Electronic Design

THE MAGAZINE OF ESSENTIAL NEWS, PRODUCTS AND TECHNOLOGY

VOL. 15 NO. 9

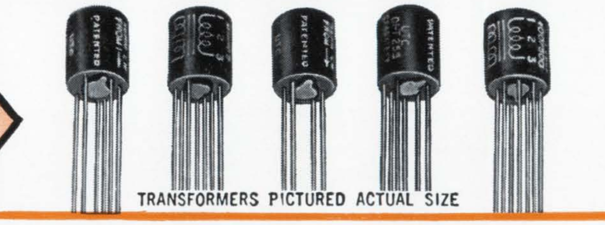
APRIL 26 1967

Seek the right semiconductor by starting here, and you'll find the devices that will make your circuit designs sparkle. Charts in this issue list more than 5000 transistors and microcircuits by function and key parameter. But don't stop there. Get detailed catalogs and application notes too. How? Turn to page 81.

PIONEERS IN MINIATURIZATION

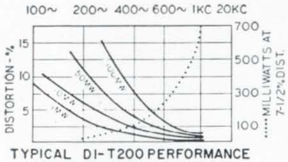
NEW

DI-T200™ SERIES

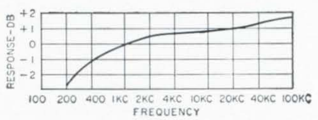


TRANSFORMERS PICTURED ACTUAL SIZE

ULTRAMINIATURE TRANSISTOR TRANSFORMERS & INDUCTORS



TYPICAL DI-T200 PERFORMANCE
SOURCE: RATED PRI. IMP. AND D.C.
LOAD : RATED SEC. IMP.



<table>
<tr><th>Type No.</th><th>Pri. Imp.</th><th>DCma‡ in Pri.</th><th>Sec. Imp.</th><th>Pri. Res.</th><th>Mw Level</th><th>Application</th></tr>
<tr><td>DI-T225</td><td>80 CT
100 CT</td><td>12
10</td><td>32 split
40 split</td><td>10</td><td>500</td><td>Interstage</td></tr>
<tr><td>DI-T230</td><td>300 CT</td><td>7</td><td>600 CT</td><td>20</td><td>500</td><td>Output or line to line</td></tr>
<tr><td>DI-T235</td><td>400 CT
500 CT</td><td>8
6</td><td>40 split
50 Split</td><td>50</td><td>500</td><td>Interstage</td></tr>
<tr><td>DI-T240</td><td>400 CT
500 CT</td><td>8
6</td><td>400 split
500 split</td><td>50</td><td>500</td><td>Interstage or output (Ratio 2:1:1)</td></tr>
<tr><td>DI-T245</td><td>500 CT
600 CT</td><td>3
3</td><td>50 CT
60 CT</td><td>65</td><td>500</td><td>Output or matching</td></tr>
<tr><td>DI-T250</td><td>500 CT</td><td>5.5</td><td>600 CT</td><td>35</td><td>500</td><td>Output or line to line or mixing</td></tr>
<tr><td>DI-T255</td><td>1,000 CT
1,200 CT</td><td>3
3</td><td>50 CT
60 CT</td><td>110</td><td>500</td><td>Output or matching</td></tr>
<tr><td>DI-T260</td><td>1,500 CT</td><td>3</td><td>600 CT</td><td>90</td><td>500</td><td>Output to line</td></tr>
<tr><td>DI-T265</td><td>2,000 CT
2,500 CT</td><td>3
3</td><td>8,000 split
10,000 split</td><td>180</td><td>100</td><td>Isol. or interstage (Ratio 1:1:1)</td></tr>
<tr><td>DI-T270</td><td>10,000 CT
12,000 CT</td><td>1
1</td><td>500 CT
600 CT</td><td>870</td><td>100</td><td>Output or driver</td></tr>
<tr><td>DI-T273</td><td>10,000 CT
12,500 CT</td><td>1
1</td><td>1,200 CT
1,500 CT</td><td>870</td><td>100</td><td>Output or driver</td></tr>
<tr><td>DI-T276</td><td>10,000 CT
12,000 CT</td><td>1
1</td><td>2,000 CT
2,400 CT</td><td>870</td><td>100</td><td>Interstage or driver</td></tr>
<tr><td>DI-T278</td><td>10,000 CT
12,500 CT</td><td>1
1</td><td>2,000 split
2,500 split</td><td>620</td><td>100</td><td>Interstage or driver</td></tr>
<tr><td>DI-T283</td><td>10,000 CT
12,000 CT</td><td>1
1</td><td>10,000 CT
12,000 CT</td><td>970</td><td>100</td><td>Isol. or interstage (Ratio 1:1)</td></tr>
<tr><td>DI-T288</td><td>20,000 CT
30,000 CT</td><td>.5
.5</td><td>800 CT
1,200 CT</td><td>870</td><td>50</td><td>Interstage or driver</td></tr>
<tr><td>DI-T204</td><td colspan="6">Split Inductor § .1 Hy @ 4 maDC, .08 Hys @ 10 maDC, DCR 25Ω
(2 wdgs) §§ .025 Hys @ 8 maDC, .02 Hys @ 20 maDC, DCR 6Ω</td></tr>
<tr><td>DI-T208</td><td colspan="6">Split Inductor § .9 Hys @ 2 maDC, .5 Hys @ 6 maDC, DCR 105Ω
(2 wdgs) §§ .2 Hys @ 4 maDC, .1 Hys @ 12 maDC, DCR 26Ω</td></tr>
<tr><td>DI-T212</td><td colspan="6">Split Inductor § 2.5 Hys @ 2 maDC, .9 Hys @ 4 maDC, DCR 630Ω
(2 wdgs) §§ .6 Hys @ 4 maDC, .2 Hys @ 8 maDC, DCR 157Ω</td></tr>
<tr><td>DI-T216</td><td colspan="6">Split Inductor § 4.5 Hys @ 2 maDC, 1.2 Hys @ 4 maDC, DCR 2300Ω
(2 wdgs) §§ 1.1 Hys @ 4 maDC, .3 Hys @ 8 maDC, DCR 575Ω</td></tr>
</table>

‡DCma shown is for single ended useage (under 5% distortion—100mw—1KC)... for push pull, DCma can be any balanced value taken by 5W transistors (under 5% distortion—500mw—1KC) DI-T200 units have been designed for transistor application only... not for vacuum tube service. U.S. Pat. No. 2,949,591 other pending.
Where windings are listed as split, ¼ of the listed impedance is available by paralleling the winding.
§Series connected; §§Parallel connected.

- **DUMET LEADS**
  (gold plated, weldable and solderable)
- **STRAIGHT PIN TERMINALS**
  (printed circuit application)
- **HIGHEST PERFORMANCE**
  for size in the industry
- **METAL ENCASED**
  (Grade 4, Ruggedized)

ALL STOCK UNITS MIL TYPE TF4RX
Class "S" Available on Special Order

High Power Rating	up to 100 times greater.
Excellent Response	twice as good at low end.
Low Distortion	reduced 80%.
High Efficiency	up to 30% better . . . compare DCR.
Moisture Proof	hermetically sealed to MIL-T-27B.
Ultraminiature Size	5/16 Dia. x ⅜" H, 1/15 Oz.

The unique structural design of the DI-T200 series transformers and inductors provides the excellent electrical characteristics, high reliability and wide application possibilities inherent in the UTC DO-T family of miniaturized units. The DI-T200 series units employ the same high quality design found in UTC's DO-T, DI-T, and PIP lines. This unique transformer constructural concept affords unprecedented power handling capabilities coupled with extremely small size. Further, the high degree of reliability has been dynamically proven in the field. These characteristics are basic in the structure, which is ruggedized, hermetically sealed, employing a completely rigid bobbin, eliminating stress and wire movement. The turns are circular in shape rather than square, eliminating turn corner stress, and effecting uniform wire lay. The coil wire and external lead are rigidly anchored terminal board fashion, employing no tapes and brought out through strain relief. The curves illustrated indicate the superior performance of these units compared to similar size units now on the market.

The leads are uninsulated 1" long, .016 D Dumet wire, spaced on a .1" radius circle to conform to terminal spacing techniques of the "TO-5" case semiconductors and micrologic elements.

IMMEDIATE DELIVERY FROM STOCK

Write for catalog of over 1,300 UTC TOP QUALITY STOCK ITEMS IMMEDIATELY AVAILABLE from your local distributor.

UNITED® TRANSFORMER CO.

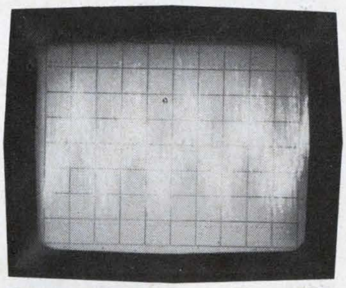
DIVISION OF TRW INC. • 150 VARICK STREET, NEW YORK, N. Y. 10013

ON READER-SERVICE CARD CIRCLE 127

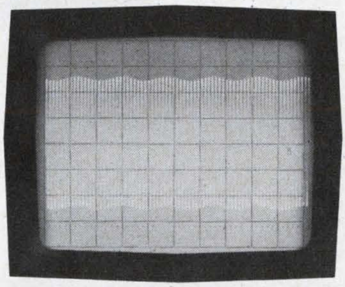
AC MICROVOLTMETER

SEES THROUGH NOISE!

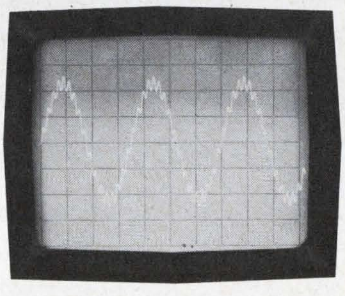
New hp 3410A Measures 300 nanovolts Buried in Noise



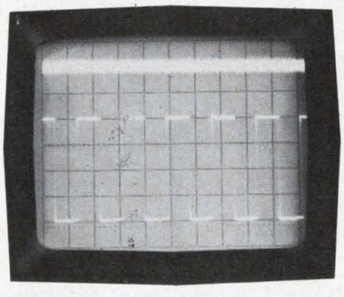
Measure 1 μV, 500 kHz signal out of 40 dB noise.



Measure 10 mV, 5 Hz amplitude modulating 1 V, 400 Hz.



Measure 300 nanovolts, 10 kHz signal superimposed on 10 μV, 1 kHz.



Measure frequency of signal in noise up to 560 kHz by using square wave output, i.e. as a counter preamplifier.

New hp Model 3410A AC Microvoltmeter measures low level repetitive signals obscured by noise—3 μV to 3 V full scale—accuracy ±3%. RMS noise voltages up to 20 dB above full scale *do not affect* readings. Sensitivity, low cost and ease of operation are the 3410A's contribution.

This new microvoltmeter uses an hp designed phase-locked synchronous detector to separate effects of noise from signal. The detector is an electronic gate controlled by an oscillator phase-locked to the input signal. No external reference is required to lock to the input signal. Simply adjust front panel tuning control within 1% of signal frequency and phase-lock circuits *lock-on and track* input signal with ±5% variation in the 5 Hz to 600 kHz frequency range. Phase-lock circuits track 0.5%/sec change in signal frequency without a change in voltmeter accuracy. Input impedance is 10 MΩ shunted by 20 pF.

The new Model 3410A has two outputs on the rear panel. One is a dc recorder output for monitoring long term drifting ac voltage amplitudes. The other is an output for driving an electronic counter to make precise frequency measurements.

For full specifications on the new hp Model 3410A AC Voltmeter, call your hp field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304, Tel. (415) 326-7000; Europe: 54 Route des Acacias, Geneva. Price: hp Model 3410A, $800.00.

097/11

HEWLETT hp PACKARD
An extra measure of quality

ON READER-SERVICE CARD CIRCLE 2

Unit Citation

We're honored! Not that we've won our crusade yet...just another battle ribbon. A while back we scored a military victory with our Model 880, the *first* solid state Mil Spec counter. This time it's a fully-militarized 5MHz all-silicon solid state universal counter-timer. Call it USN/AN-245, sir.

