first \overline{SE} ="H" MSB first																																								
4	A _{IN3}	13	DO	[DATA OUTPUT] Output data is sent out in series.																																								
5	A _{IN4}	14	\overline{SARS}	[SAR STATUS] When a start bit ("L" level) is detected at DI input, \overline{SARS} is set "L" level and conversion starts. When conversion is completed, \overline{SARS} returns to "H" level.																																								
6	A _{IN5}	15	CK	[CLOCK INPUT] Basic system clock. Duty cycle is to be 50%.																																								
7	A _{IN6}	16	DI	[DATA INPUT] For starting the conversion a start bit ("L" level) and channel select bit (from CH2 to CH0 in order) are to be applied.																																								
8	A _{IN7}	17	\overline{CS}	[CHIP SELECT] At the falling edge of \overline{CS} , the device is set stand-by for conversion. When \overline{CS} is "H" the device is reset and all outputs become high impedance.																																								
9	V _{SS}	[DIGITAL GROUND]	18	V _{DD}	[Power Supply] 5V ± 10%																																							

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Reference Voltage	V _{REF}	V _{DD} =5V, AGND=0V	2.0	V _{DD}	V _{DD}	V
Analog Ground Voltage	AGND	V _{DD} =5V, V _{REF} =5V	0.0	0.0	3.0	V
Voltage Between V _{REF} and AGND		V _{DD} =5V±10%	2.0	V _{DD}	V _{DD}	V
Clock Frequency	f _{CP}	V _{DD} =5V±10%	-	-	400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V±10%	0.63	1.25	-	μs
Operating Temperature	T _{opr}		-40	-	+85	°C

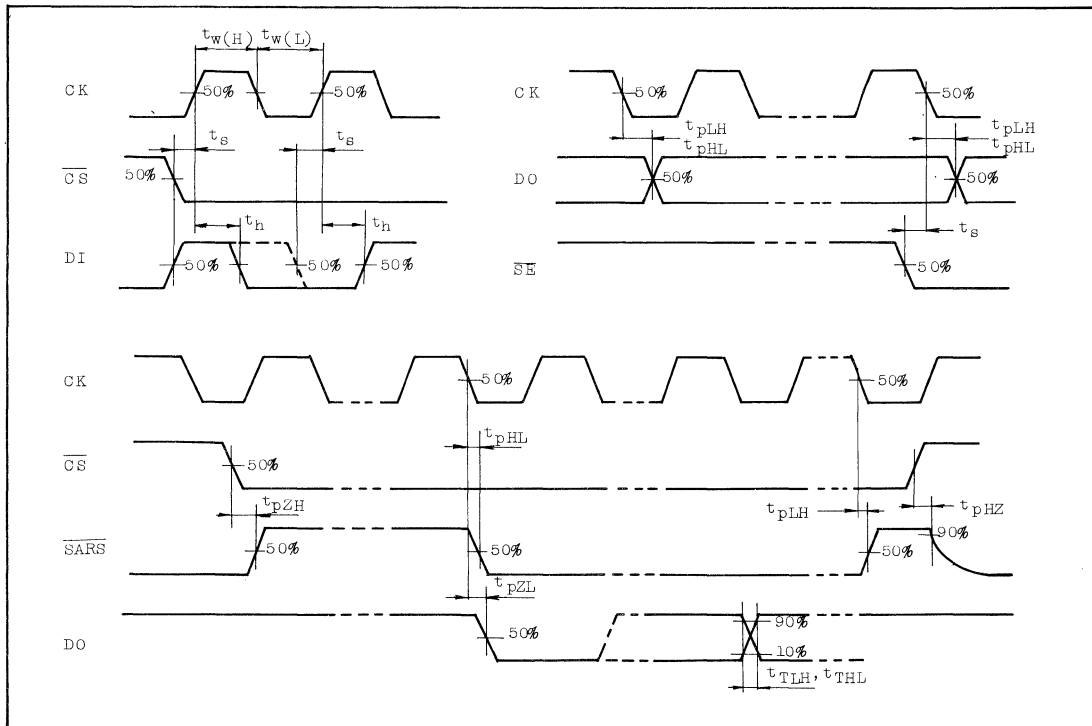
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V ± 10%, V_{SS}=0V)

PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 ~ 85°C		UNIT
			MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} -0.05	V _{DD}	-	V _{DD} -0.05	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 × V _{DD}	-	-	0.7 × V _{DD}	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V		-	0.3 × V _{DD}	-	0.3 × V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V		-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.3	-	±1	μA
ON Channel Input Current	I _{ON}	V _{IH} =V _{REF} or V _{IL} =0.0V f _{CP} =400kHz	-	-	±2	-	±5	μA
OFF Channel Input Current	I _{OFF}	V _{IH} =V _{DD} or V _{IL} =0.0V	-	-	±0.2	-	±1	μA
Operating Current	I _{DD}	f _{CP} =400kHz	-	-	1.1	-	1.4	mA
Reference Resistance	R _{REF}		1.4	2.6	3.8	1.2	4.2	kΩ

SWITCHING CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V, Ta=25°C)

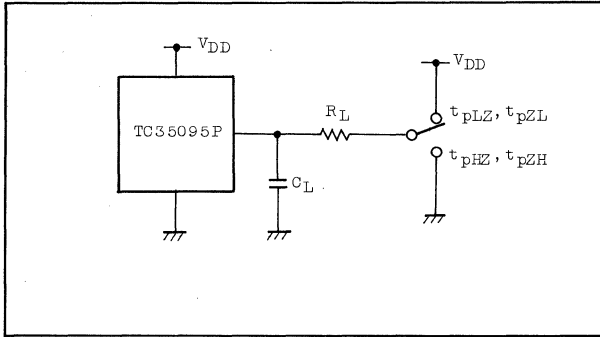
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-		100	nS
Propagation Delay Time (CK-Data)	t _{pLH} t _{pHL}	C _L =50pF	-		250	
Propagation Delay Time (CK-SARS)	t _{pLH} t _{pHL}	C _L =50pF	-		250	
3-State Output Enable Time (CS-SARS, SARS-Data)	t _{pZH} t _{pZL}	C _L =50pF	-		200	
3-State Output Disable Time (CS-SARS, Data)	t _{pHZ} t _{pLZ}	R _L =1k	-		200	
Minimum Pulse Width (CS)	t _{w(H)}	C _L =50pF	-		100	
Minimum Set-up Time (CS, SE, DI)	t _s	C _L =50pF	-		150	
Minimum Hold Time (DI)	t _h	C _L =50pF	-		50	
Input Capacitance	C _{IN1}	Digital Input	-	5	-	pF
Input Capacitance	C _{IN2}	Analog In(ON)	-	5	-	
Input Capacitance	C _{IN3}	Analog In(OFF)	-	5	-	
Output Capacitance	C _{OUT}	3-State Out	-	10	-	

SWITCHING CHARACTERISTICS TEST WAVEFORM



TC35095P

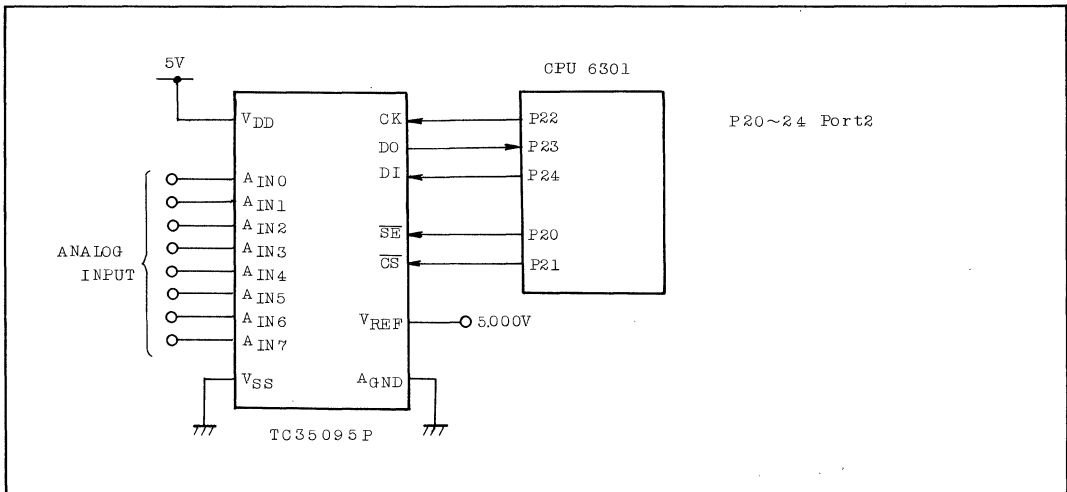
3-STATE OUTPUT TEST CIRCUIT



SYSTEM CHARACTERISTICS (T_a = -40 ~ 85°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.0V V _{REF} =5.000V f _{CP} =400kHz Duty=50%	-	±1/4	±1/2	LSB
Full Scale Error	E _{FS}		-	±1/4	±1/2	
Nonlinearity Error	E _{LI}		-	±1/4	-	
Total Error	E _T		-	±1/4	±3/4	
Conversion Time	T _C	f _{CP} =400kHz	-	35	36.5	μS

APPLICATION CIRCUIT (EXAMPLE) $T_c = \frac{14}{f_{cp}} \pm \alpha$ $0 < \alpha < \frac{1}{2f_{cp}}$



TC35096P 8 BIT 4-CH SERIAL I/O ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35096P is a monolithic CMOS 8 bit successive approximation A/D converter with serial I/O and 4 channel multiplex inputs.

Conversion start when \overline{CS} is set low and start bit ("L" level) and channel select bit (two bits) are given to serial input DI.

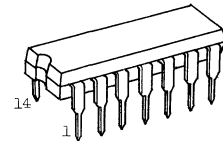
In case that \overline{SE} is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

In case that \overline{SE} is low, after the conversion is completed a start bit, 8 bit conversion data (LSB first) and a stop bit appear at DO.

The TC35096P has features of high speed, high accuracy and microprocessor compatible I/O which make the device well suited to a broad application field such as process and machine control and automotive equipment.

FEATURES

- High accuracy $\pm \frac{3}{4}$ LSB MAX
- High speed conversion 32.5 μ s MAX @ $f_{CP}=400$ kHz
- Single power supply 5V $\pm 10\%$
- Low power consumption 5 mW MAX @ $T_a=25^\circ\text{C}$
- Serial I/O
- 4 channel analog multiplex input
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free

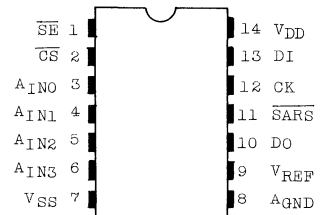


DIP 14 (3D14A-F)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5 ~ V _{SS} +7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Reference Voltage	V _{REF}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Analog Ground Voltage	A _{GND}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	± 10	V
Power Dissipation	P _D	300	mA
Storage Temperature	T _{stg}	-65 ~ 150	$^\circ\text{C}$
Lead Temperature 10 sec.	T _L	300	$^\circ\text{C}$