There's a good reason you should be interested. You see, the military model had its basic reliability well proved by our original commercial version, Model 607A. Now *there's* the one for *you!* It offers more features and capabilities than even the Admirals asked for. And it's available on-the-double.

Now hear this: Our lowest-bidder-type price is only $1,575. (Check *that* saving against our competitor!) Then check these features: Model 607A is ideal for wide-range frequency measurements, frequency ratio determination, period and multiple period or time interval measurements, and pulse count totalizing. Time base is a 1 MHz crystal oscillator (for 1 microsec resolution). Display is six decade inline with display storage. BCD output transfers directly to CMC Model 410 tape printer, computer systems, etc. Automatically positioned illuminated decimal. Either ac or dc coupling of input signal. Front and rear A and B channel inputs. Rugged, compact (approx. 3½" high). Available for bench or rack.

THANKS

With all our pride and excitement over our USN/AN-245 award, and other new products, we haven't forgotten our fellow Crusaders who've made this success possible...YOU. A FREE Crusading Engineers medal is our fun-loving way of saying thanks. Get yours by writing for data so you can "Check the Specs" of our 607A. Your "chief" will be so proud of you at mail call!

12973 Bradley/San Fernando, California
Phone (213) 367-2161 / TWX 910-496-1487

CMC

Computer Measurements Company is a Leading Designer and Manufacturer of Electronic Instrumentation to Count, Measure, and Control.

ON READER-SERVICE CARD CIRCLE 3

Electronic Design

THE MAGAZINE OF ESSENTIAL NEWS, PRODUCTS AND TECHNOLOGY

VOL. 15 NO. 9

APRIL 26 1967

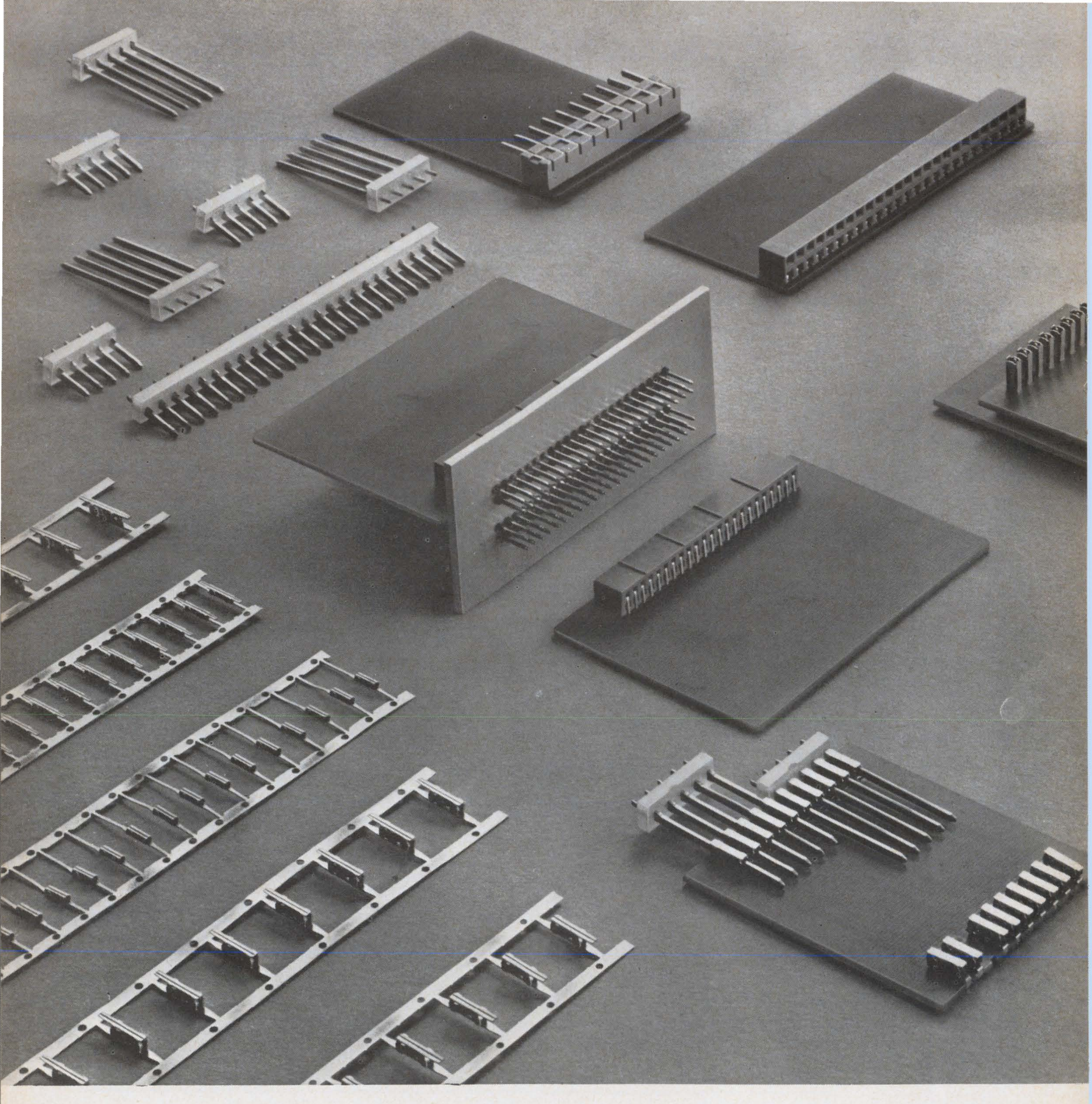
NEWS

TECHNOLOGY

PRODUCTS

Departments

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York, N. Y. 10022. James S. Mulholland, Jr., President. Printed at Poole Bros., Inc., Chicago, Ill. Controlled-circulation postage paid at Chicago, Ill., Cleveland, Ohio, and New York, N. Y. Application to mail at controlled postage rates pending at St. Louis, Mo. 61,945 copies this issue.

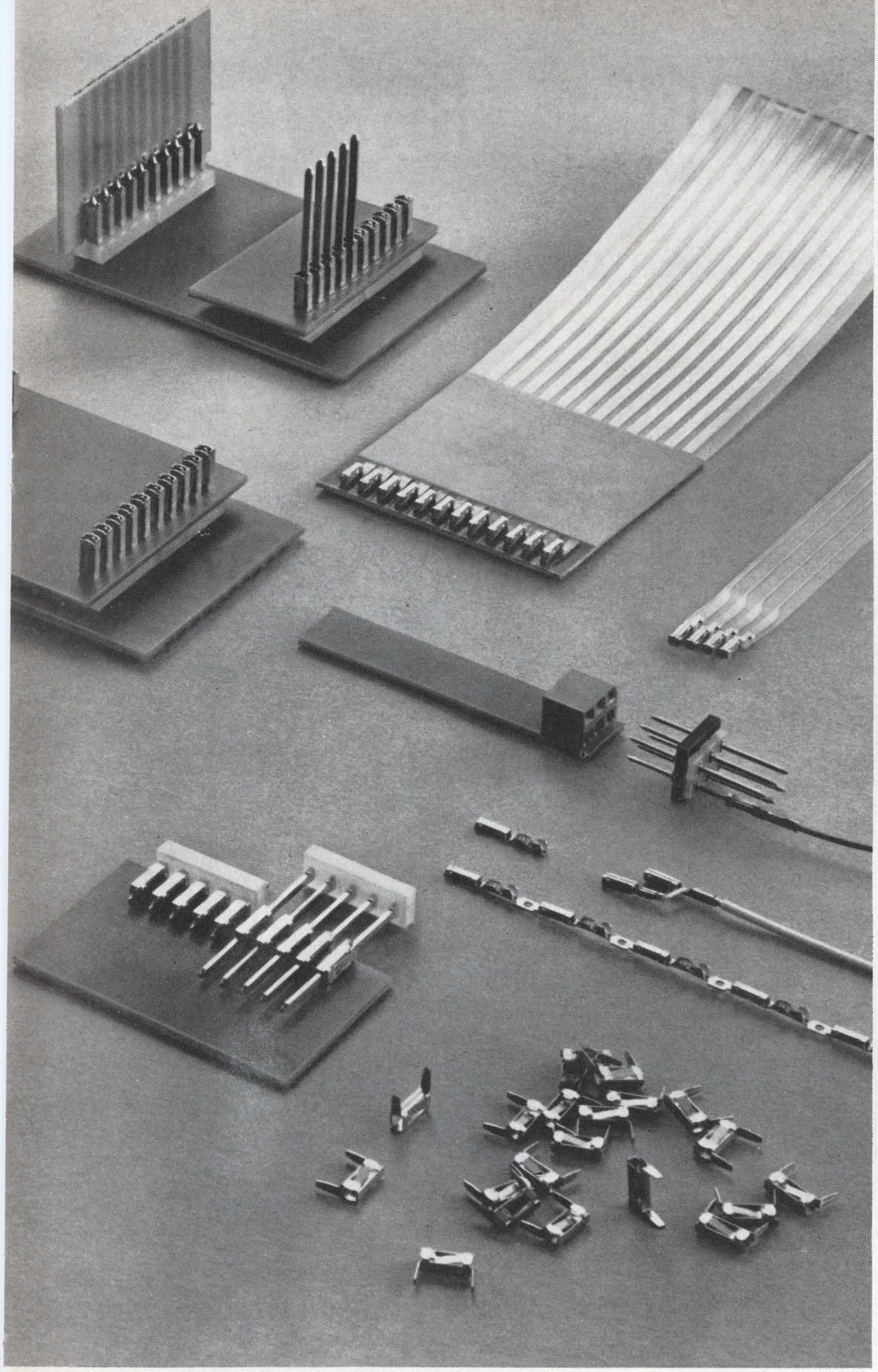


Go modular the easy way

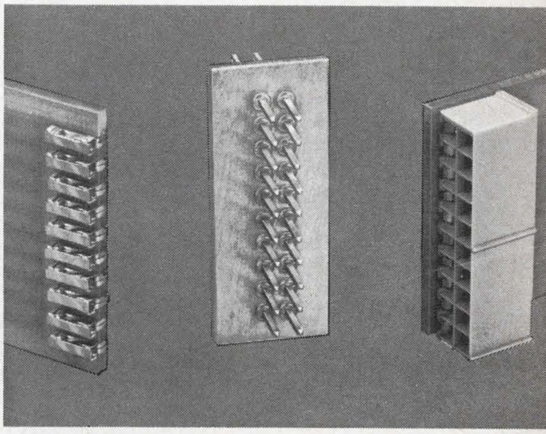
This entirely new approach to modularization is the AMPMODU* Interconnection System. It permits almost unlimited design flexibility, high production speed, and economies resulting from automation and low per line cost.

Specifically designed for modular applications using printed circuit boards, it enables mounting module cards at 90° to a mother board, stacking them, or putting them end to end. The female contacts may be staked directly to a printed circuit board or enclosed in molded housings. Male contacts may be staked directly to a printed circuit board, used in nylon incremental connectors, or mounted with nylon bushings in aluminum grid plates. Two sizes of contacts are available: the standard size, which uses .031 x .062″ posts for mounting on .156″ centers, and the miniature size, which uses .025 x .025″ posts for mounting as dense as .100″. Electrical and mechanical efficiency are enhanced by the simplicity of the female contact design, which includes dual cantilever-beam springs for redundant contact action and anti-overstress devices to ensure reliability. The long life of the phosphor bronze contacts is a result of AMP's special gold plating.

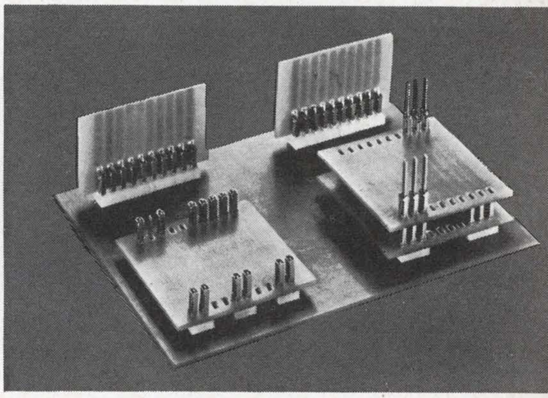
New modular ideas don't have to dead-end at the design stage. For information on how you might use the AMPMODU Interconnection System to modularize your product and lower your costs, write us today.



Automatic machines can stake contacts to printed circuit boards at rates of up to 1800 an hour

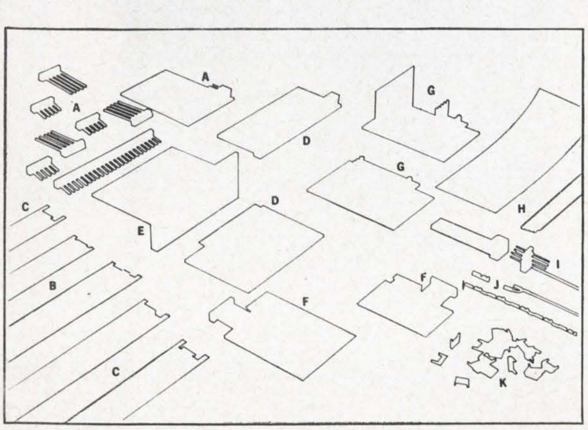


Miniature AMPMODU contacts may be mounted ten to the inch



The AMPMODU female contacts may be mounted in one of three ways for modular connection versatility

ON READER-SERVICE CARD CIRCLE 4



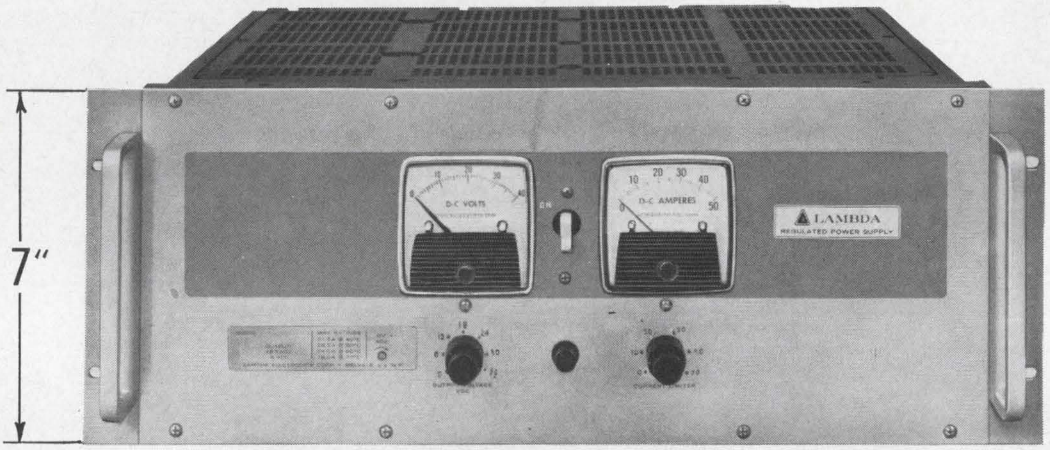
A. AMPMODU Male Incremental Connectors
B. Miniature AMPMODU Female Contacts in strip form
C. Standard AMPMODU Female Contacts in strip form
D. Miniature contacts in two-row housings
E. Grid Plate Header
F. Horizontally staked AMPMODU Contacts with incremental connectors
G. Vertically staked AMPMODU Contacts
H. Flexible tape cable AMPMODU Connectors
I. Molded-in AMPMODU Pin Header and printed circuit board connector
J. Miniature Crimp-Barrel AMPMODU Female Contacts
K. Individual Standard AMPMODU Female Contacts

AMP
INCORPORATED
Harrisburg, Pennsylvania

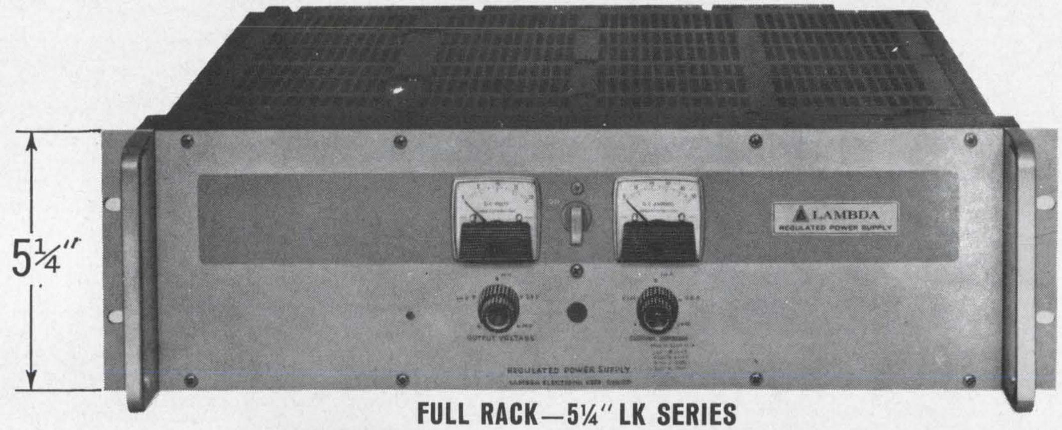
A-MP★ products and engineering assistance are available through subsidiary companies in: Australia · Canada · England · France · Holland · Italy · Japan · Mexico · Spain · West Germany ★Trademark of AMP Incorporated

Only from Lambda—New 7-inch, broadest line of .015% regulated

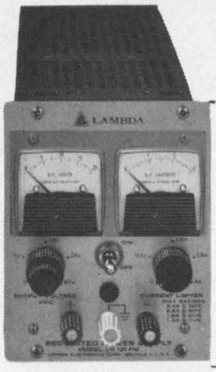
All convection cooled



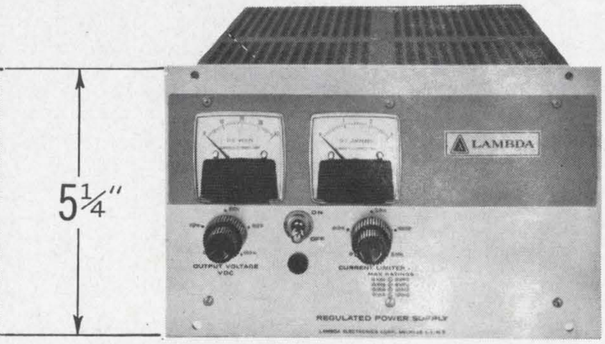
FULL RACK—7" LK SERIES



FULL RACK—5¼" LK SERIES



1/4 RACK—LH SERIES



5 Year Guarantee

HALF RACK—LK SERIES
LH SERIES

LA-178

high current models in the all-silicon power supplies

For test equipment and lab use—rack or bench
From 1/2 to 66 amps, 0-10, 0-20, 0-40, 0-60, 0-120 VDC
Full five year guarantee on materials and labor

Features and Data

- **Convection Cooled**
- **Remote Programming**
- **Remote Sensing**
- **Regulation**—.015% or 1 MV (Line or Load)
- **Temp. Coef.** .015%/°C
- **Transformer**—designed to MIL-T-27 Grade 6
- **Completely Protected**—
  Short circuit proof—
  Continuously adjustable
  Automatic current limiting
- **Constant I./Constant V.** by automatic crossover
- **Series/Parallel Operation**
- **No Voltage Spikes or Overshoot** on "turn on", "turn off" or power failure
- **Meet Mil. Environment Specs.**

  Vibration: MIL-T-4807A

  Shock: MIL-E-4907A
  Proc. 1 & 2

  Humidity: MIL-STD-810
  Meth. 507

  Temp Shock:
  MIL-E-5272C (ASG) Proc. 1

  Altitude: MIL-E-4970A (ASG) Proc. 1

  Marking: MIL-STD-130

  Quality: MIL-Q-9858
- **Ripple**—
  LK models—500 µV RMS
  LH models—250 µV RMS, 1 MV P-P
- **Wide Input Voltage and Frequency Range**—
  Models LK360-362FM: 200-250 VAC, 47-63 cps
  Other LK models: 105-132 VAC, 47-63 cps
  LH models: 105-135 VAC, 45-480 cps.
- **LH models meet RFI Spec.**—Mil-I-16910
- **Rack Adapters**
  LRA-1—5¼" Height x 16½" Depth (For use with chassis slides) Price $60.00
  LRA-2—5¼" Height Price $25.00

3 Full-rack Models — Size 7" x 19" x 18½"

Model[2]	Voltage Range	CURRENT RANGE AT AMBIENT OF:[1]				Price[2]
		40°C	50°C	60°C	71°C	
LK 360 FM	0–20VDC	0–66A	0–59A	0–50A	0–40A	$995
LK 361 FM	0–36VDC	0–48A	0–43A	0–36A	0–30A	950
LK 362 FM	0–60VDC	0–25A	0–24A	0–22A	0–19A	995

3 Full-rack Models — Size 5¼" x 19" x 16½"

Model[2]	Voltage Range	CURRENT RANGE AT AMBIENT OF:[1]				Price[2]
		40°C	50°C	60°C	71°C	
LK 350	0–20VDC	0–35A	0–31A	0–26A	0–20A	$675
LK 351	0–36VDC	0–25A	0–23A	0–20A	0–15A	640
LK 352	0–60VDC	0–15A	0–14A	0–12.5A	0–10A	650

5 Quarter-rack Mcdels — Size 5³⁄₁₆" x 4³⁄₁₆" x 15½"

Model[2]	Voltage Range	CURRENT RANGE AT AMBIENT OF:[1]				Price[2]
		30°C	50°C	60°C	71°C	
LH 118	0–10VDC	0–4.0A	0–3.5A	0–2.9A	0–2.3A	$175
LH 121	0–20VDC	0–2.4A	0–2.2A	0–1.8A	0–1.5A	159
LH 124	0–40VDC	0–1.3A	0–1.1A	0–0.9A	0–0.7A	154
LH 127	0–60VDC	0–0.9A	0–0.7A	0–0.6A	0–0.5A	184
LH 130	0–120VDC	0–0.50A	0–0.40A	0–0.35A	0–0.25A	225

11 Half-rack Models — Size 5³⁄₁₆" x 8⅜" x 15⅝"

Model[2]	Voltage Range	CURRENT RANGE AT AMBIENT OF:[1]				Price[2]
		30°C	50°C	60°C	71°C	
LH 119	0–10VDC	0– 9.0A	0– 8.0A	0– 6.9A	0–5.8A	$289
LH 122	0–20VDC	0– 5.7A	0– 4.7A	0– 4.0A	0–3.3A	260
LH 125	0–40VDC	0– 3.0A	0– 2.7A	0– 2.3A	0–1.9A	269
LH 128	0–60VDC	0– 2.4A	0– 2.1A	0– 1.8A	0–1.5A	315
LH 131	0–120VDC	0– 1.2A	0– 0.9A	0– 0.8A	0–0.6A	320

Model[2]	Voltage Range	CURRENT RANGE AT AMBIENT OF:[1]				Price[2]
		40°C	50°C	60°C	71°C	
LK 340	0–20VDC	0– 8.0A	0– 7.0A	0– 6.1A	0–4.9A	$330
LK 341	0–20VDC	0–13.5A	0–11.0A	0–10.0A	0–7.7A	385
LK 342	0–36VDC	0– 5.2A	0– 5.0A	0– 4.5A	0–3.7A	335
LK 343	0–36VDC	0– 9.0A	0– 8.5A	0– 7.6A	0–6.1A	395
LK 344	0–60VDC	0– 4.0A	0– 3.5A	0– 3.0A	0–2.5A	340
LK 345	0–60VDC	0– 6.0A	0– 5.2A	0– 4.5A	0–4.0A	395

[1] Current rating applies over entire voltage range.