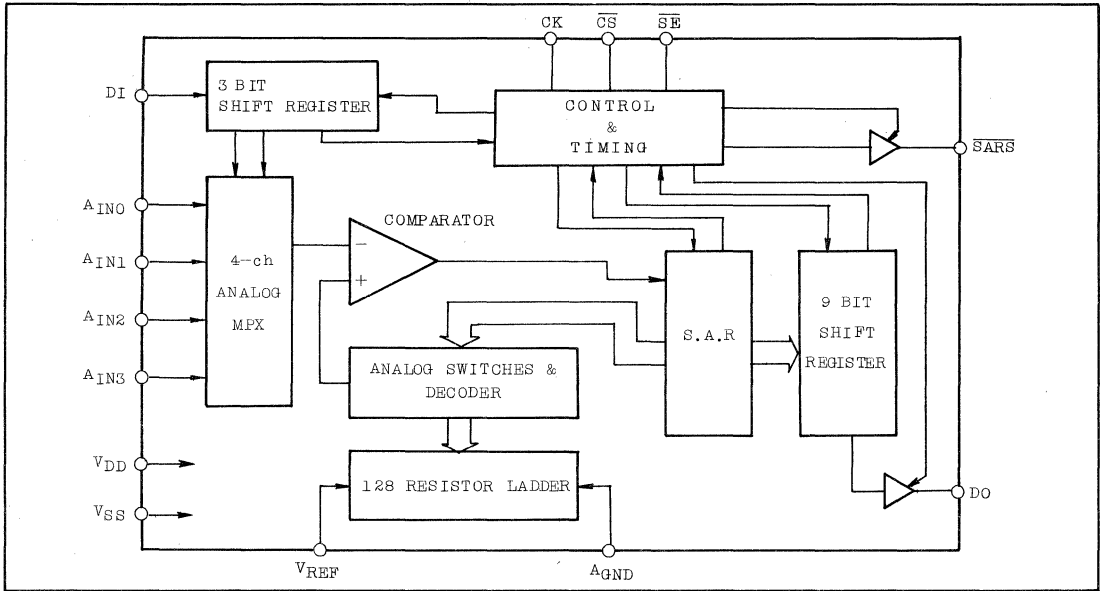
PIN ASSIGNMENT



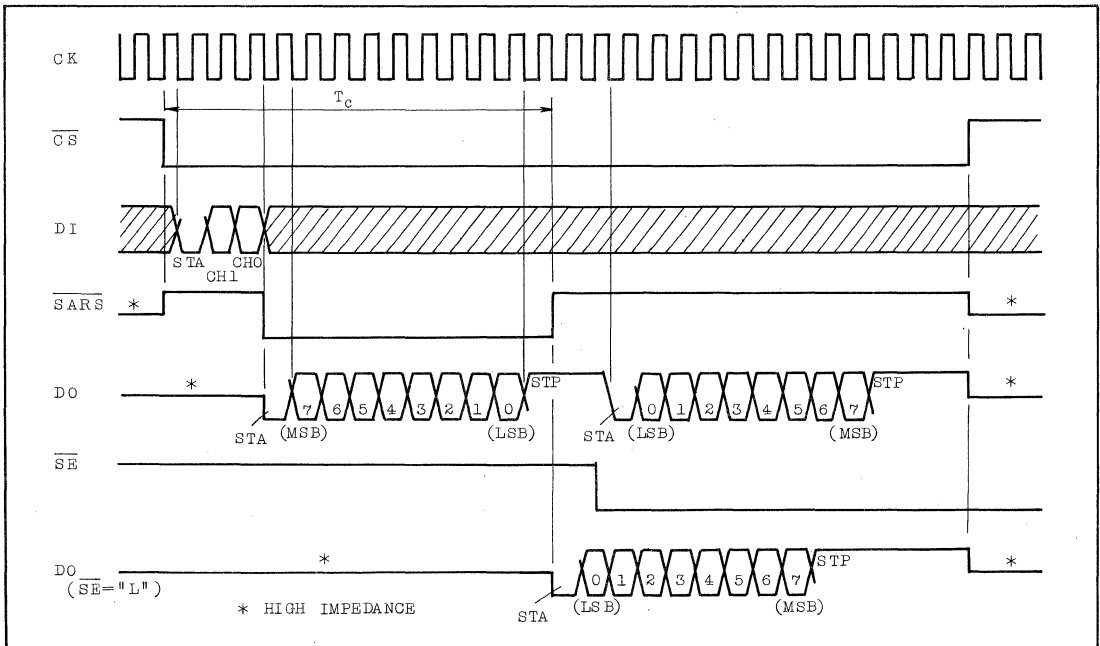
(TOP VIEW)

TC35096P

BLOCK DIAGRAM



TIMING CHART



PIN & FUNCTION

PIN NO.	SYMBOL	PIN NAME & FUNCTION	PIN NO.	SYMBOL	PIN NAME & FUNCTION																	
1	\overline{SE}	[SELECT] \overline{SE} determines the order of output data. \overline{SE} = "L" LSB first \overline{SE} = "H" MSB first	8	$AGND$	[ANALOG GROUND] $AGND$ defines the zero level of A_{IN} .																	
2	\overline{CS}	[CHIP SELECT] At the falling edge of \overline{CS} , the device is set stand-by for conversion. When \overline{CS} is "H" the device is reset and all outputs become high impedance.	9	V_{REF}	[REFERENCE VOLTAGE] V_{REF} defines the full scale of A_{IN} .																	
			10	DO	[DATA OUTPUT] Output data is sent out in series.																	
3	A_{IN0}	[ANALOG INPUT] One of $A_{IN0} \sim A_{IN3}$ is selected according to the serial channel select bit applied on DI input. Full range of input signal is to be from $AGND$ to V_{REF} .	11	\overline{SARS}	[SAR STATUS] When a start bit ("L" level) is detected at DI input, \overline{SARS} is set "L" level and conversion starts. When conversion is completed \overline{SARS} returns to "H" level.																	
4	A_{IN1}																					
5	A_{IN2}																					
6	A_{IN3}																					
<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">ON Channel</th> <th colspan="2">DI Serial Data</th> </tr> <tr> <th>CH1</th> <th>CH0</th> </tr> </thead> <tbody> <tr> <td>A_{IN0}</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN1}</td> <td>L</td> <td>H</td> </tr> <tr> <td>A_{IN2}</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN3}</td> <td>H</td> <td>H</td> </tr> </tbody> </table>			ON Channel	DI Serial Data		CH1	CH0	A_{IN0}	L	L	A_{IN1}	L	H	A_{IN2}	L	L	A_{IN3}	H	H	12	CK	[CLOCK INPUT] Basic system clock. Duty cycle is to be 50%.
ON Channel	DI Serial Data																					
	CH1	CH0																				
A_{IN0}	L	L																				
A_{IN1}	L	H																				
A_{IN2}	L	L																				
A_{IN3}	H	H																				
			13	DI	[DATA INPUT] For starting conversion, a start bit ("L" level) and channel select bit (from CH1 to CH0 in order) are to be applied.																	
7	V_{SS}	[DIGITAL GROUND]	14	V_{DD}	[POWER SUPPLY] 5V ± 10%																	

TC35096P

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

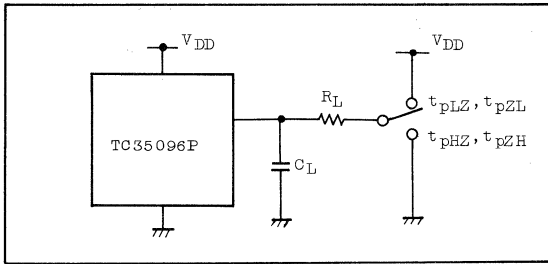
PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Reference Voltage	V _{REF}	V _{DD} =5V, AGND=0V	2.0	V _{DD}	V _{DD}	V
Analog Ground Voltage	AGND	V _{DD} =5V, V _{REF} =5V	0.0	0.0	3.0	V
Voltage Between V _{REF} and AGND		V _{DD} =5V ±10%	2.0	V _{DD}	V _{DD}	V
Clock Frequency	f _{CD}	V _{DD} =5V ±10%	-	-	400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V ±10%	0.63	1.25	-	μs
Operating Temperature	t _{opr}		-40	-	+85	°C

DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V)

PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 85°C		
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} - 0.05	V _{DD}	-	V _{DD} - 0.05	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 × V _{DD}	-	-	0.7 × V _{DD}	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V		-	0.3 × V _{DD}	-	0.3 × V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V		-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.3	-	±1	μA
ON Channel Input Current	I _{ON}	V _{IH} =V _{REF} or V _{IL} =0.0V f _{CP} =400kHz		-	±2	-	±5	μA
OFF Channel Input Current	I _{OFF}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.2	-	±1	μA
Operating Current	I _{DD}	f _{CP} =400kHz		-	1.1		1.4	mA
Reference Resistance	R _{REF}		1.4	2.6	3.8	1.2	4.2	kΩ

TC35096P

3-STATE OUTPUT TEST CIRCUIT

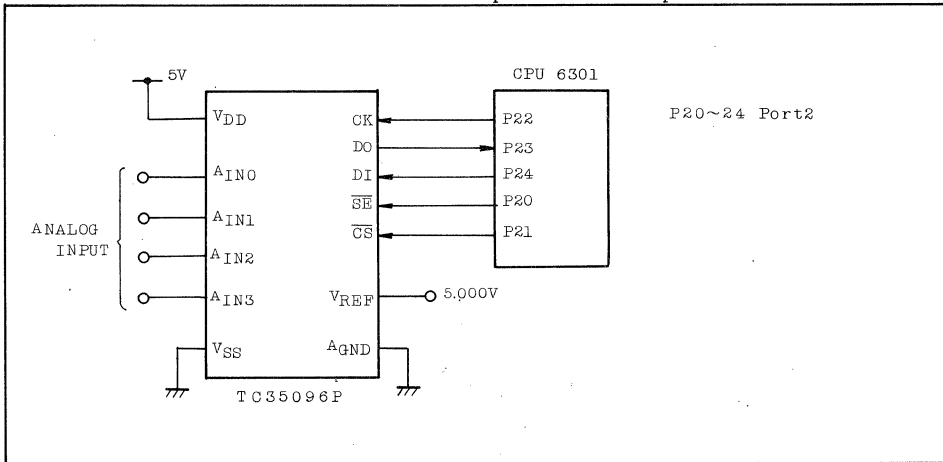


SYSTEM CHARACTERISTICS (T_a = -40 ~ 85°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.0V V _{REF} =5.000V f _{cp} =400kHz Duty=50%	-	±1/4	±1/2	LSB
Full Scale Error	E _{FS}		-	±1/4	±1/2	
Nonlinearity Error	E _{LI}		-	±1/4	-	
Total Error	E _T		-	±1/4	±3/4	
Conversion Time	TC	f _{cp} =400kHz	-	32.5	34	μS

APPLICATION CIRCUIT (EXAMPLE)

$$T_c = \frac{13}{f_{cp}} \pm \alpha \quad 0 < \alpha < \frac{1}{2f_{cp}}$$



TC35097P 8 BIT 2-CH SERIAL I/O ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35097P is a monolithic CMOS 8 bit successive approximation A/D converter with serial I/O and 2 channel multiplex inputs.

Conversion start when \overline{CS} is set low and start bit ("L" level) and channel select bit are given to serial input DI.

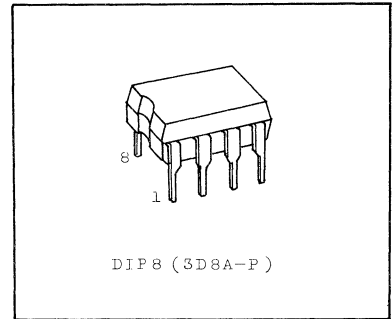
As soon as conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

The device requires no external zero and full scale adjustments.

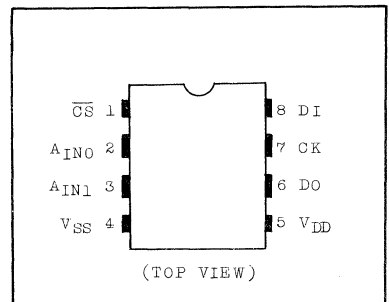
The TC35097P has features of high speed, high accuracy and microprocessor compatible I/O which make the device well suited to a broad application field such as process and machine control, automotive equipment and consumer apparatus.