[2] Prices are for non-metered models (except for models LK360FM thru LK362FM which are not available without meters). For metered models, add suffix (FM) and add $25 to price of LH models; add $30 to price of LK models.

[3] Overvoltage Protection: add suffix (OV) to model number and add $60 to the price of LH models; add $70 to price of half-rack LK models; add $90 to price of 5¼" full-rack LK models; add $120 to price of 7" full-rack LK models.

[4] Chassis Slides for full rack models: Add suffix (CS) to model number and add $60 to the price.

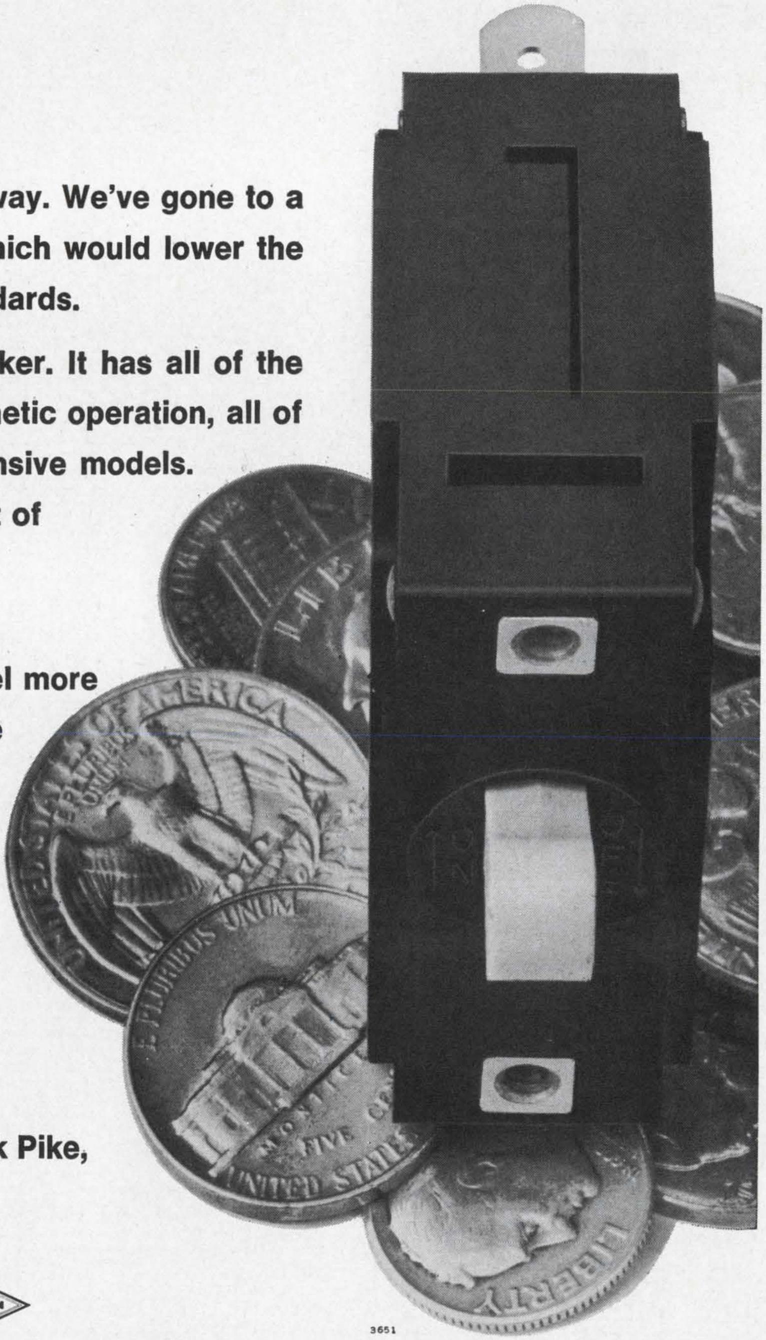
**SEND FOR NEW
LAMBDA CATALOG**

LAMBDA ELECTRONICS CORP.
515 BROAD HOLLOW ROAD • MELVILLE, L.I., NEW YORK 11746 • (516) 694-4200
A Veeco SUBSIDIARY

ON READER-SERVICE CARD CIRCLE 5

Are you sure you can't afford Heinemann circuit breakers?

Here's one you can have for just $4.05.



We really are trying to meet you half-way. We've gone to a lot of trouble to produce a breaker which would lower the price barrier without lowering our standards.

The result is our little Series JA breaker. It has all of the advantages inherent in hydraulic-magnetic operation, all of the features of our larger, more expensive models. But it's priced to make new friends out of passing acquaintances.

In quantities of just six to twenty-five, OEM's can buy this breaker for a nickel more than four dollars. And of course, as the quantity goes up, the price goes down even lower.

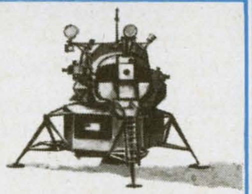
The JA is our idea of meeting you half-way. If you'd like to learn more about it, or any of our other breakers, drop us a line. We'll be happy to send you more complete information.

Heinemann Electric Co., 2616 Brunswick Pike,
Trenton, N. J. 08602.

HEINEMANN

ON READER-SERVICE CARD CIRCLE 6

. . . ABOARD GRUMMAN'S LUNAR MODULE



ERIE — GRUMMAN'S CHOICE FOR EMI FILTERS

These superior EMI FILTERS passed Grumman's critical qualification requirements — including random vibration and high transient withstanding capability. Most of these very small filters weigh less than 10 grams, and their inherent reliability make Erie a natural selection as Grumman's filter source.

Bonded Filter Stock . . . inventories under lock and key in our Quality Control Department . . . is available for LM subcontractors or for other critical programs requiring Established Reliability Filters.

The typical 100 Vdc rated Erie Filter will provide an insertion loss of 67 db @ 150 kHz. A broad line of ERIE FILTERS is available — including MULTIPLE SECTION FILTERS and special configurations for STRIP LINE applications. Custom filters for your applications can be designed. Why not call in an Erie Filter specialist for *your* project?

Write for new catalog 9000 . . . ERIE ELECTRONIC FILTERS

Another Series of Components in Erie's Project "ACTIVE"
Advanced Components Through Increased Volumetric Efficiency

ERIE
TECHNOLOGICAL
PRODUCTS, INC.

ERIE

Erie, Pennsylvania

ON READER-SERVICE CARD CIRCLE 7

Did You Know Sprague Makes 51 Types of Foil and Wet Tantalum Capacitors?

125 C FOIL-TYPE TUBULAR TANTALEX® CAPACITORS

Type 120D polarized plain-foil
Type 121D non-polarized plain-foil
Type 122D polarized etched-foil
Type 123D non-polarized etched-foil

ASK FOR BULLETIN 3602C

ON READER-SERVICE CIRCLE 161

FOIL-TYPE RECTANGULAR TANTALEX® CAPACITORS

Type 300D polarized plain-foil
Type 301D non-polarized plain-foil
Type 302D polarized etched-foil
Type 303D non-polarized etched-foil

ASK FOR BULLETIN 3650

ON READER-SERVICE CIRCLE 162

FOIL-TYPE TANTALUM CAPACITORS TO MIL-C-3965C

CL20, CL21 tubular 125 C polarized etched-foil
CL22, CL23 tubular 125 C non-polar etched-foil
CL24, CL25 tubular 85 C polarized etched-foil
CL26, CL27 tubular 85 C non-polar etched-foil
CL30, CL31 tubular 125 C polarized plain-foil
CL32, CL33 tubular 125 C non-polar plain-foil
CL34, CL35 tubular 85 C polarized plain-foil
CL36, CL37 tubular 85 C non-polar plain-foil
CL51 rectangular 85 C polarized plain-foil
CL52 rectangular 85 C non-polar plain-foil
CL53 rectangular 85 C polarized etched-foil
CL54 rectangular 85 C non-polar etched-foil

ON READER-SERVICE CIRCLE 163

85 C FOIL-TYPE TUBULAR TANTALEX® CAPACITORS

Type 110D polarized plain-foil
Type 111D non-polarized plain-foil
Type 112D polarized etched-foil
Type 113D non-polarized etched-foil

ASK FOR BULLETIN 3601C

ON READER-SERVICE CIRCLE 164

SINTERED-ANODE TUBULAR TANTALEX® CAPACITORS

Type 109D elastomer seal 85 C
Type 130D elastomer seal 125 C
Type 137D hermetic seal 125 C

ASK FOR BULLETINS 3700F, 3701B, 3703

ON READER-SERVICE CIRCLE 165

SINTERED-ANODE CUP STYLE TANTALEX® CAPACITORS

Type 131D 85 C industrial-type
Type 132D 85 C vibration-proof
Type 133D 125 C vibration-proof

ASK FOR BULLETINS 3710B, 3711

ON READER-SERVICE CIRCLE 166

SINTERED-ANODE CYLINDRICAL TANTALEX® CAPACITORS

Type 140D up to 175 C operation, ⅞″ diam.
Type 141D up to 175 C operation, 1⅛″ diam.

ASK FOR BULLETIN 3800

ON READER-SERVICE CIRCLE 167

SINTERED-ANODE RECTANGULAR TANTALEX® CAPACITORS

Type 200D negative terminal grounded

Type 202D both terminals insulated

ASK FOR BULLETIN 3705A

ON READER-SERVICE CIRCLE 168

SINTERED-ANODE TANTALUM CAPACITORS TO MIL-C-3965C

CL14 cylindrical, ⅞″ diam.
CL16 cylindrical, ⅞″ diam., threaded neck
CL17 cylindrical, 1⅛″ diam.
CL18 cylindrical, 1⅛″ diam., threaded neck
CL44 cup style, uninsulated
CL45 cup style, insulated
CL55 rectangular, both terminals insulated
CL64 tubular, uninsulated
CL65 tubular, insulated

ON READER-SERVICE CIRCLE 169

For comprehensive engineering bulletins on the capacitor types in which you are interested, write to:

Technical Literature Service
Sprague Electric Company
347 Marshall Street
North Adams, Mass. 01247

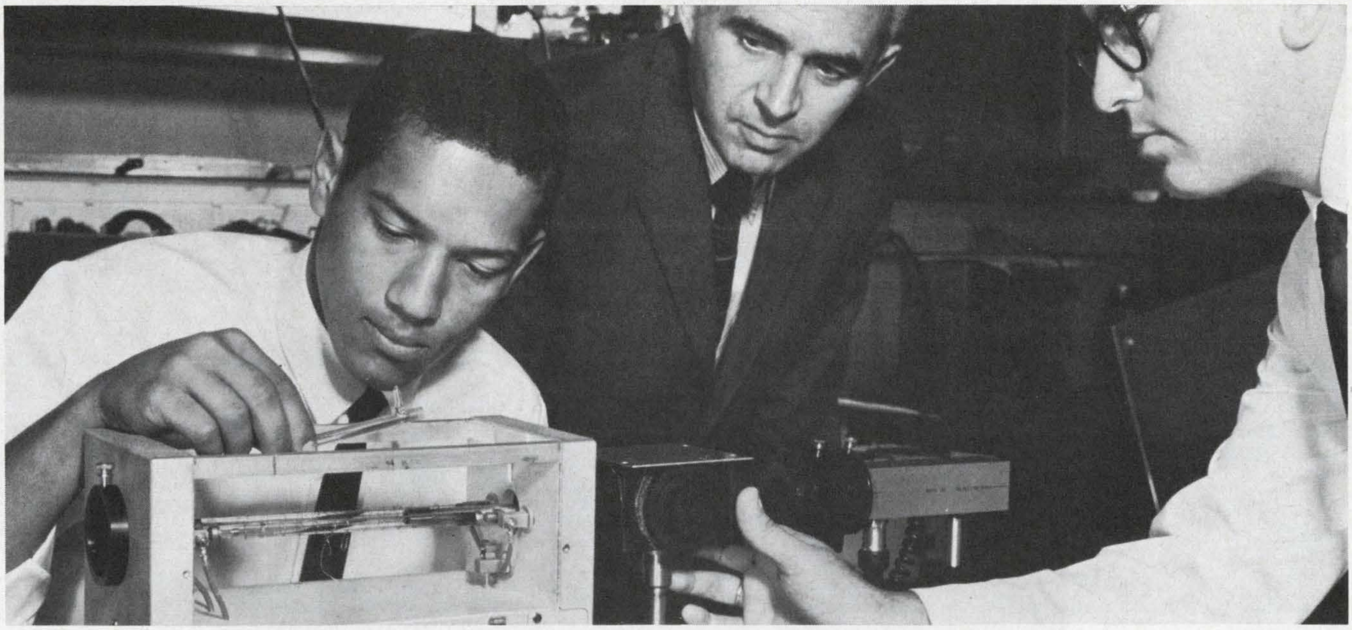
4SC-5158

SPRAGUE®

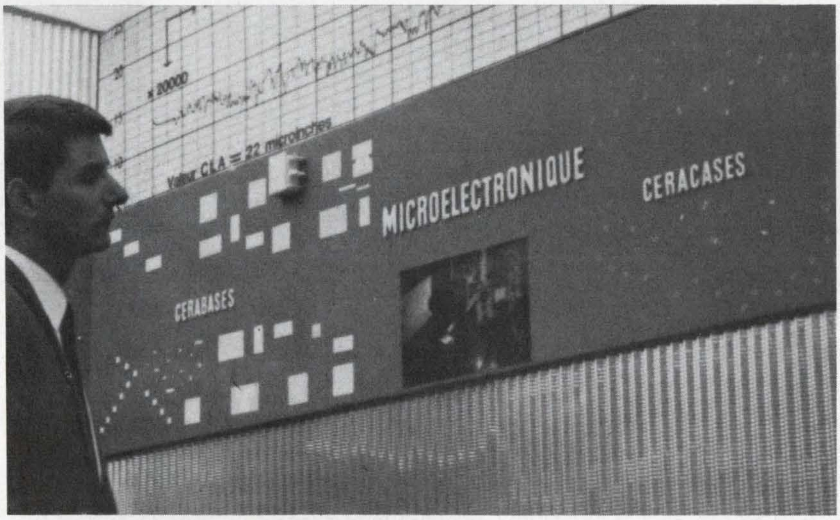
THE MARK OF RELIABILITY

Sprague' and '②' are registered trademarks of the Sprague Electric Co.

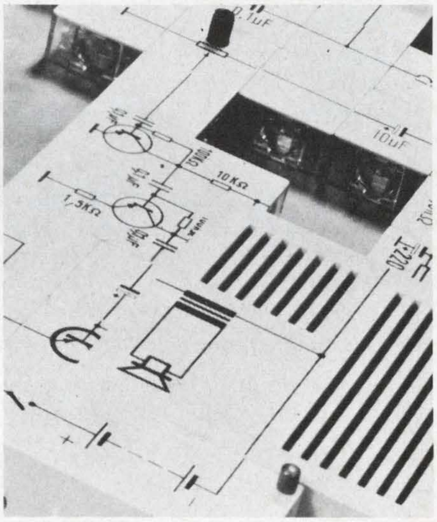
News



Laboratory liquid lasers open new vistas for communications and biological research. Here a device is placed in a flash tube that pumps it to a 1-MW energy burst. Page 17



Europe's dependence on U.S. electronics expertise—and its reaction—evident at Paris components show. Page 24



'Domino' modules help the study of electronics. Page 33

Also in this section:

Electronic robots simulate patients' conditions as medical training aid. Page 38

Complementary MOS arrays about to be marketed. Page 21

News Scope, Page 13 . . . **Washington Report,** Page 29 . . . **Editorial,** Page 77

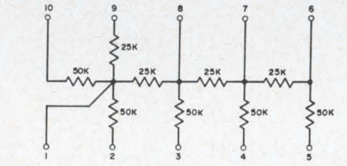
Only from Sprague!

DIGITAL-TO-ANALOG

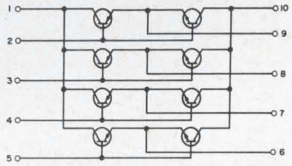
HYBRID D to A CIRCUITS

with precision components not found in monolithic integrated microcircuits

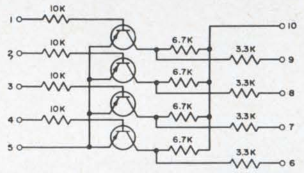
FOUR BIT SERIES



UT-1000 LADDER NETWORK

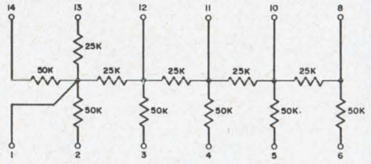


UD-4001 LADDER SWITCH

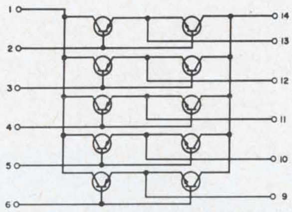


UD-4024 BUFFER AMPLIFIER

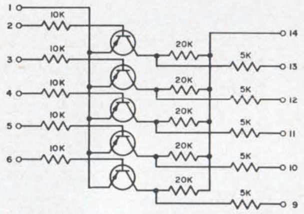
FIVE BIT SERIES



UT-1001 LADDER NETWORK



UD-4036 LADDER SWITCH



UD-4037 BUFFER AMPLIFIER

Up to 12 bits with less than ½ bit error!

- Silicon-base hybrid microcircuits in hermetically-sealed flat packs.
- 3 to 1 size reduction over conventional converters using discrete components.
- Improved tracking over temperature range of −55 C to +125 C.
- Reduced handling of components . . . fewer external connections . . . lower assembly costs.
- 4-bit series expandable to 8 or 12 bits . . . 5-bit series expandable to 10 bits.
- Combination of precision thin-film tantalum nitride resistors, nickel-chromium resistors, and active devices of planar construction.
- Packaged for compatibility with monolithic circuits.

• • • • • • •

For complete technical data on D-to-A microcircuits, write to Technical Literature Service, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts 01247.

SPRAGUE COMPONENTS

THIN-FILM MICROCIRCUITS
INTEGRATED CIRCUITS
TRANSISTORS
CAPACITORS
RESISTORS
PULSE TRANSFORMERS
INTERFERENCE FILTERS
PULSE-FORMING NETWORKS
TOROIDAL INDUCTORS
ELECTRIC WAVE FILTERS
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
BOBBIN and TAPE WOUND MAGNETIC CORES
SILICON RECTIFIER GATE CONTROLS
FUNCTIONAL DIGITAL CIRCUITS

4SS-7101

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

ON READER-SERVICE CARD CIRCLE 8

NASA and contractor take blame for Apollo Fire

The massive 3000-page final report issued earlier this month on the tragic Apollo accident appears to have raised more questions than it answered.

Though the specific cause of the tragedy may never be known, the report did reveal many problems of a technical as well as a managerial nature which, many observers feel, could seriously affect the nation's $23 billion Apollo project.

In their testimonies before Congressional investigating committees, officials of the National Aeronautics and Space Administration and of North American Aviation, Inc., the Apollo spacecraft manufacturer, conceded that they were both blameworthy for the accident and agreed generally with the board's findings.

James E. Webb, NASA Administrator, told sharply critical Congressional investigators that the men of the Apollo project could correct their errors and reach their goal of placing a man on the moon by 1970. He suggested, however, that the review board may have "overstated the case" against Apollo.

North American executives defended their quality control procedures and denied charges that there had been deficiencies in the electrical wiring design, though they admitted that the company had not designed the cockpit to guard against a fire on the ground.

The special eight-man Accident Review Board identified, in their report, the probable cause of the fire as Teflon insulation in a power cable near the environmental control unit. Repeated opening and closing of a compartment door may have worn the wire thin, they said.

Although the board was unable to determine the specific initiator of the Apollo fire, it identified the conditions which it felt led to the disaster. These were:

- A sealed cabin, pressurized with an oxygen atmosphere.
- An extensive distribution of combustible materials in the cabin.
- Vulnerable wiring carrying spacecraft power.
- Vulnerable plumbing carrying a combustible and corrosive coolant.
- Inadequate provisions for the crew to escape.
- Inadequate provisions for rescue or medical assistance.

The board concluded that "in its devotion to the many difficult problems of space travel, the Apollo team failed to give adequate attention to certain mundane but equally vital questions of crew safety."

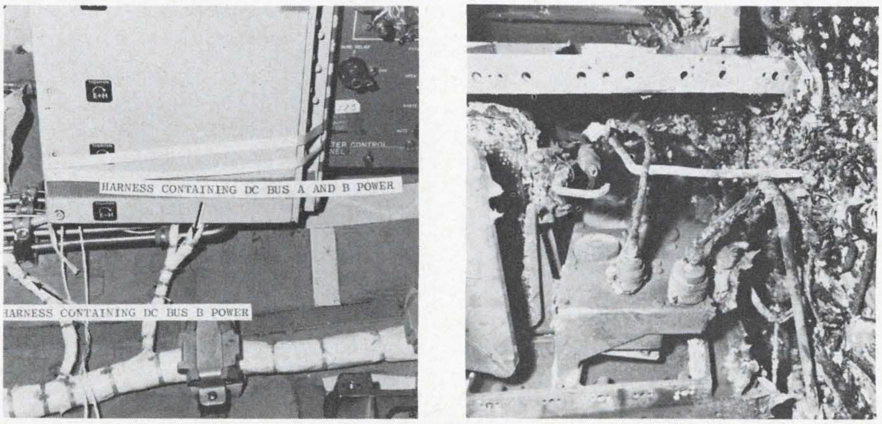
The investigation revealed "many deficiencies in design and engineering, manufacture and quality control."

The board reported that it found "numerous examples of poor installation, design and workmanship in the wiring." For instance, it cited a wrench socket found among some cabling in the spacecraft.

The report gave a wide sampling of problems and shortcomings with the Apollo program in support of its conclusions. Typical of those cited were these three:

- A NASA memorandum issued in September 1966 during mating of the command module with the service module which stated: "Many open design change orders were completed and various malfunctions were noted and corrected. . . ."
- A manned test with flight crew which was initiated soon afterwards but was discontinued after reaching a simulated altitude of 13,000 feet because of failure of a transistor in a spacecraft inverter.
- A second manned altitude test which was discontinued when a failure occurred in an oxygen system regulator.

The review board concluded its report with a long list of recommendations, some of which the space agency is already reported to be implementing. A new quick-release hatch is on the drawing boards. More fire-resistant materials will be substituted for nylon, where it was used, and they will be located at a safe distance from potential ignition sources.



Apollo environmental control unit where fatal fire may have broken out.

French color-TV tube challenges shadow mask

The French are confident that they have come up with a new color-TV tube that will replace the shadow-mask tube in worldwide color set manufacture. It uses a grille of vertical wires and color stripes, rather than dots, to produce color pictures. The wire-grille tube takes one-third the power of the shadow-mask, and thus lends itself well to transistorized design.

The developer of the tube, CFT (Compagnie Française de Télévision)—which also developed SECAM, the French color-TV transmission system—showed a transistorized prototype in operation at its laboratories in Lavellois, near Paris, during the International Components Exhibition, April 5-10. The set produced bright, high-quality pictures in a well-lighted room.

Several other advantages of the tube were cited during the demonstration by André Fouquier, one of the engineers on the CFT team that developed the tube. These include:

- Simple production.
- Flat screens.
- Brighter pictures.
- Use of the same glass as for black-and-white tubes, rather than special glass as the shadow-mask requires.

Since CFT is only an R&D laboratory, it will license manufacturers to make the tube. Already a pilot plant has been sold to the Soviet Union, although the Russians are using the shadow-mask tube for initial color-set production. The French company hopes to get an American licensee to supply the U.S. market; talks are in progress although the company declines to discuss details.