FEATURES

- High accuracy $\pm \frac{3}{4}$ LSB MAX
- High speed conversion 30 μ sec MAX @ $f_{CP}=400$ KHz
- Single power supply 5V \pm 10%
- Low power consumption 17.5mW MAX @ $T_a=25^\circ$ C
- Serial I/O
- 2 channel analog multiplex input
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free



PIN ASSIGNMENT

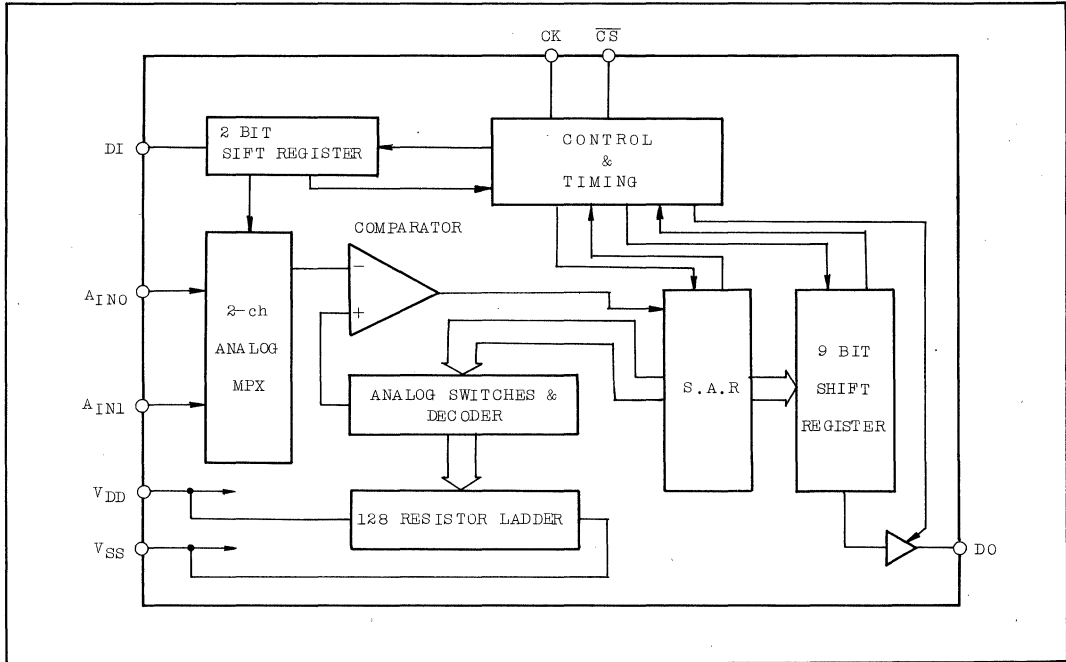


ABSOLUTE MAXIMUM RATINGS

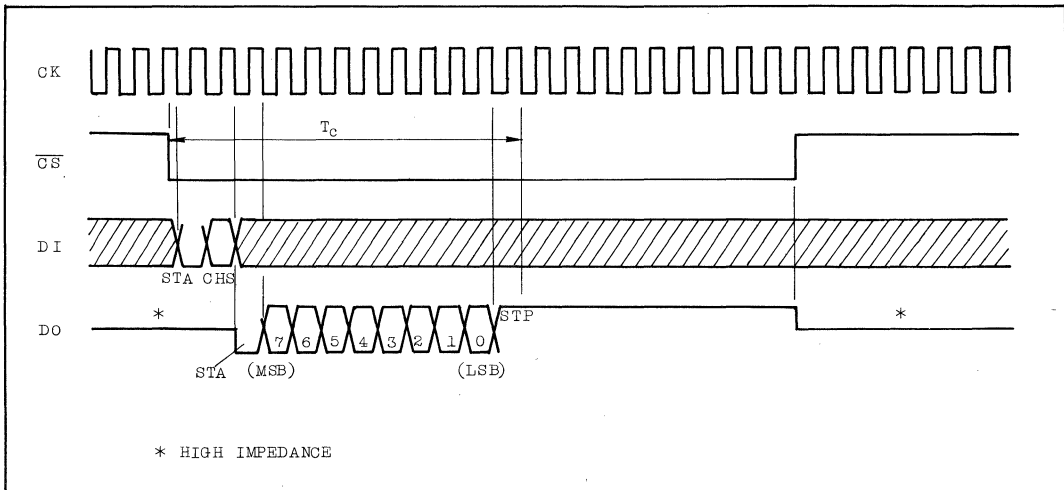
PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5~V _{SS} +7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	\pm 10	mA
Power Dissipation	P _D	300	mW
Storage Temperature	T _{stg}	-65 ~150	$^\circ$ C
Lead Temperature 10sec.	T _L	300	$^\circ$ C

TC35097P

BLOCK DIAGRAM



TIMING CHART



PIN & FUNCTION

PIN NO.	SYMBOL	NAME & FUNCTION	PIN NO.	SYMBOL	NAME & FUNCTION						
1	\overline{CS}	[CHIP SELECT] At the falling edge of \overline{CS} , the device is set stand-by for conversion. When \overline{CS} is "H" the device is reset and all outputs become high impedance.	5	V_{DD}	[POWER SUPPLY] V_{DD} is connected internally to 128 resistor ladder as a reference voltage $5V \pm 10\%$						
2	A_{INO}	[ANALOG INPUT] A_{INO} or A_{IN1} is selected according to the channel select bit applied on DI input. Full range of input signal is to be from V_{SS} to V_{DD} .	6	DO	[DATA OUTPUT] A start bit ("L" level), 8 bit conversion data (MSB first) and a stop bit ("H" level) are sent out in series.						
3	A_{IN1}	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>ON Channel</th> <th>DI Data CHS</th> </tr> </thead> <tbody> <tr> <td>A_{INO}</td> <td>L</td> </tr> <tr> <td>A_{IN1}</td> <td>H</td> </tr> </tbody> </table>	ON Channel	DI Data CHS	A_{INO}	L	A_{IN1}	H	7	CK	[CLOCK INPUT] Basic system clock Duty cycle is to be 50%.
ON Channel	DI Data CHS										
A_{INO}	L										
A_{IN1}	H										
4	V_{SS}	[GROUND] V_{SS} is connected internally to 128 resistor ladder as an analog ground.	8	DI	[DATA INPUT] For starting conversion, a start bit ("L" level) and channel select bit (CHS) are to be applied.						

SYSTEM CHARACTERISTICS (Ta=-40 ~ 85°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E_{ZR}	$V_{DD}=5.000V$ $f_{cp}=400kHz$ Duty=50%	-	$\pm 1/4$	$\pm 1/2$	LSB
Full Scale Error	E_{FS}		-	$\pm 1/4$	$\pm 1/2$	
Nonlinearity Error	E_{LI}		-	$\pm 1/4$	-	
Total Error	E_T		-	$\pm 1/4$	$\pm 3/4$	
Conversion Time	T_C	$f_{cp}=400kHz$		30	31.5	μS

$$T_c = \frac{12}{f_{cp}} \pm \alpha \quad 0 < \alpha < \frac{1}{2f_{cp}}$$

TC35097P

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Clock Frequency	f _{cp}	V _{DD} =5V±10%			400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V±10%	0.63	1.25	-	μs
Operating Temperature	T _{opr}		-40	-	+85	°C

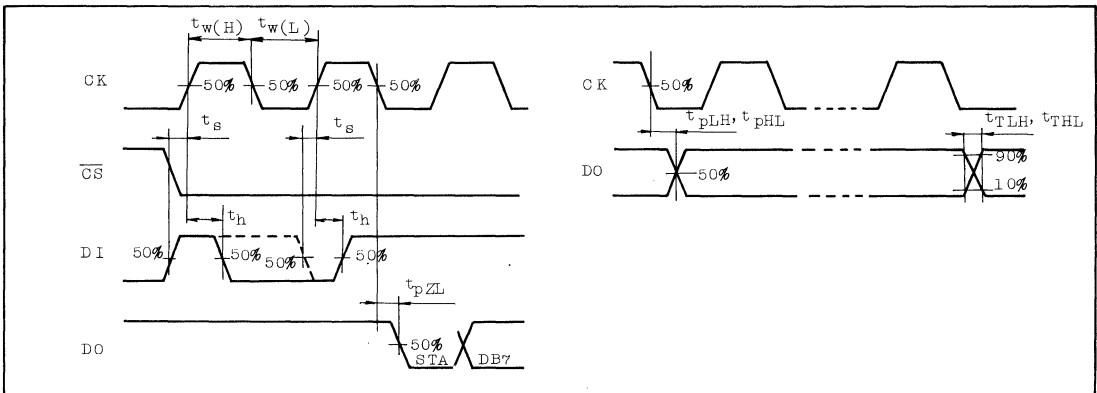
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V ± 10%, V_{SS}=0V)

PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 ~ 85°C		UNIT
			MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} -0.05	V _{DD}	-	V _{DD} -0.05	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 ×V _{DD}	-	-	0.7 ×V _{DD}	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V		-	0.3 ×V _{DD}	-	0.3 ×V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V		-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.3	-	±1	μA
ON Channel Input Current	I _{ON}	V _{IH} =V _{REF} or V _{IL} =0.0V f _{cp} =400kHz	-	-	±2	-	±5	μA
OFF Channel Input Current	I _{OFF}	V _{IH} =V _{DD} or V _{IL} =0.0V	-	-	±0.2	-	±1	μA
Operating Current	I _{DD}	f _{cp} =400kHz	-	-	3.9	-	4.3	mA

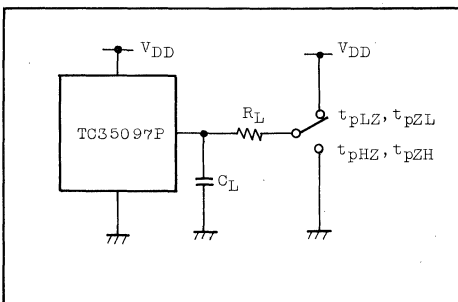
SWITCHING CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-		100	nS
Propagation Delay Time (CK-Data)	t _{pLH} t _{pHL}	C _L =50pF	-		250	
3-State Output Enable Time (CK-Data)	t _{pZL}	C _L =50pF R _L =1kΩ	-		200	
3-State Output Disable Time (CS-Data)	t _{pHZ} t _{pLZ}		-		200	
Minimum Pulse Width (CS)	t _{w(H)}	C _L =50pF	-		100	
Minimum Set-up Time (CS, DI)	t _s	C _L =50pF	-		150	
Minimum Hold Time (DI)	t _h	C _L =50pF	-		50	
Input Capacitance	C _{IN1}	Digital Input	-	5	-	pF
Input Capacitance	C _{IN2}	Analog In (ON)	-	5	-	
Input Capacitance	C _{IN3}	Analog In (OFF)	-	5	-	
Output Capacitance	C _{OUT}	3-State Out	-	10	-	

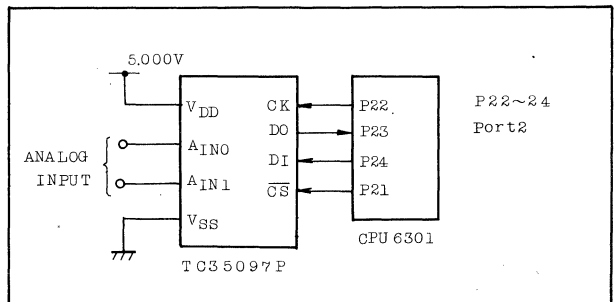
SWITCHING CHARACTERISTICS TEST WAVEFORM



3-STATE OUTPUT TEST CIRCUIT



APPLICATION CIRCUIT (EXAMPLE)



TC35098P

C²MOS DIGITAL INTEGRATED CIRCUIT
SILICON MONOLITHIC

TC35098P 8 BIT SERIAL I/O ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35098P is a monolithic CMOS 8 bit successive approximation A/D converter with serial I/O.

When \overline{CS} is set low \overline{SARS} goes to high level from high impedance state. And at the next falling edge of clock \overline{SARS} goes to low level and conversion starts.

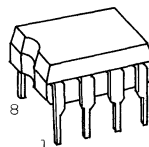
In case that \overline{SE} is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

In case that \overline{SE} is low, after conversion is completed a start bit, 8 bit conversion data (LSB first) and a stop bit appear at DO.

The TC35098P has features of high speed, high accuracy and microprocessor compatible I/O which make the device well suited to a broad application field such as process and machine control, automotive equipment and consumer apparatus.