The tube is a 3-gun type with a series of 550 thin stainless-steel wires strung side by side vertically between the guns and the screen. The wires are 0.1 mm in diameter and are spaced 0.75 mm apart. The phosphors are coated on the screen in vertical stripes. There are 480 groups of three color stripes—in blue-green-red sequence—coated on the screen with no spacing between them. Each of these color stripes is 0.27 mm wide.

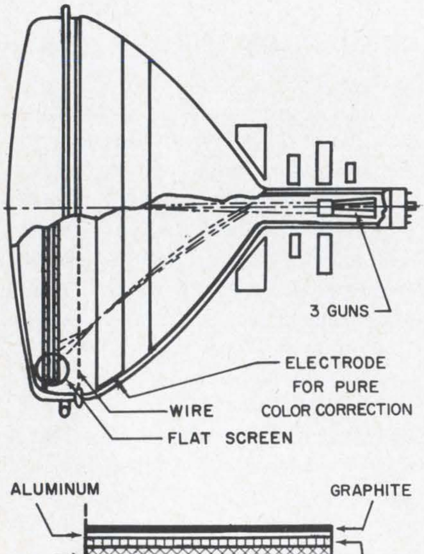
This vertical striping gives the viewer a picture with vertical lines rather than the familiar horizontal pattern. At full brightness no horizontal scan pattern was visible at all, although scanning is done in the normal horizontal manner. At low beam currents, the horizontal pattern begins to be visible, but this would not occur normally.

Voltages for the CFT transistorized set are 25 kV for the screen, 7500 volts for the grid, and 8 kV for the last electrode of each electron gun, according to François Dognin, the engineer who designed the set. He showed that at full brightness the three guns were draining only 100 μA. The tube draws a mean value of about 88 watts from the mains, he said, compared with 350-400 watts for a shadow-mask set.

Key to the low power requirements is the high transmissibility of the mesh. It is about 80% transparent to the beams.

In production the grilles and screens can be made separately, and then any mesh used with any screen. In the shadow-mask tube, matching of mask and dot-pattern on the screen is critical. Alignment of the mask and screen is also simpler in the CFT tube, according to Fouquier, because it has to be done in only the vertical plane. The wires are bonded into the tube envelope between two glass surfaces.

One problem the tube does not eliminate is achieving wider deflection angles, and thus a shorter tube. This tube would run into convergence problems just as the shadow-mask would, according to Fouquier.



Color-TV tube contains flat screen and three guns.

GE enters market for linear ICs

General Electric Co. has revealed that this year it will begin selling off-the-shelf, low-cost, plastic linear integrated circuits. This was disclosed in the company's announcement of a multimillion-dollar program to accelerate development and manufacture of integrated circuits. Hitherto the company has manufactured ICs only for internal use and in limited quantities for special orders.

The program includes establishment of an Internal Integrated-Circuit Center to fill the research and development needs of General Electric's electronic equipment manufacturers. The company will also expand the development and manufacturing capabilities of its Semiconductor Products Dept.

The Internal Integrated-Circuit Center (IICC) will be an organizational part of the company's Research and Development Center, headquartered in Schenectady, N. Y. It will, however, be located at GE's Electronics Park in Syracuse, N. Y. The expanded facilities of the Semiconductor Products Dept. will be added to existing integrated-circuit activities at Electronics Park. The department is responsible for innovations and development in inexpensive electronic devices.

Several GE consumer products paved the way for this expansion, according to a company spokesman. A micro-circuit clock-radio with a built-in battery charger was announced last year. A portable stereo phonograph and a recent stereo tape cartridge player have proved the flexibility of the integrated-circuit approach to entertainment products, he said. A zero-voltage switching IC for application in electric heating has also been announced recently.

Army moves to adopt computer-aided design

Computer-aided circuit design is likely to become a standard Army engineering tool, according to a Pentagon spokesman. Lt Col. Daniel J. Walsh of the Army Office of the Chief of Research and Development said that the move would probably accompany the Army's adoption of large-scale integration.

He told a NASA seminar at MIT that the Army was already putting computer-aided design to extensive use in a number of applications:

- ECAP, NET-1 and CIRCUS programs are in use at the Redstone Laboratories, Huntsville, Ala., in the analysis of the effects of radiation on electronic circuitry.
- SCEPTRE is being investigated by the Nuclear Engineering Directorate at Picatinny Arsenal, Dover, N. J., for use in the safety analysis of solid-state circuits.
- NET-1 is being applied to synthesizing uhf switching circuits as part of an optimization program at Fort Monmouth, N. J.

evaluating
semiconductors?

use one of these Tektronix transistor curve tracers to meet your needs

The performance range of the Type 575 enables you to evaluate the dynamic characteristics of most semiconductor devices.

Several transistor characteristic curves may be displayed including the collector family of NPN or PNP devices in a common base or a common emitter configuration with forward or reverse biasing. The Type 575 features collector sweep supply ranges continuously variable from 0 to 20 V at 10 A, or 0-200 V at 1 A. A base or emitter step generator, operating at either 2 or 4 times the line frequency, provides 4 to 12 steps per family of characteristic curves in single or repetitive display modes. The step generator provides voltage increments from .01 V/step to 0.2 V/step or current increments from .001 mA/step to 200 mA/step.

Choose the Type 575 MOD 122C transistor curve tracer for evaluating higher voltage devices.

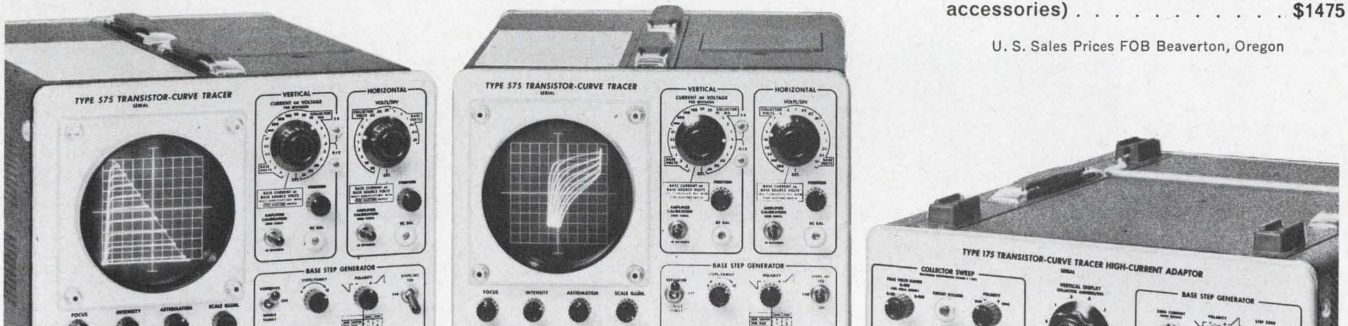
The Type 575 MOD 122C has the same features of the Type 575 plus the capability of diode breakdown test voltage variable from 0 to 1500 V at 1 mA and a much higher collector supply voltage of up to 400 V at 0.5 A.

For evaluating high current semiconductors, add the Type 175 High Current Adapter to either of these curve tracers.

The Type 175 features collector sweep supply ranges of 0-200 A at 0-20 V and 0-40 A at 0-100 V. The Type 175 step generator provides current ranges from 1 mA/step to 1000 mA/step and voltage steps from 0.5 to 10 V/step with driving resistance selectable from 11 values ranging from 0.5 ohms to 1 k ohm. Other resistance values may be added externally.

Type 575 Transistor Curve Tracer (including accessories)	$1075
Type 575 Transistor Curve Tracer MOD 122C (including accessories)	$1325
Type 175 High Current Adapter (including accessories)	$1475

U. S. Sales Prices FOB Beaverton, Oregon



Tektronix, Inc.

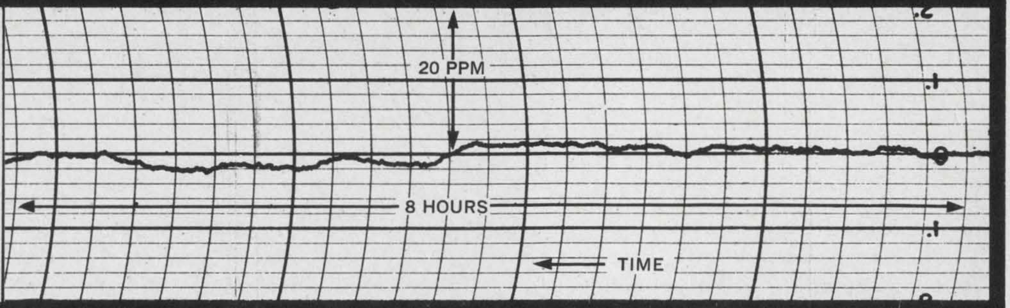
For complete information, contact your
nearby Tektronix field engineer or write:
Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005

ON READER-SERVICE CARD CIRCLE 9

PAR offers a line of superior precision voltage/current reference sources

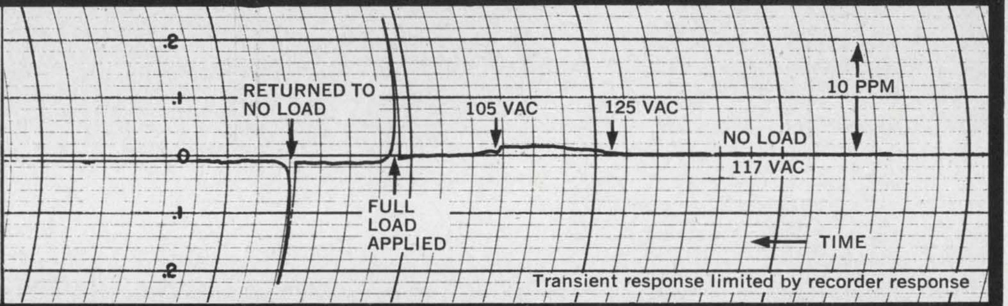
.001%

STABILITY



.0001%

LINE & LOAD REGULATION



Model TC-100.2BR

Princeton Applied Research Corporation offers a sophisticated line of power supplies providing extremely stable voltage and current outputs whose accuracy is traceable to N.B.S. All models are completely solid state and feature a careful, conservative design leading to highly reliable operation. Indicative of the features found in these units is a unique chopper-stabilized amplifier with a DC open-loop gain of 5 x 10^6, falling off no faster than 6 db/octave to unity gain. This insures extremely low output impedance (less than 10 micro-ohms at DC) and fast transient response without ringing.

PAR Reference Sources permit considerable operational flexibility, having been used in such diverse applications as serving as the reference voltage in analog computers to providing the constant current required in "bucking" coils in elaborate magnetometer systems. All units feature digital output selectors, complete short circuit protection, and low ripple and noise. Write for Bulletin No. 112.

INDEX OF PAR REFERENCE SOURCES

MODEL NO.	OUTPUTS		ACCURACY		RESOLUTION		100 HOUR STABILITY		PRICE
	CONST. V.	CONST. I.	CONST. V.	CONST. I.	CONST. V.	CONST. I.	CONST. V.	CONST. I.	
TC-260R	0 to 60 V @ 2 A max.	0 to 2 A @ 60 V max. (Requires Ext. Resistors)	0.01%	0.01% ± Accuracy of Ext. Resistors	1 μV	Determined by Ext. Resistors	.001%	.001% ± stability of external resistors	$1,250.
TC-100.2R	0 to 100 V @ 200 mA max.	0 to 100 mA* @ 100 V max.	0.01% of F. S.	0.02% of F. S.	1 mV	1 μA	.001%	.002%	$1,500.
TC-602CR	0 to 6 V 0 to 60 V @ 2 A max.	0 to 60 mA 0 to 600 mA 0 to 2 A @ 60 V max.	0.01% of F. S.	0.03% of F. S.	1 μV min.	10 nA min.	.001%	.002%	$1,750.
TC-100.2AR	0 to 100 V 0 to 10 V 0 to 1 V @ 200 mA max.	0 to 100 mA* 0 to 10 mA 0 to 1 mA @ 100 V max.	0.01%	0.02%	10 μV min.	10 nA min.	.001%	.002%	$1,800.
TC-100.2BR	0 to 100 V 0 to 10 V 0 to 1 V @ 200 mA max.	0 to 100 mA* 0 to 10 mA 0 to 1 mA @ 100 V max.	0.01%	0.02%	100 nV min.	100 pA min.	.001%	.001%	$2,200.
SF-Series (Fixed)	Any fixed voltage to 100 V @ 2 amps max.	Any fixed current to 2 amps @ 100 V max.	Within setting resolution		Up to 1 ppm of adjustable range about nominal		.001%	.001%	By quotation only.

*Available to 200 mA (at extra charge).

P A R **PRINCETON**
APPLIED RESEARCH CORP.

Dept. E
Box 565 Princeton, N. J., Tel. (609) 924-6835

ON READER-SERVICE CARD CIRCLE 10

Liquid lasers for high-power cw operation sought

Wider pulsed applications and such laboratory features as 'tunable' colors are also investigated

Richard N. Einhorn
News Editor

The search for new laser materials has been going on ever since Theodore H. Maiman developed the first working model of a laser in 1960. Solids, gases, plasmas, semiconductors, plastics—all have been tried with varying degrees of success. Liquids, too, have been used, and, in the opinion of some scientists, liquid lasers offer the greatest potential for high-power, continuous operation. But other applications are being studied, too.

Two recent developments in liquid-laser technology have been announced by major companies.

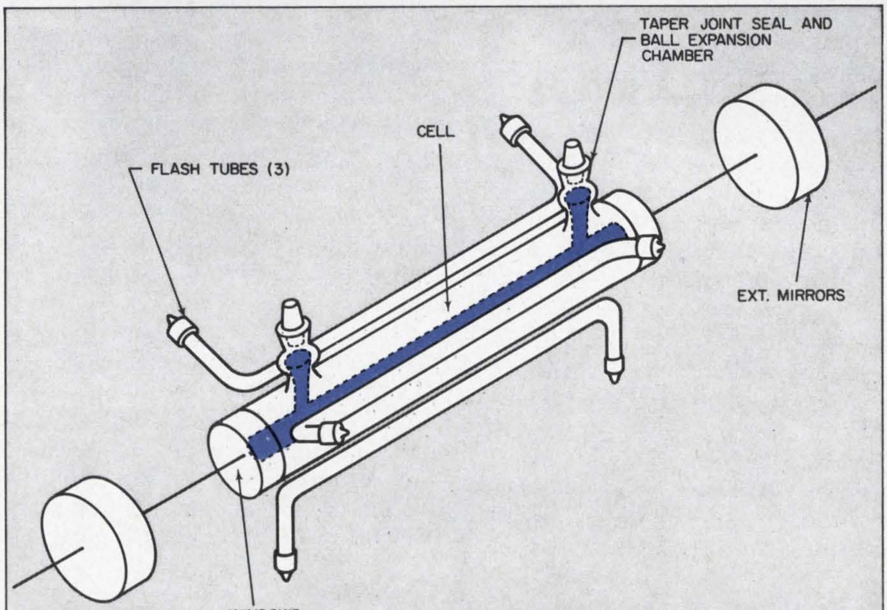
In the first, General Telephone and Electronics Laboratories, New York, unveiled an experimental device using a class of chemicals not previously tried as a lasing medium. Its laser is capable of producing a 1-MW burst that lasts a fraction of a microsecond. Researchers hope ultimately to achieve continuous operation at high power for communications applications.

The second was the disclosure by the Research Div. of the International Business Machines Corp., Yorktown Heights, N. Y., of a rapidly pumped liquid laser that can radiate four colors, one at a time, through the routine substitution of one solution of organic dye for another in the laser cell. The previous color literally goes down the drain. In principle, this offers a useful source of all wavelengths in the visible–infrared spectrum for laboratory work.

Liquids may best solids

Why the interest in liquids? Well, the energy output of a laser is a function of the volume of the active medium. The larger the lasing medium, the greater the ultimate energy output. Since liquid lasers can be made in lengths far exceeding those of crystalline lasers, the ultimate energy output of the liquid laser is expected to be higher. But there are other advantages as well.

Take solids. To get solid-state lasers to function, an almost perfect glass is needed, for example. It must be free from strains or distortions, and it must possess a uniform refractive index. Even a slight imperfection might ruin it for laser purposes, because of erratic operation and shortened lifetime.



1. **Energies of 1 MW** have been achieved in liquid laser by General Telephone scientists. Three flash tubes activate a lasing solution in a cell only 6 inches long. The medium is a rare earth in a heavy inorganic solvent.

In high-power operation, rubies and other crystals often fail catastrophically when subjected to the massive internal scattering that accompanies laser action. The heat causes cracking and sometimes explosions of the crystal or glass. In liquid lasers, on the other hand, circulation of the liquid could remove heat and thereby permit continuous operation. Even without circulation the liquid can restore itself during pulsed operation.

Liquid lasers have the potential of constant optical character. They are about as good as gas lasers in spatial coherence and beam divergence. They are not readily degraded. Even if the lasing solution decomposes or is contaminated, it can be purified by circulation through a bladder-like device. Or, if a nonlasing peroxide should form because of exposure to air, oxygen can be driven off by heating in the dark.

Still another benefit is the economy of producing liquid lasing materials. Fabricating a perfect glass rod a foot or more in length is a major undertaking that costs thousands of dollars. Solid-state crystal lasers require a laborious, expensive growing process. By way of contrast, liquids can be prepared in a few minutes in the laboratory.

First liquid laser used chelate

The first successful demonstration of a liquid laser was reported in 1963 by Alexander Lempicki and Harold Samelson of General Telephone and Electronics Research Laboratories. Acting on the 1958 theoretical prediction of Charles H. Townes and Arthur L. Schawlow that it should be possible to build a laser using +3 ions of the rare-earth element europium, Lempicki and Samelson proceeded to do just that. However, they introduced a

(**liquid lasers,** *continued*)

new wrinkle: they dissolved europium benzoylacetonate in an alcohol solution. Townes and Schawlow had had a solid in mind.

This material is known as a chelate—a compound of a rare earth in an organic solvent. Unfortunately, chelate lasers were limited in performance because the light atoms of the chelate absorb much of the energy.

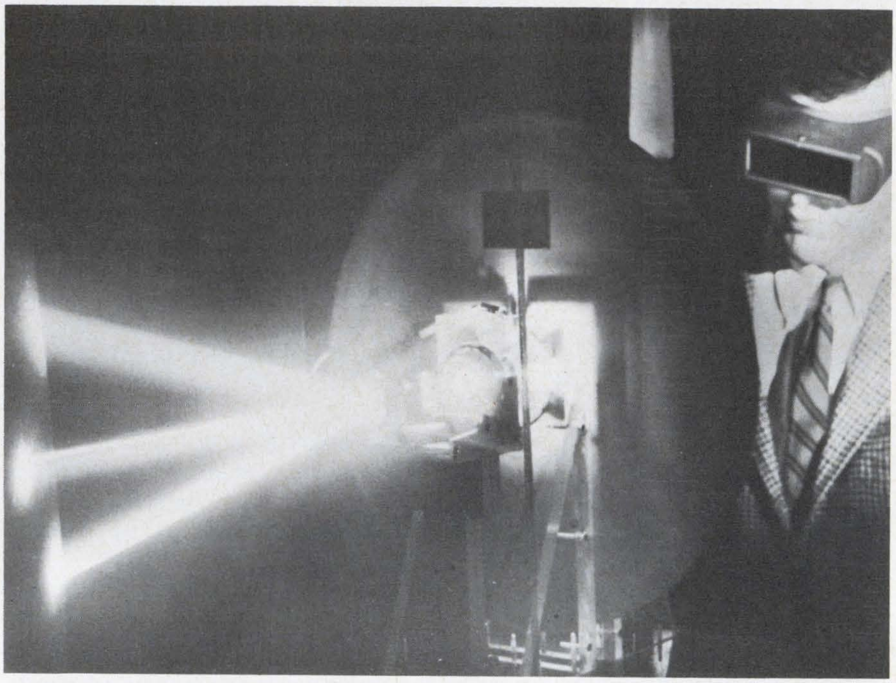
Recently scientists at General Telephone and Electronics Laboratories improved upon their pioneering efforts. Lempicki and Adam Heller evolved a liquid laser in which the active medium is formed by dissolving neodymium, a rare earth, in selenium oxychloride, an inorganic compound. The advantage lies in the absence of atoms of low mass. This greatly increases efficiency, because the neodymium ions are more likely to emit photons, which are discrete quanta of light energy, than to dissipate their energy in heating the solvent. The new approach is not limited to these specific chemicals. Conceivably a whole new family of liquid lasers could arise in which the active medium would be a combination of rare-earth ions and heavy-atomic-weight solvents.

Already Lempicki and Heller have achieved energy bursts of 1 MW peak—approximately 100 times greater than the output of previous liquid lasers—but only for a fraction of a microsecond. Still, they claim to have the first liquid laser that is competitive with solid lasers.

Engineering problems loom

High-power, continuously operating liquid lasers, however, are not imminent. Says Lempicki: "There are both fundamental and engineering problems to be solved before continuous liquid lasers can be developed. From the point of view of efficiency of the medium itself, it (the neodymium-selenium oxychloride solution) is a completely satisfactory material. But no one has come up with a really good method for handling the liquids.

"There are serious engineering problems in the circulation. The liquid is quite corrosive and requires the development of a special pump."



2. **High-speed flash lamp** is the key to IBM liquid laser that varies color of beam simply by flushing cell and introducing different organic dye solution.

The compound is indeed chemically stable. At the recent IEEE International Convention the laser was flashed more than 500 times for curious engineers, and at the end the liquid was just as good as at the beginning.

The device operates most effectively at room temperature or slightly above it. Its properties are affected only by variations in temperature, not by elevated temperature per se. Circulating the fluid would maintain uniform temperature, but this, of course, would require the special pump that Lempicki mentioned.

"One of our objectives is to build a laser which will pulse 20 times a second," he says, "but for high repetition rate you must have circulation of the lasing liquid." In its present version, with stationary fluid, the laser is flashed once a minute.

Communications use desired

The application for a continuously operating liquid laser would be obvious: communications. A continuous laser beam is theoretically capable of accommodating a great many telephone conversations, as well as business data and television data. It is particularly well suited to space communications.

"If we had a continuous laser, we would definitely try to use it for communications," Lempicki says. "However, we are also working on pulsed lasers for special communications, such as for the Air Force."

At present the device works at a wavelength of 1.06 microns, which lies within the infrared region. This is not unlike glass lasers.

When asked whether devices of this type could work in the visible spectrum, Lempicki replied, "We have not done this yet. Offhand, there is no fundamental reason why it shouldn't be possible to do this."

The General Telephone laser (Fig. 1) uses commercially available flash tubes to activate the lasing medium. Input energy required is about the same as that for a solid-state or glass laser of comparable size.