FEATURES

- High accuracy $\pm \frac{3}{4}$ LSB MAX
- High speed conversion 27.5 μ sec MAX @ $f_{CP}=400$ kHz
- Single Power supply 5V \pm 10%
- Low Power consumption 17.5mW MAX @ $T_a=25^\circ$ C
- Serial I/O
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free

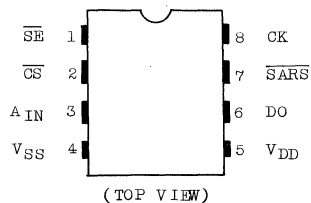


DIP8 (3D8A-P)

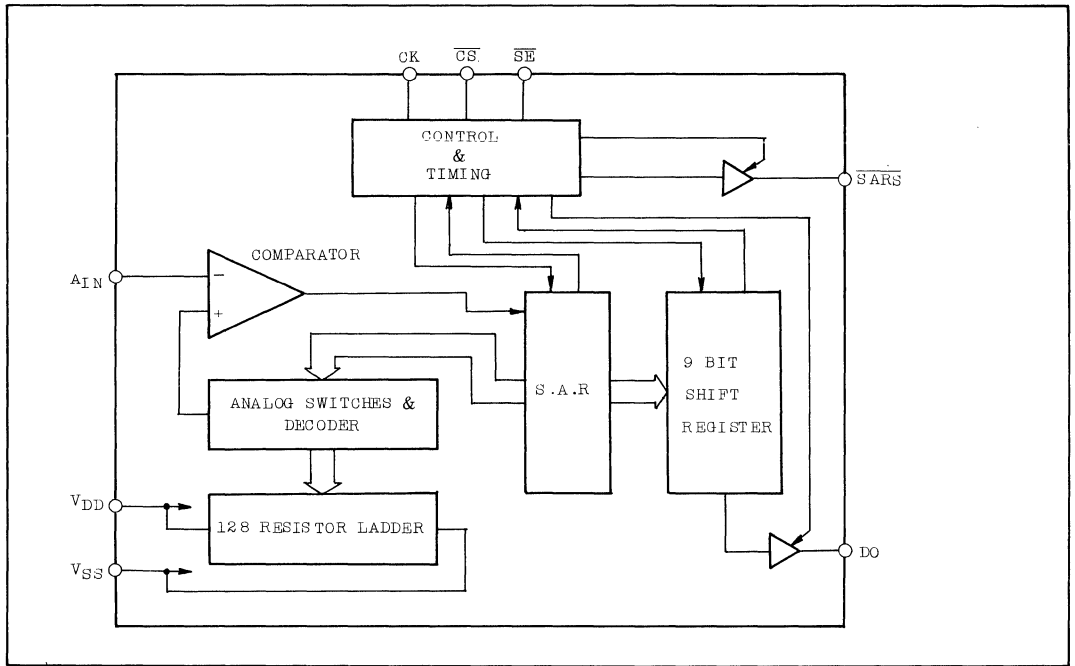
ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5~V _{SS} +7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5~V _{DD} +0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5~V _{DD} +0.5	V
DC Input Current	I _{IN}	\pm 10	mA
Power Dissipation	P _D	300	mW
Storage Temperature	T _{stg}	-65 ~ 150	$^\circ$ C
Lead Temperature 10sec.	T _L	300	$^\circ$ C

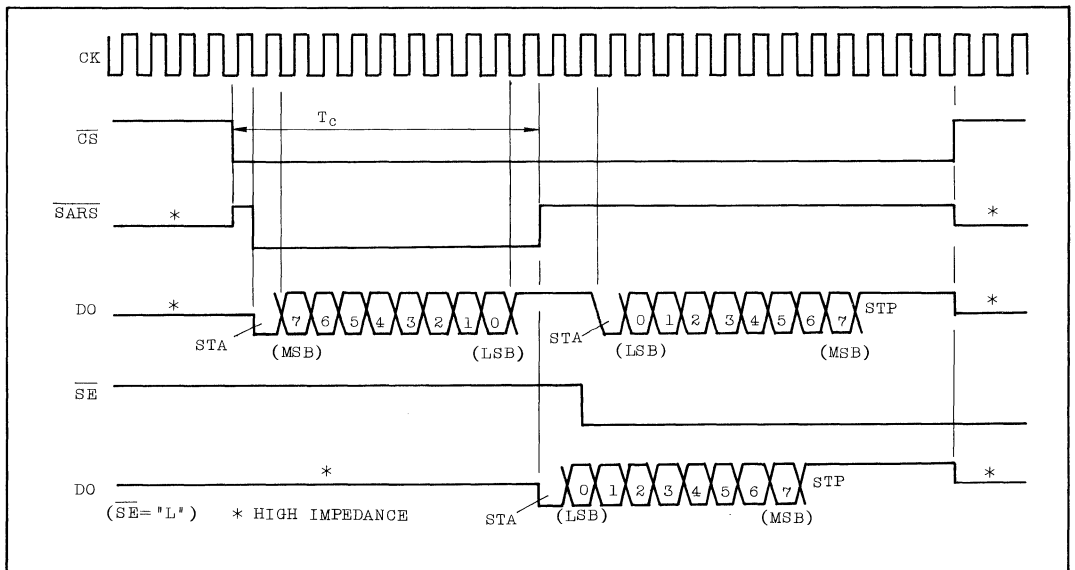
PIN ASSIGNMENT



BLOCK DIAGRAM



TIMING CHART



TC35098P

PIN & FUNCTION

PIN NO.	SYMBOL	NAME & FUNCTION	PIN NO.	SYMBOL	NAME & FUNCTION
1	\overline{SE}	[SELECT] \overline{SE} determines the order of output data. \overline{SE} ="L" LSB first \overline{SE} ="H" MSB first	5	VDD	[POWER SUPPLY] VDD is connected internally to 128 resistor ladder as a reference voltage. 5V ± 10%
2	\overline{CS}	[CHIP SELECT] When \overline{CS} is set low conversion starts. When \overline{CS} is set high the device is reset and all outputs become high impedance.	6	DO	[DATA OUTPUT] Output data is sent out in series.
			7	\overline{SARS}	[SAR STATUS] When \overline{CS} is set low \overline{SARS} goes to high level from high impedance state. And at the next falling edge of clock \overline{SARS} goes to low level and conversion start. When conversion is completed \overline{SARS} goes to high level.
3	A _{IN}	[ANALOG INPUT] Full range of input signal is to be from V _{SS} to V _{DD} .	8	CK	[CLOCK INPUT] Basic system clock. Duty cycle is to be 50%.
4	V _{SS}	[GROUND] V _{SS} is connected internally to 128 resistor ladder as an analog ground.			

SYSTEM CHARACTERISTICS (Ta=-40 ~ 85°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.000V f _{CP} =400kHz Duty=50%	-	±1/4	±1/2	LSB
Full Scale Error	E _{FS}		-	±1/4	±1/2	
Nonlinearity Error	E _{LI}		-	±1/4	-	
Total Error	E _T		-	±1/4	±3/4	
Conversion Time	T _C	f _{CP} =400kHz		27.5	29	μS

$$T_c = \frac{11}{f_{cp}} \pm \alpha \quad 0 < \alpha < \frac{1}{2f_{cp}}$$

RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Clock Frequency	f _{CP}	V _{DD} =5V±10%			400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V±10%	0.63	1.25	-	μs
Operating Temperature	T _{opr}		-40	-	+85	°C

DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V ± 10%, V_{SS}=0V)

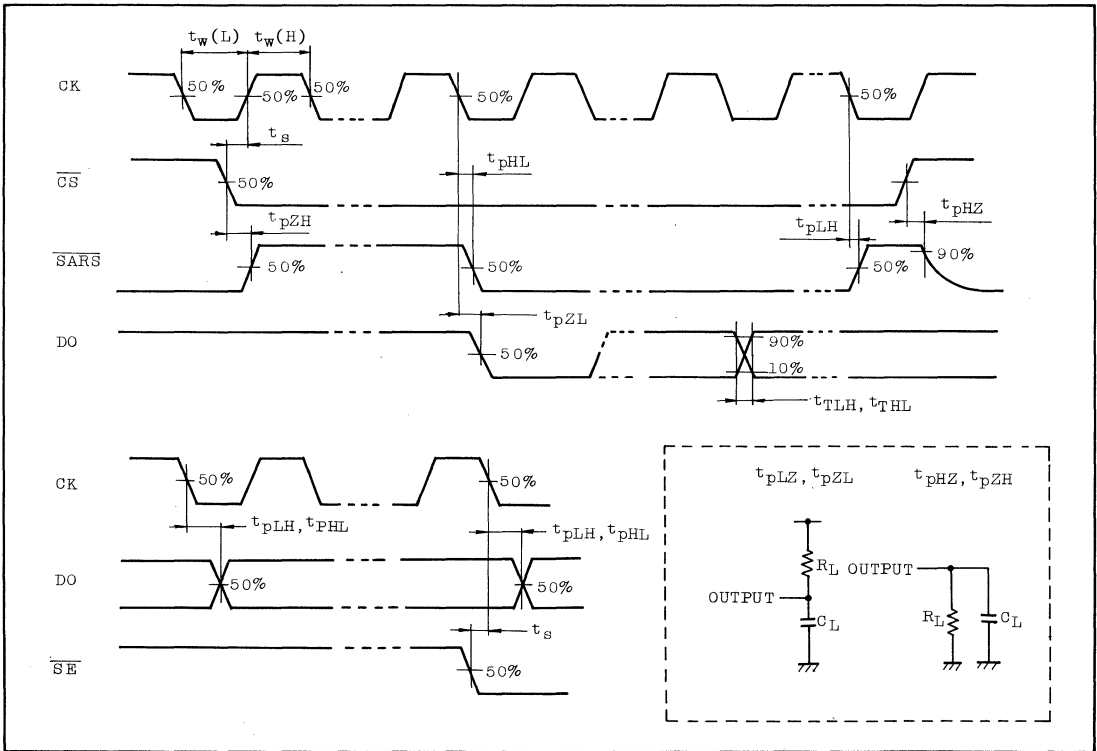
PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 ~ 85°C		UNIT
			MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} -0.05	V _{DD}	-	V _{DD} -0.05	-	V
Low Level Output Voltage	V _{OL}	|I _{OUT}| < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 × V _{DD}	-	-	0.7 × V _{DD}	-	V
Low Level Input Voltage	V _{IL}	|I _{OUT}| < 1μA V _{OUT} =0.5V, V _{DD} -0.5V		-	0.3 × V _{DD}	-	0.3 × V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V		-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V		-	±0.3	-	±1	μA
Analog Input Current	I _{AIN}	V _{IH} =V _{REF} or V _{IL} =0.0V f _{CP} =400kHz	-	-	±2	-	±5	μA
Operating Current	I _{DD}	f _{CP} =400kHz	-	-	3.9	-	4.3	mA

TC35098P

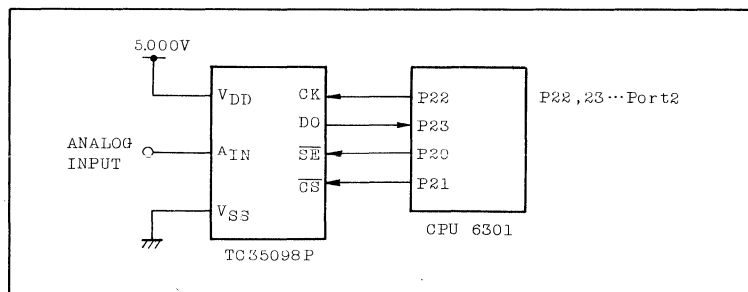
SWITCHING CHARACTERISTICS ($V_{DD}=5V\pm 10\%$, $V_{SS}=0V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t_{TLH} t_{THL}	$C_L=50pF$	-		100	nS
Propagation Delay Time (CK-Data)	t_{pLH} t_{pHL}	$C_L=50pF$	-		250	
Propagation Delay Time (CK-SARS)	t_{pLH} t_{pHL}	$C_L=50pF$	-		250	
3-State Output Enable Time (CS-SARS, SARS-Data)	t_{pZH} t_{pZL}	$C_L=50pF$ $R_L=1k$	-		200	
3-State Output Disable Time (CS-SARS, Data)	t_{pHZ} t_{pLZ}		-		200	
Minimum Pulse Width (CS)	$t_w(H)$	$C_L=50pF$	-		100	
Minimum Set-up Time (\overline{CS} , \overline{SE})	t_s	$C_L=50pF$	-		150	
Input Capacitance	C_{IN1}	Digital Input	-	5	-	pF
Input Capacitance	C_{IN2}	Analog Input	-	5	-	
Output Capacitance	C_{OUT}	3-State Out	-	10	-	

SWITCHING CHARACTERISTICS TEST WAVEFORM



APPLICATION CIRCUIT

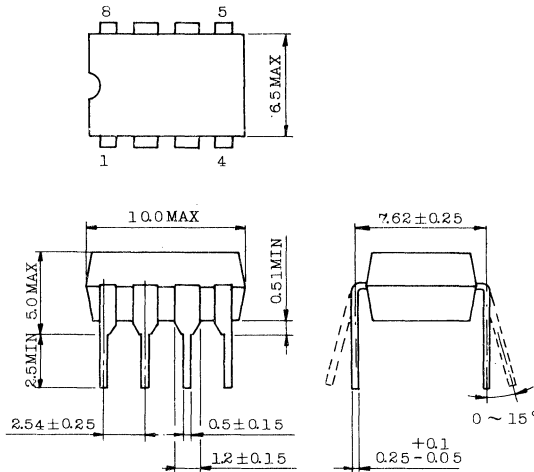


DIMENSIONAL OUTLINES



DIP-8 PIN OUTLINE DRAWING (3D8A-P)

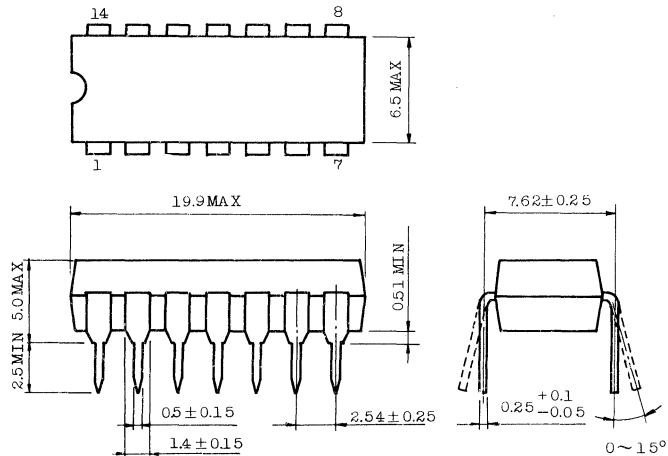
Unit in mm



Note) Lead pitch is 2.54 and tolerance is ± 0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.8 leads.

DIP-14 PIN OUTLINE DRAWING (3D14A-P)

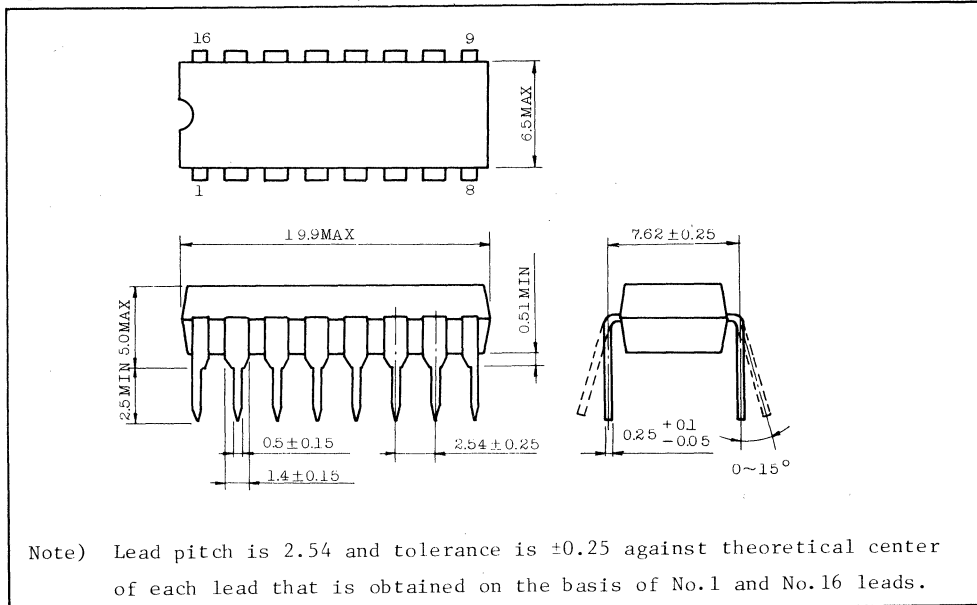
Unit in mm



Note) Lead pitch is 2.54 and tolerance is ± 0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.14 leads.

DIP 16 PIN OUTLINE DRAWING (3D16A-P)

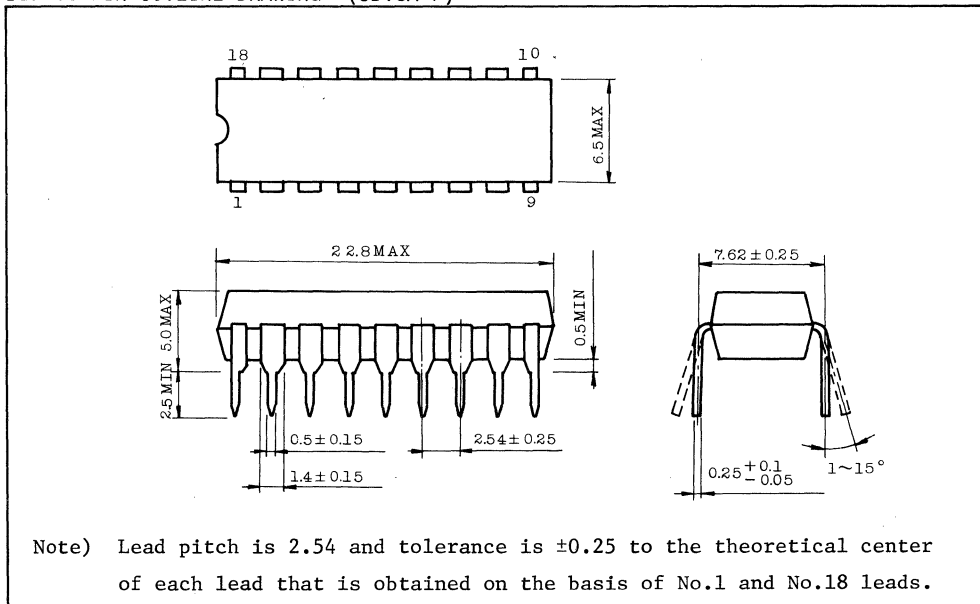
Unit in mm



Note) Lead pitch is 2.54 and tolerance is ± 0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.16 leads.

DIP 18 PIN OUTLINE DRAWING (3D18A-P)

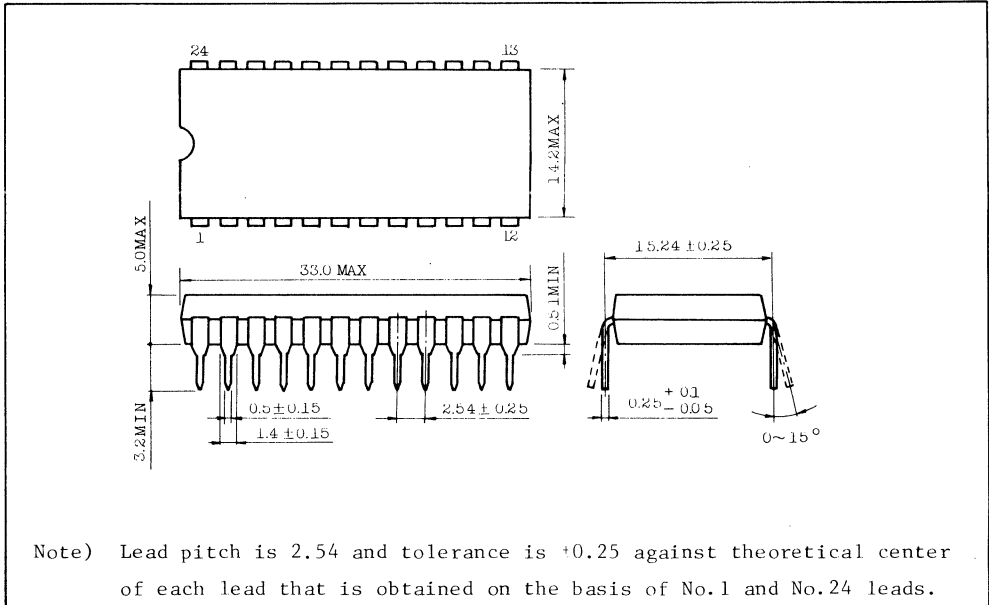
Unit in mm



Note) Lead pitch is 2.54 and tolerance is ± 0.25 to the theoretical center of each lead that is obtained on the basis of No.1 and No.18 leads.

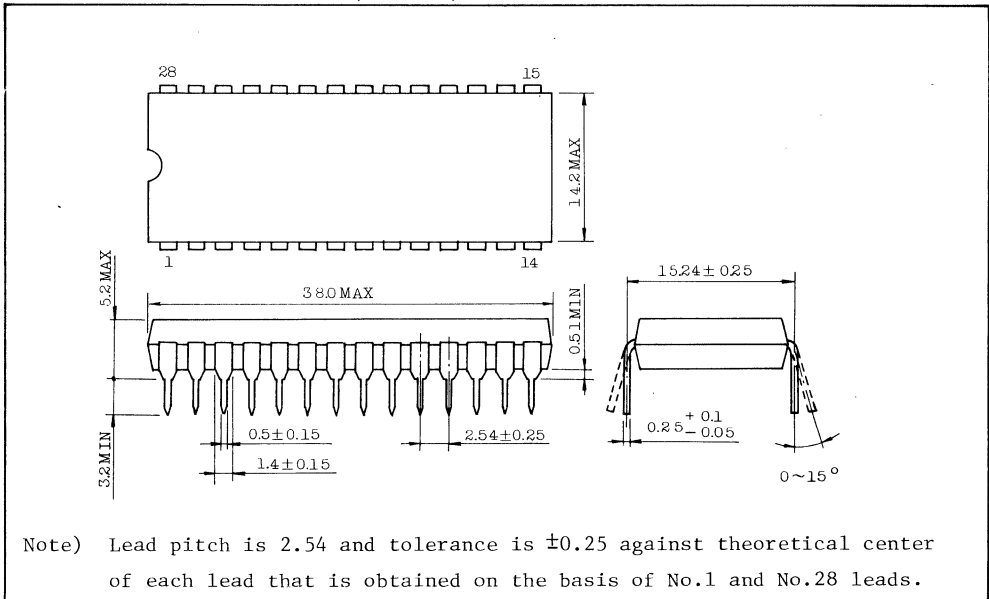
DIP 24 PIN OUTLINE DRAWING (6D24A-P)

Unit in mm



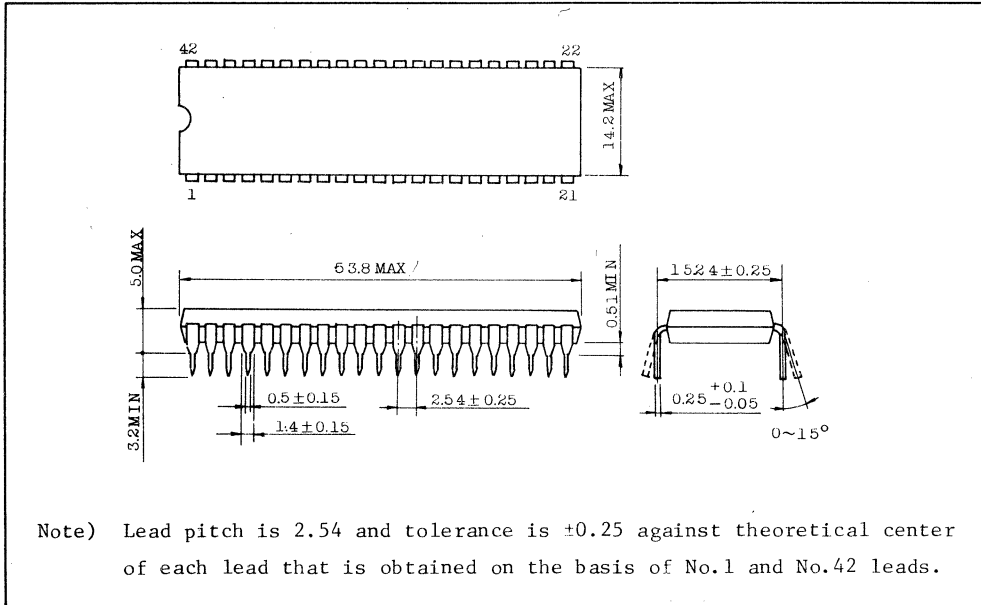
DIP 28-PIN OUTLINE DRAWING (6D28A-P)

Unit in mm



DIP 42 PIN OUTLINE DRAWING (6D42A-P)

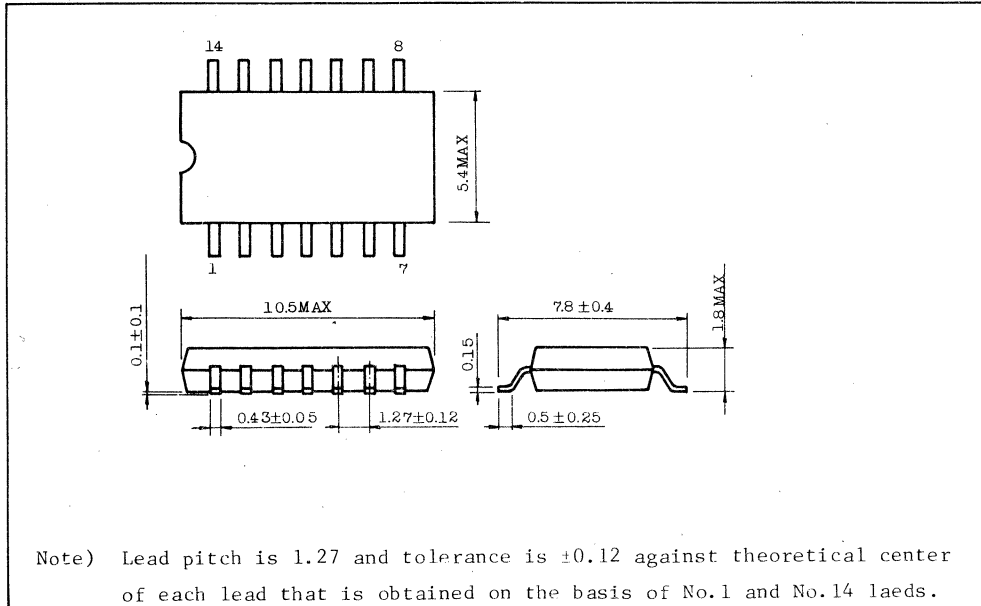
Unit in mm



Note) Lead pitch is 2.54 and tolerance is ± 0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.42 leads.

MFP 14 PIN OUTLINE DRAWING (F14GB-P)

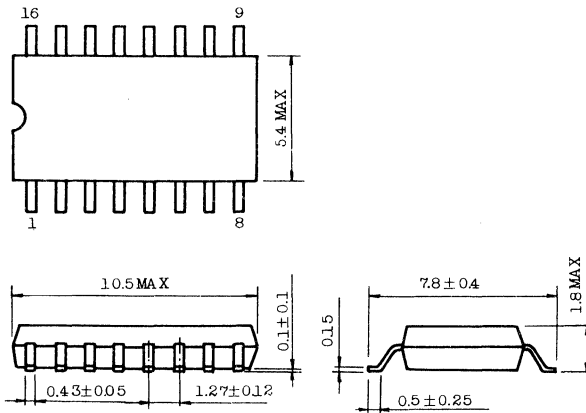
Unit in mm



Note) Lead pitch is 1.27 and tolerance is ± 0.12 against theoretical center of each lead that is obtained on the basis of No.1 and No.14 leads.

MFP 16 PIN OUTLINE DRAWING (F16GC-P)

Unit in mm



Note) Lead pitch is 1.27 and tolerance is ± 0.12 against theoretical center of each lead that is obtained on the basis of No.1 and No.16 leads.

RELIABILITY REPORT



1. Test Results

A. Life Test Results

Table 1 shows the life test results of B Series C²MOS IC. B Series is classified into SSI Family (less than 100 transistors) and MSI Family (More than transistors).

Table 1 Life Test Results of C²MOS Family

TYPE	TEST ITEMS	CONDITION	SAMPLE SIZE	TEST TIME (hrs)	EQUIVALENT DEVICE HOURS @ 60°C Ea=0.6eV	NUMBER OF FAILURES	
						DEGRADATION	CATASTROPHIC
B Series C ² MOS (SSI Family)	Steady State Operation	Ta=85°C V _{DD} =18V	4740	1000 to 5000	22.7 × 10 ⁶	2*	0
	High Temp. DC Bias	Ta=125°C V _{DD} =18V	4140	1000	125.7 × 10 ⁶	1*	0
	High Temp. Storage	Ta=150°C	2780	to 5000	-	2*	0
	High Temp. High Humidity Storage	Ta=60°C RH=90%	1080	1000 to 2000	-	1*	0
	High Temp. High Humidity Bias	Ta=85°C RH=85% V _{DD} =18V	730	1000	-	0	0
			210	5000	-	1*	1**
B Series C ² MOS (MSI Family)	Steady State Operation	Ta=85°C V _{DD} =18V	3730	1000 to 5000	16.6 × 10 ⁶	1*	0
	High Temp. DC Bias	Ta=125°C V _{DD} =18V	2580	1000	78.3 × 10 ⁶	0	0
	High Temp. Storage	Ta=150°C	2090	1000 to 5000	-	2*	0
	High Temp. High Humidity Storage	Ta=60°C RH=90%	1080	1000 to 2000	-	0	0
	High Temp. High Humidity Bias	Ta=85°C RH=85% V _{DD} =18V	370	1000	-	0	0

Note: * Leakage Failure
** Al Corrosion

B. Environmental Test Results

Table 2 to 4 shows the results of thermal environmental, mechanical and other tests, classified based upon package types.

Table 2 Thermal Environmental Test Results

TEST ITEM	TEST CONDITION	DIP14	DIP16
Soldering Heat	Tsol=260°C 10 sec. once	0/870	0/745
Temperature Cycle	-65°C ~ 25°C ~ 150°C ~ 25°C (30') (5') (30') (5') _____ 1 cycles _____ 300 cycles	0/870	0/745
Thermal Shock	100°C - 0°C (5') (5') — 1 cycle — 30 cycles	0/870	0/745
Moisture Resistance	MIL - STD - 883B Method 1004 10 cycles	0/870	0/745

Tests performed on the same samples

Table 3 Mechanical Test Results

TEST ITEM	TEST CONDITION	DIP14	DIP16
Vibration Fatigue	60±20Hz, 20G 3 orientations 32 hrs.	0/270	0/240
Variable Vibration Freq.	100~2000~100Hz, 20G 4 min. 3 orientations, 4 times each	0/270	0/240
Mechanical Shock	1500G, 0.5ms 4 orientations, 3 times each	0/270	0/240
Constant Acceleration	20000G, 6 orientations 1 min. each	0/270	0/240

Table 4 Other Test Results

TEST ITEM	TEST CONDITION	DIP14	DIP16
Solderability	Tsol=230°C 5 sec. once	0/430	0/270
Lead Integrity	Weight=250g Bending 3 times 0°~90°~0°	0/320	0/200
Salt Mist	5% salt atmosphere 35°C, 24 hrs.	0/270	0/150
Pressure Cooker	2 atm, 121°C, 100% 100 hrs.	0/1660	0/1360

2. Failure Rates Estimation

It is well known from various data that life time of not only C²MOS but also all semiconductor devices are greatly affected by temperature.

In general, the relation between failure rates and temperature of semiconductor devices is expressed in ARRHENUS equation.

$$F=A \cdot \exp(-E_a/kT)$$

Whereas F : Failure rate (Fit)
 T : Temperature (°K)
 K : BOLTZMANN constant 8.62×10^{-5} (eV/°K)
 E_a : Activation energy (eV)
 A : Constant

Failure rates increases as temperature rises.

For B Series C²MOS, an activation energy(E_a) of 0.6eV has been obtained from the results of life test which are shown in table 1. Table 5 indicates the estimated failure rates at ambient temperature of 60°C calculated by the ARRHENUS equation based on this activation energy.

Table 5 Estimated Failure Rates of C²MOS Family

TYPE	SAMPLE SIZE	EQUIVALENT DEVICE HOURS @ 60°C, E _a =0.6eV	NUMBER OF FAILURES	FAILURE RATE* @ 60°C FIT	
B-Series C ² MOS	15190	243.3 × 10 ⁶	4	21.5 (18V)	3.2 (5V)

* 60% Confidence level

3. Voltage Acceleration of Failure Rate

One of the features of B Series C²MOS IC is the wide operating voltage range of 3 to 18V.

For C²MOS IC, the correlation of the failure rate and supply voltage V_{DD} , $\lambda \propto V_{DD}^{1.5}$ has been obtained.

The failure rates at different supply voltages are estimated by applying the failure rates to the equation mentioned above. The rates are obtained from Table 5 at ambient temperature of 60°C and maximum supply voltage. Figure 1 shows the supply voltage dependence of the failure rates.

According to the above mentioned items, following failure rates can be estimated, when the C²MOS IC operates at a supply voltage of 5V and the ambient temperature is 60°C.

B Series

3.2 Fit

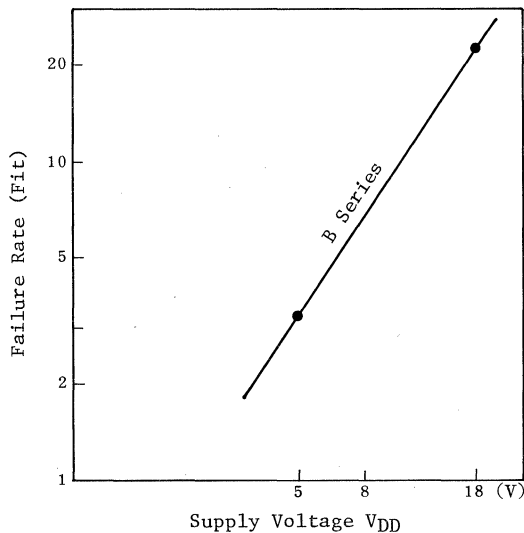


Fig. 1 Voltage Acceleration of Failure Rate

4. Moisture Resistance of Plastic Packaged IC

A. Performance In Moisture Resistance Test

The Moisture resistance has a great influence on the life time of plastic packaged IC. Alcorrosion, especially, induces an open failure mode in electrical characteristics which becomes a catastrophic failure mode. The life time of the plastic packaged IC has been extended by reducing contamination in sealed resin that may cause the moisture resistance failure, and by controlling phosphorous concentration in PSG used as passivation film.

The failure rates within a certain period obtained by plotting the C²MOS data to WELBULL are shown in Figures 2 and 3. The data are derived from results of PCT (121°C, 2 atm) and THB (85°C/85%, 15V) which are typical moisture resistance tests.

As shown in the figure, the C²MOS IC has a life time of more than 7000 hours at THB test, this became possible because of progress such as the improvement of resin being made.

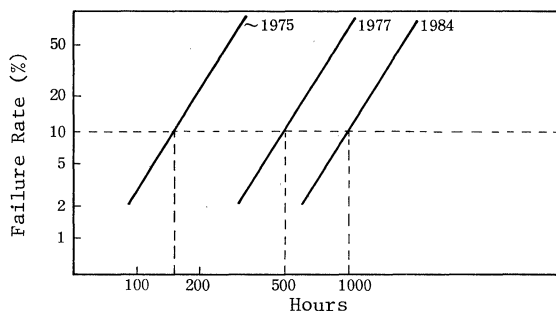


Fig. 2 Moisture Resistance (121°C, 2 atm)

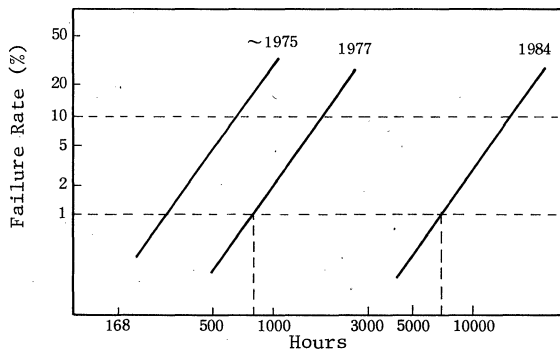


Fig. 3 Moisture Resistance (85°C/85% with Bias)

B. Moisture Resistance Acceleration Model

Several acceleration models, which are used in estimating the life time of the plastic packaged IC by applying the moisture resistance acceleration test data, have been reported. The followings are examples of the life time estimated by using the ARRHENUS model that is relatively close to the acceleration test data obtained by using Toshiba plastic packaged IC.

The ARRHENUS acceleration model is widely used in estimating the life time based upon the high temperature operating test data. It is assumed that the same type of moisture acceleration can be applied to moisture resistance where relative humidity is constant. Thus, the life time is expressed in the following equation.

$$\mu = A \cdot \exp(Ea/kT)$$

Whereas A : Constant
 Ea : Activation energy
 k : BOLTZMANN constant
 T : Absolute temperature

Ea of 0.8eV has been obtained by Toshiba based upon data of the acceleration test performed at constant 85% RH. THB (85°C/85% RH) data of each year are applied to the acceleration curve which is shown in Figure 4. The life time of current C²MOS IC is at least 1,000,000 hours, or more than 100 years, even in the relatively high humidity environment of 25°C and 85% RH. Therefore, C²MOS is sufficient to be used for equipments which require high reliability.

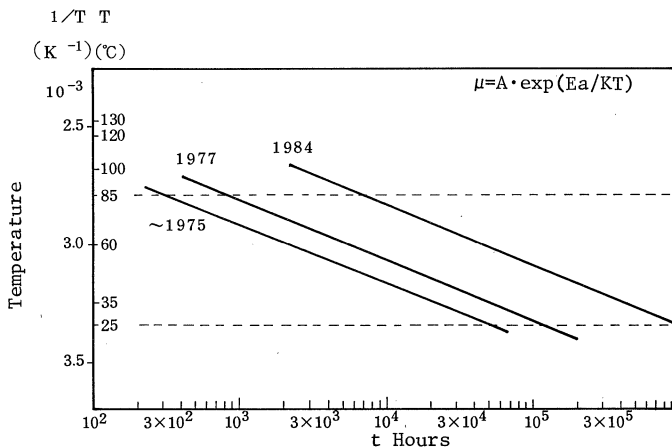


Fig. 4 Life Time Estimation of Humidity Test

5. Other Test Results

A. Electrostatic Discharge (ESD)

It is said that the insulation strength of silicon-diode films of IC and transistors is approximately 10V/cm. In case of gate oxide films of MOS IC, it will be destroyed by the even low voltage of about 100V since it is a very thin gate oxide film of about 0.1 μ m.

To prevent the destruction caused by the exceeding voltage, a protective diode is inserted to all input terminals of C²MOS IC. However, there is a limit in the capacity of the protective diode, and the device will be destroyed when the voltage applied to the device exceeds the limit.

Table 6 shows the static electric sensitivity test data of TC4011BP that is one of our typical gates of C²MOS IC.

Table 6 Static Electric Sensitivity Test Results of TC4011BP

APPLIED CONDITION	(c=200pF, R=0 Ω)
Input Plus Voltage	350V
Input Minus Voltage	300V
Output Plus Voltage	>1kV
Output Minus Voltage	>1kV

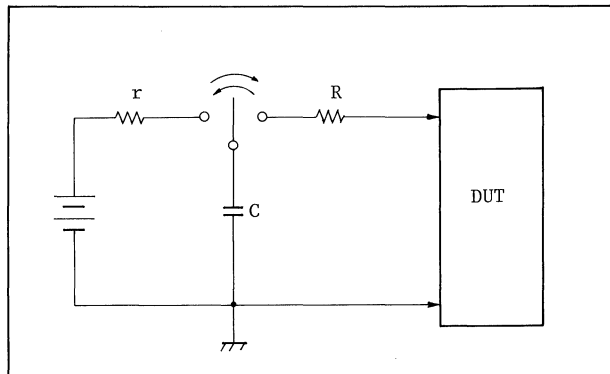


Fig. 5 Test Circuit of ESD

B. Latch-Up

In general, for the CMOS type IC, the phenomenon called latch-up may induce the degradation or destruction of a device, except for the types with SOS structure or oxide film isolating structure.

The latch-up does not occur in the normal operation within the maximum ratings. However when a voltage lower than $V_{SS}(GND)$ or higher than V_{DD} is applied the input or output terminals, or when a device break down with exceeding V_{DD} , the latch-up can occur.

Therefore, in operating the device, it is essential to take care not to apply a higher voltage than pointed out in the maximum ratings. The latch-up trigger current of C²MOS IC, TC4011BP, is shown in Table 7.

Table 7 Latch-Up Test Results of TC4011BP

INJECTION CONDITION	LATCH-UP
Input Plus Direction	>150mA
Input Minus Direction	>-30mA
Output Plus Direction	>150mA
Output Minus Direction	>-150mA

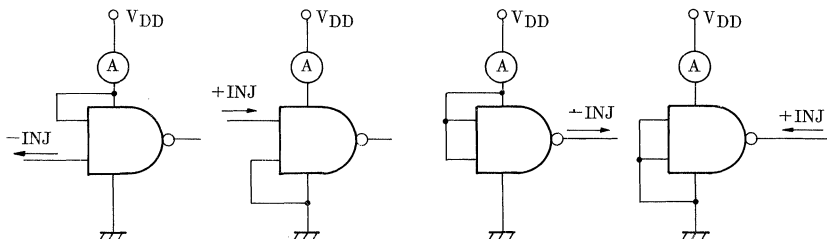


Fig. 6 Test Circuit of Latch-Up

- Note) 1. The measurement of a negative injection mode by applying more than -30mA is not performed since the mode is limited by resistor of an input protective circuit.
2. The measurement of positive side of input and negative pins by applying more than 150mA is not performed with same reason as Note 1.

8. Field Performance

C²MOS IC has been used for various purposes since it has been put on the market. Table 8 shows the field data of major examples. As this data indicates, the actual field performance is expected in a range of a few and ten Fit.

Table 8 Field Performance Data of C²MOS IC

SYSTEM	APPLICATION CONDITION	Q'ty (pcs)	OPERATION TIME	NUMBER OF FAILURES (pcs)	FAILURE RATE FIT
Process I/O System	Room air	20,000	Since Feb. 1974 8 hrs/day	1	1.6(3.4*)
Industrial Meter System	15 to 40°C	21,000	Since Oct. 1974 10 hrs/day	0	0(1.6*)
Highway Tunnel ITV System	up to 30°C up to 85% RH	25,000	Since Aug. 1975 24 hrs/day	0	0(0.5*)
Computer Terminal Unit On-Line Data Terminal Printer Marked Card Reader	5 to 37°C (Tested at 0 to 40°C)	3,500 (LSI)	Since Feb. 1983 10 hrs/day	2	14.2 (22*)

* Failure Rate Estimation 60% confidence level.

9. Test Results of B Series Mini-Flat Package C²MOS; TC4000B/TC4500B Series.
(Surface mount device)

Mini-Flat devices have same dies as dual-inline devices. It is considerable that life test results of mini-flat devices are equivalent to that of dual-inline devices except humidity and mechanical items.

In this chapter, it is described only for the life test results related to humidity and mechanical items.

Please refer to the results of dual-inline devices for the other life test.

(1) Humidity Storage

TEST	TEST CONDITION	SAMPLE SIZE	DURATION (H)	NUMBER OF FAILURETS	
				DEGRADATION	CATASTROPHIC
Humidity Storage	Ta=60°C, RH=90%	2420	1000	0	0

(2) High Temp. Humidity Bias

TEST	TEST CONDITION	SAMPLE SIZE	DURATION (H)	NUMBER OF FAILURETS	
				DEGRADATION	CATASTROPHIC
High Temp. Humidity Bias	Ta=85°C, RH=85% V _{DD} =18V	1890	1000	1*	0

* Leakage failure

(3) Pressure Cooker

TEST	TEST CONDITION	FP-14pins TYPE	FP-16pins TYPE
Pressure Cooker	2 atm, Ta=121°C, RH=100%, 100hrs	0/840	0/660

(4) Complex Test (Pressure cooker test followed by solder dipping)

① Precondition

↓ 85°C, 85%, 20Hrs storage

② Solder dipping (Completely inserted to solder tab.)

↓ Solder Temperature 260°C, Solder Dipping Time 10sec.

③ Pressure Cooker Test

TEST CONDITION	FP-14pins TYPE	FP-16pins TYPE
2 atm, Ta=121°C, RH=100%, 100hrs	0/350	0/300

(5) Others

TEST	TEST CONDITION	FP-14pins TYPE	FP-15pins TYPE
Lead Bend	Weight=100g 0°~90°~0°, 3 times	0/80	0/50
Lead Stretch	Weight=250g Maintenance during 30 time	0/80	0/50
Temperature Cycling	-65°C ~ 25°C ~ 150°C ~ 25°C (30') (5') (30') (5') ———— 1 cycle ———— 300 cycles	0/140	0/100

CROSS REFERENCE TABLE



TOSHIBA 4000 SERIES LOGIC FAMILY CROSS REFERENCE

TOSHIBA	RCA	MOTOROLA	SIGNETICS	NATIONAL SEMICONDUCTOR	SGS
TC400BP	CD4000BE	MC14000BCP	HEF4000BP	CD4000CN	HCF4000BE
TC4001BP	CD4001BE	MC14001BCP	HEF4001BP	CD4001BCN	HCF4001BE
TC4001UBP	CD4001UBE	MC14001UBCP	HEF4001UBP	CD4001CN	
TC4002BP	CD4002BE	MC14002BCP	HEF4002BP	CD4002BCN	HCF4002BE
TC4006BP	CD4006BE	MC14006BCP	HEF4006BP	CD4006BCN	HCF4006BE
TC4007UBP	CD4007UBE	MC14007UBCP	HEF4007UBP	CD4007CN	HCF4007UBE
TC4008BP	CD4008BE	MC14008BCP	HEF4008BP	CD4008BCN	HCF4008BE
TC4009UBP	CD4009BE			CD4009CN	
TC4010BP	CD4010BE				
TC4011BP	CD4011BE	MC14011BCP	HEF4011BP	CD4011BCN	HCF4011BE
TC4011UBP	CD4011UBE	MC14011UBCP	HEF4011UBP	CD4011CN	
TC4012BP	CD4012BE	MC14011BCP	HEF4012BP	CD4012BCN	HCF4012BE
TC4013BP	CD4013BE	MC14013BCP	HEF4013BP	CD4013BCN	HCF4013BE
TC4014BP	CD4014BE	MC14014BCP	HEF4014BP	CD4014BCN	HCF4014BE
TC4015BP	CD4015BE	MC14015BCP	HEF4015BP	CD4015BCN	HCF4015BE
TC4016BP	CD4016BE	MC14016BCP	HEF4016BP	CD4016BCN	HCF4016BE
TC4017BP	CD4017BE	MC14017BCP	HEF4017BP	CD4017BCN	HCF4017BE
TC4018BP	CD4018BE	MC14018BCP	HEF4018BP	CD4018BCN	NCF4018BE
TC4019BP	CD4019BE		HEF4019BP	CD4019BCN	HCF4019BE
TC4020BP	CD4020BE	MC14020BCP	HEF4020BP	CD4020BCN	HCF4020BE
TC4021BP	CD4021BE	MC14021BCP	HEF4021BP	CD4021BCN	HCF4021BE
TC4022BP	CD4022BE	MC14022BCP	HEF4022BP	CD4022BCN	HCF4022BE
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TC4024BP	CD4024BE	MC14024BCP	HEF4024BP	CD4024BCN	HCF4024BE
TC4025BP	CD4025BE	MC14025BCP	HEF4025BP	CD4205BCN	HCF4025BE
TC4027BP	CD4027BE	MC14027BCP	HEF4027BP	CDd027BCN	HCF4027BE
TC4028BP	CD4028BE	MC14028BCP	HEF4028BP	CD4028BCN	HCF4028BE
TC4029BP	CD4029BE	MC14029BCP	HEF4029BP	CD4029BCN	HCF4029BE
TC4030BP	CD4030BE		HEF4030BP		HCF4030BE
TC4032BP	CD4032BE	MC4032BCP			HCF4032BE
TC4034BP	CD4034BE	MC14034BCP		CD4034BCN	HCF4034BE
TC4035BP	CD4035BE	MC14035BCP	HEF4035BP	CD4035BCN	HCF4035BE
TC4036BP					
TC4038BP	CD4038BE	MC14038BCP			HCF4038BE
TC4039BP					
TC4040BP	CD4040BE	MC14040BCP	HEF4040BP	CD4040BCN	HCF4040BE

TOSHIBA 4000 SERIES LOGIC FAMILY CROSS REFERENCE (Continued)

TOSHIBA	RCA	MOTOROLA	SIGNETICS	NATIONAL SEMICONDUCTOR	SGS
TC4042BP	CD4042BE	MC14042BCP	HEF4042BP	CD4042BCN	HCF4042BE
TC4043BP	CD4043BE	MC14043BCP	HEF4043BP	CD4043BCN	HCF4043BE
TC4044BP	CD4044BE	MC14044BCP	HEF4044BP	CD4044BCN	HCF4044BE
TC4047BP	CD4047BE		HEF4047BP	CD4047BCN	HCF4047BE
TC4049BP	CD4049UBE	MC14049UBCP	HEF4049UBP	CD4049CN	HCF4049BE
TC4050BP	CD4050BE	MC14050BCP	HEF4050BP	CD4050BCN	HCF4050BE
TC4051BP	CD4051BE	MC14051BCP	HEF4051BP	CD4051BCN	HCF4051BE
TC4052BP	CD4052BE	MC14052BCP	HEF4052BP	CD4052BCN	HCF4052BE
TC4053BP	CD4053BE	MC14053BCP	HEF4053BP	CD4053BCN	HCF4053BE
TC4054BP	CD4054BE				HCF4054BE
TC4055BP	CD4055BE				HCF4055BE
TC4056BP	CD4056BE				HCF4056BE
TC4063BP	CD4063BE				HCF4063BE
TC4066BP	CD4066BE	MC14066BCP	HEF4066BP	CD4066BCN	HCF4066BE
TC4068BP	CD4068BE	MC14068BCP	HEF4068BP		HCF4068BE
TC4069UBP	CD4069UBE	MC14069UBCP	HEF4069UBP	CD4069CN	HCF4069UBE
TC4071BP	CD4071BE	MC14071BCP	HEF4071BP	CD4071BCN	HCF4071BE
TC4072BP	CD4072BE	MC14072BCP	HEF4072BP	CD4072BCN	HCF4072BE
TC4073BP	CD4073BE	MC14073BCP	HEF4073BP	CD4073BCN	HCF4073BE
TC4075BP	CD4075BE	MC14075BCP	HEF4075BP	CD4075BCN	HCF4075BE
TC4076BP	CD4076BE	MC14076BCP	HEF4076BP	CD4076BCN	HCF4076BE
TC4077BP	CD4077BE	MC14077BCP	HEF4077BP		HCF4077BE
TC4078BP	CD4078BE	MC14078BCP	HEF4078BP		HCF4078BE
TC4081BP	CD4081BE	MC14081BCO	HEF4081BP	CD4081BCN	HCF4081BE
TC4082BP	CD4082BE	MC14082BCP	HEF4082BP	CD4082BCN	HCF4082BE
TC4085BP	CD4085BE		HEF4085BP		HCF4085BE
TC4086BP	CD4086BE		HEF4086BP		HCF4086BE
TC4093BP	CD4093BE	MC14093BCP	HEF4093BP	CD4093BCN	HCF4093BE
TC4094BP	CD4094BE	MC14094BCP	HEF4094BP	CD4094BCN	HCF4094BE
TC4099BP	CD4099BE	MC14099BCP		CD4099BCN	HCF4099BE
TC40102BP	CD40102BE				HCF40102BE
TC40103BP	CD40103BE				HCF40103BE
TC40104BP	CD40104BE				HCF40104BE
TC40107BP	CD40107BE				HCF40107BE
TC40117BP	CD40117BE				
TC40160BP	CD40160BE	MC14160BCP	HEF40160BP	CD40160BCN	HCF40160BE
TC40161BP	CD40161BE	MC14161BCP	HEF40161BP	CD40161BCN	HCF40161BE

TOSHIBA 4000 SERIES LOGIC FAMILY CROSS REFERENCE (Continued)

TOSHIBA	RCA	MOTOROLA	SIGNETICS	NATIONAL SEMICONDUCTOR	SGS
TC40162BP	CD40162BE	MC14162BCP	HEF40162BP	CD40162BCN	HCF40162BE
TC40163BP	CD40163BE	MC14163BCP	HEF40163BP	CD40163BCN	HCF40163BE
TC40174BP	CD40174BE	MC14174BCP	HEF40174BP	CD40174BCN	HCF40174BE
TC40175BP	CD40175BE	MC14175BCP	HEF40175BP	CD40175BCN	
TC40192BP	CD40192BE		HEF40192BP	CD40192BCN	HCF40192BE
TC40193BP	CD40193BE		HEF40193BP	CD40193BCN	HCF40193BE
TC40194BP	CD40194BE	MC14194BCP	HEF40194BP		HCF40194BE
TC4502BP	CD4502BE	MC14502BCP	HEF4502BP		HCF4502BE
TC4503BP		MC14503BCP		CD4503BCN	
TC4508BP	CD4508BE	MC14508BCP	HEF4508BP		HCF4508BE
TC4510BP	CD4510BE	MC14510BCP	HEF4510BP	CD4510BCN	HCF4510BE
TC4511BP	CD4511BE	MC14511BCP	HEF4511BP	CD4511BCN	HCF4511BE
TC4512BP	CD4512BE	MC14512BCP	HEF4512BP	CD4512BCN	HCF4512BE
TC4514BP	CD4514BE	MC14514BCP	HEF4514BP	CD4514BCN	HCF4514BE
TC4515BP	CD4515BE	MC14515BCP	HEF4515BP	CD4515BCN	HCF4515BE
TC4516BP	CD4516BE	MC14516BCP	HEF4516BP	CD4516BCN	HCF4516BE
TC4518BP	CD4518BE	MC14518BCP	HEF4518BP	CD4518BCN	HCF4518BE
TC4519BP		MC14519BCP	HEF4519BP	CD4519BCN	
TC4520BP	CD4520BE	MC14520BCP	HEF4520BP	CD4520BCN	HCF4520BE
TC4521BP		MC14521BCP	HEF4521BP		
TC4522BP		MC14522BCP	HEF4522BP	CD4522BCN	
TC4526BP		MC14526BCP	HEF4526BP	CD4526BCN	
TC4527BP	CD4527BE	MC14527BCP	HEF4527BP	CD4527BCN	HCF4527BE
TC4528BP	CD4528BE	MC14528BCP	HEF4528BP	CD4528BCN	
TC4530BP		MC14530BCP			
TC4531BP		MC14531BCP	HEF4531BP		
TC4532BP	CD4532BE	MC14532BCP	HEF4532BP		HCF4532BE
TC4538BP	CD4538BE	MC14538BCP	HEF4538BP	CD4538BCN	HCF4538BE
TC4539BP		MC14539BCP	HEF4539BP		
TC4543BP	CD4543BE	MC14543BCP	HEF4543BP	CD4543BCN	
TC4555BP	CD4555BE	MC14555BCP	HEF4555BP		HCF4555BE
TC4556BP	CD4556BE	MC14556BCP	HEF4556BP		HCF4556BE
TC4560BP		MC14560BCP			
TC4561BP		MC14561BCP			
TC4572BP		MC14572BCP			
TC4583BP		MC14583BCP			
TC4584BP	CD40106BE	MC14584BCP		CD4584BCN	
TC4585BP	CD4585BE	MC14585BCP	HEF4585BP		HCF4585BE

**MAINTENANCE-DISCONTINUED
TYPE NUMBERS**

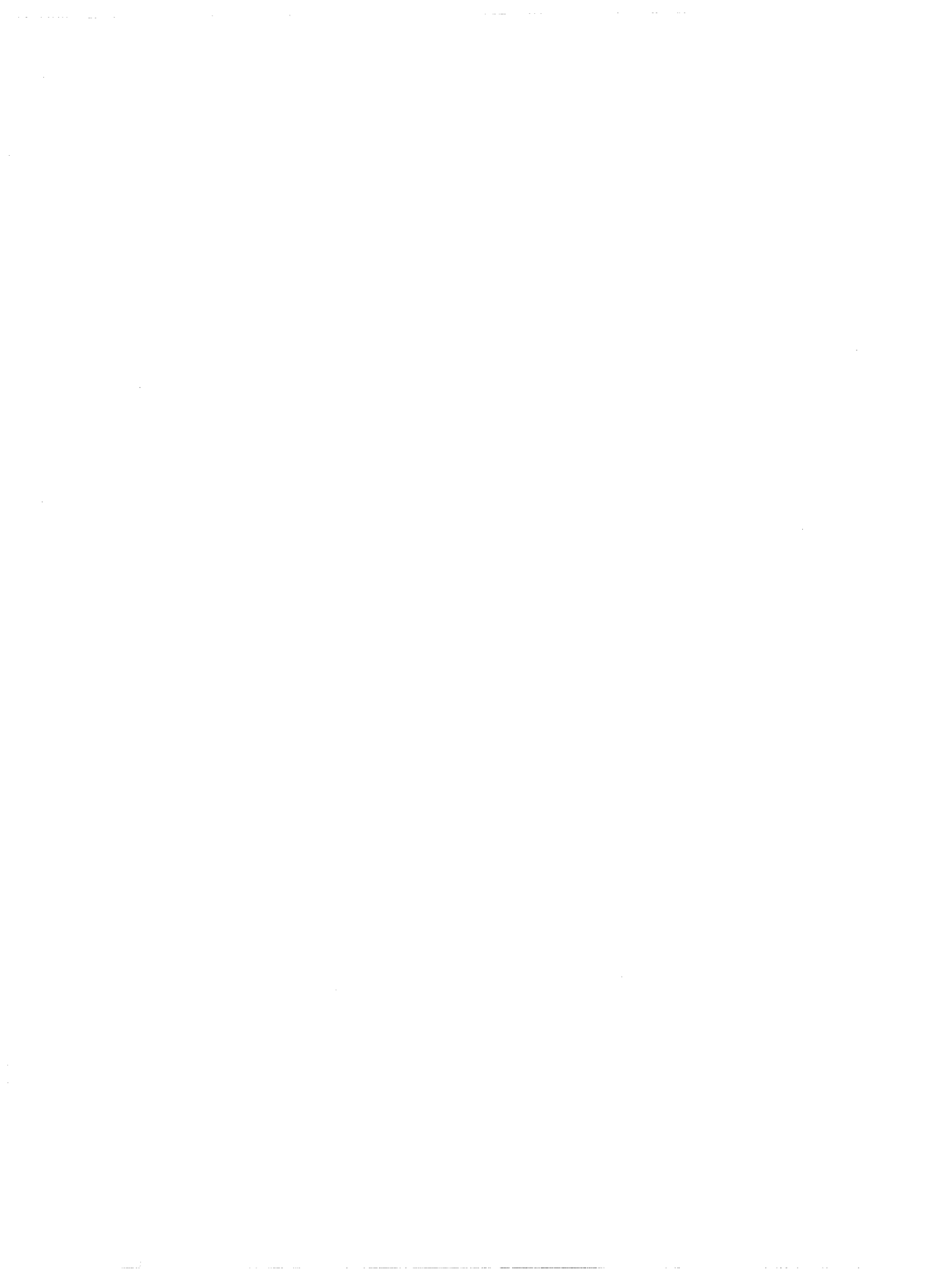


◦ MAINTENANCE-DISCONTINUED TYPE NUMBERS

TYPE NO.	FUNCTION	REPLACEMENT
TC4508C	DUAL 4-BIT LATCH	TC4508BP
TC5000C/P	DUAL 50/64 STAGE STATIC SHIFT REGISTER	TC5050P
TC5001C	4-DIGIT DECADE COUNTER	TC5001P
TC5004P	DUAL 500/512-BIT DYNAMIC SHIFT REGISTER	-
TC5010P	4-DIGIT UP/DOWN COUNTER WITH TIMER	(TC5053P), (TC5054P)
TC5030BP	QUAD 2-INPUT NAND GATE WITH P-CHANNEL OPEN DRAIN OUTPUT	-
TC5034P	4-BIT PRESETTABLE "N" COUNTER/DECODER/DRIVER	-
TC5042BP	BCD TO 7-SEGMENT DECODER/DRIVER	TC5002BP, TC5022BP
TC5055P	3 1/2 DIGIT DVM CIRCUIT	-
TC7410BP	TRIPLE 3-INPUT POSITIVE NAND GATE	TC4023BP
TC7420BP	DUAL 4-INPUT POSITIVE NAND GATE	TC4012BP

Note: The replacement types are approximately similar to the maintenance types in terms of the characteristics and functions, but not exact equivalent. In case of doubt the original data sheets should be consulted before use.





CORPORATE OFFICE

9775 Toledo Way
Irvine, California 92718
Telephone: (714) 455-2000
FAX: (714) 859-3963
Telex: 314-138

NORTH WESTERN REGION

1220 Midas Way
Sunnyvale, CA 94086
(408) 737-9844
FAX: (408) 737-9905

SOUTHWEST REGION

15621 Redhill Ave.
Suite 205
Tustin, CA 92680
(714) 259-0368
FAX: (714) 259-9439

EASTERN AREA

25 Mall Road
5th Floor
Burlington, MA 01803
(617) 272-4352
FAX: (617) 272-3089
TWX: 710-321-6730
Answerback Toshiba Burl

SOUTH EAST REGION

Waterford Centre
5555 Triangle Parkway
Suite 300
Norcross, GA 30092
(404) 368-0203
FAX: (404) 368-0075

CENTRAL REGION

1101A Lake Cook Rd.
Deerfield, IL 60015
(312) 945-1500
TWX: 29-7131
FAX: (312) 945-1044

SOUTH CENTRAL REGION

777 E. Campbell Rd.
Suite 650
Richardson, TX 75081
(214) 480-0470
FAX: (214) 235-4114

TOSHIBA AMERICA, INC.

9775 Toledo Way
Irvine, California 92718
Telephone: (714) 455-2000
FAX: (714) 859-3963
Telex: 314-138