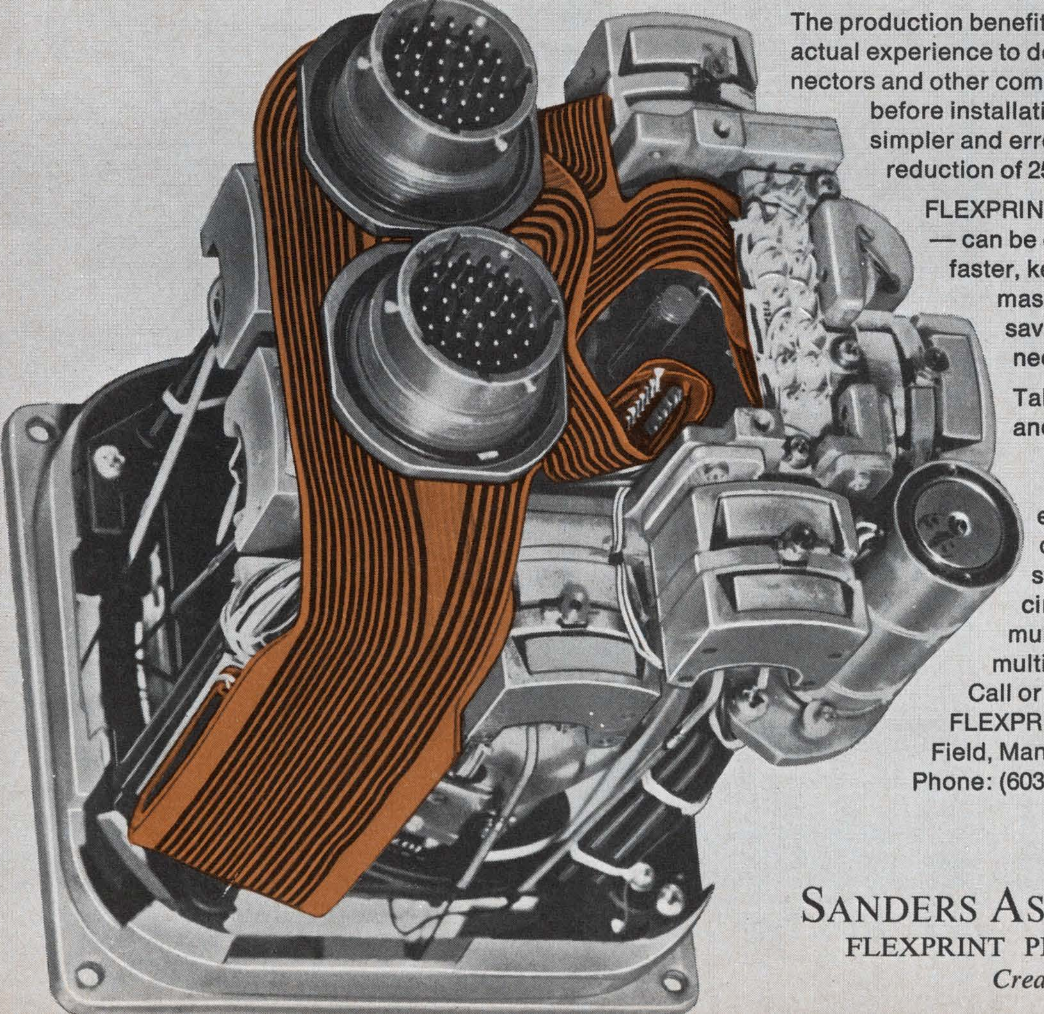
Extensive research would be needed before laser communications links could become a reality. But General Telephone's development is a significant step forward.

There are other applications for

At Sperry Phoenix...when FLEXPRINT® Circuitry goes in, the package gets smaller... and costs go down

The design advantages of FLEXPRINT circuitry for Sperry's HZ-6B Attitude Director Indicator were evident from the start. Four thin, custom-engineered FLEXPRINT circuits would replace 67 separate bulky conductors. The finished assembly would then fit into a much smaller package.

The production benefits were less obvious. It took actual experience to demonstrate that attaching connectors and other components to FLEXPRINT circuitry before installation made assembly faster, simpler and error-free . . . and resulted in a reduction of 25% in installed wiring costs.



FLEXPRINT circuits handle like components — can be completely pre-tested, assembled faster, keyed for one-way insertion, and mass produced with precision — at savings over any other interconnection method.

Take advantage of our experience and capabilities in solving interconnection problems at lower installed costs. A FLEXPRINT engineering representative is fully qualified to discuss the best answer to your needs: FLEXPRINT circuitry, FLEXMAX flexible multilayer circuits or INTRAMAX* multilayer hardboard.

Call or write Sanders Associates, Inc., FLEXPRINT Products Division, Grenier Field, Manchester, New Hampshire 03103. Phone: (603) 627-3811

*T.M., Sanders Associates, Inc.

SANDERS ASSOCIATES, INC.
FLEXPRINT PRODUCTS DIVISION
Creating New Directions in Electronics

Did you know Sprague makes...?

HIGH SPEED, FLAT T.C. MEMORY TRANSFORMERS

Featuring nanosecond output rise time, minimum variation of magnetizing inductance with temperature, and balanced output between windings. Ideally suited for interstage coupling, output drive, and sense memory applications. Rapid delivery to facilitate prototype evaluation.

ASK FOR BULLETIN 40350

On Reader Service Card Circle 882

MINIATURE MOLDED-CASE PULSE TRANSFORMERS

Molded construction for superior temperature/humidity resistance. Variety of turns ratios and magnetizing inductances with increased bandwidth available. Designed for general digital use.

ASK FOR BULLETIN SERIES 40225

On Reader Service Card Circle 883

MEMORY TEMPERATURE CONTROLLERS

EMI-free. Type VZS Series SCR firing packages employing zero voltage or cross-over switching. Low in cost. Temperature regulation, ±2° F typical. Controls resistive or inductive loads.

ASK FOR BULLETIN 87500

On Reader Service Card Circle 884

DELAY LINES

Single or multiple delay in lumped constant or distributed constant designs are tailored to meet customer requirements. Furnished in either cast epoxy or molded cases. Applications include digital circuits in computers, radar equipment, etc.

On Reader Service Card Circle 885

MAGNETIC LOGIC CIRCUITS

For those applications where only magnetics will do. Sprague Electric offers custom engineering service and experience in depth. Fixed and variable incremental scalers, shift registers, gates, and associated driving circuitry.

On Reader Service Card Circle 886

DYNACOR® BOBBIN CORES

Logical flux values in popular physical sizes are stocked in production quantities for fast delivery. Value engineered for quality with economy. Widely used for current regulation and memory drive.

ASK FOR BULLETIN SERIES 50000

On Reader Service Card Circle 887

For complete technical data on any of the standard products, write for applicable Engineering Bulletin(s) to Technical Literature Service, Sprague Electric Co., 347 Marshall St., North Adams, Mass. 01247. For information on custom delay lines or magnetic logic devices, address your inquiry to Special Components Marketing.

4SSC-6157

SPRAGUE®

THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

(**liquid lasers,** *continued*)

liquid lasers, and other configurations as well. For example, Bell Telephone Laboratory scientists make incidental use of liquid media for frequency-mixing experiments.

Organic dyes change beam color

A completely different tack has been taken by Peter P. Sorokin and J. R. Lankard of the IBM Research Div. They have developed a compact, conveniently operated device that may well provide energy at almost every wavelength in the visible–infrared spectrum. The basic idea is to substitute organic dyes in a range of colors to fill the spectrum. The color of the beam is changed simply by flushing the cell and refilling it with another dye.

Following the unsuccessful attempts of others, these two men observed lasing action in organic dyes in 1966. In their initial experiments, however, they had to pump the active medium with a giant pulsed-ruby laser. This was expensive and cumbersome, and no wavelengths shorter than the ruby's could be produced without complex frequency-doubling techniques.

Sorokin and Lankard learned to circumvent this by observing the properties of the organic dyes. They came to the conclusion that earlier experiments using flashlamps as laser pumps had failed because there had been no control over occurrence of the giant pulse. Intense flashlamps with slow rise times tended to introduce more loss than gain because of inductance effects. Since flashlamps were rich in energy throughout the infrared and visible spectrum, they would, however, be an ideal source.

Sorokin and Lankard proceeded to develop a flashlamp with a rise time measured in nanoseconds. The new laboratory device consists of an active laser cell, a flashlamp that surrounds the cell and a disk-shaped discharge capacitor (Fig. 2).

The cell that contains the liquid is a quartz tube with polished ends. This is surrounded by a second quartz cylinder. The flashlamp discharges into the space between the two cylinders. The capacitor is a thin disk mounted coaxially with the two cylinders. A copper conducting sleeve fits over the outer cylinder to form a path to the two end electrodes. This configuration lowers lamp inductance, thereby contributing to a sharper rise time for the pumping pulse.

To date, Sorokin and Lankard have successfully produced lasing in four different fluorescent organic dyes of the xanthene family. They have observed green, yellow, orange and red. Sorokin says that there is no theoretical reason they cannot reproduce all the wavelengths in the visible–infrared spectrum.

Multicolor for biological research

One use to which the IBM laser may be put is as a laboratory tool for cell biology.

"The different components of a cell, which in turn have different functions, often have the property of being stained with different dyes," Sorokin explains. "When a given component takes up a dye, you can selectively destroy it by pulsing it with a laser frequency that coincides with the dye absorption spectrum. You can study the cell for a few minutes to discover how it functions without the destroyed component."

Microphotographers have already used ruby lasers, but the IBM laser is more widely useful because the experimenter can run through the spectrum until every component has been tested. Sorokin uses the term "tunability" in order to describe the usefulness of the dye-substitution method.

Tunability is not an idly chosen word. In addition to gross changes in color, the emission band of any one dye can be shifted at least 600 A by changing the concentration of the dye.

Other applications for this laser might be in aircraft, beacons and for satellite-tracking, Sorokin points out. It is compact and inexpensive to make and it can be designed for high repetition rates.

The optical properties of this laser more closely resemble those of a solid laser than of a gas laser. Since alcohol is commonly used in the solvent, the swirling action must be allowed to settle after the flash. There is an initial decrease in power after flashing, but this tends to stabilize.

IBM laser does not operate cw

Unlike the General Telephone and Electronics laser, the IBM device is not expected to serve in continuous operation.

"It will not have the brute continuous power or duty cycle of a carbon dioxide laser, but it will give off 1-MW pulses," Sorokin says.

The device is scaled down in power from a ruby laser. With an input energy of 50 joules, the output is 0.2 joule—an efficiency of 0.4%. However, this was achieved with air as the pumping gas. Sorokin sees no difficulty in achieving 1% efficiency with xenon.

By way of comparison, Bell Telephone Laboratories cites 0.1% for helium-neon lasers at 0.2 watts in continuous operation. YAG (yttrium-aluminum-garnet) solid lasers operate at 1% efficiency at 25 watts continuous. But YAG lasers are limited to the kilowatt range for pulsed operation, whereas the liquid devices mentioned have megawatt potentialities.

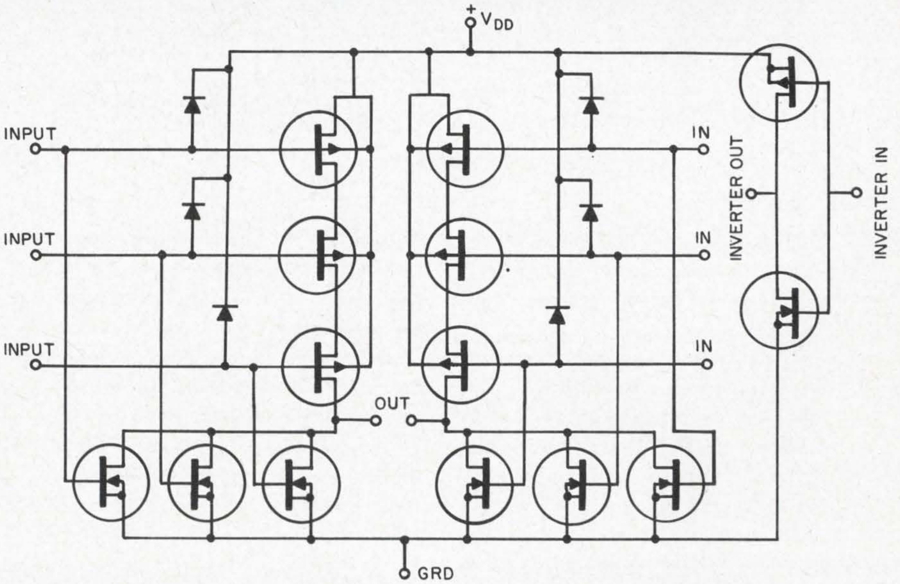
The future of liquid lasers, like that of all other types, is problematical. Sorokin points out that the entire laser technology is less than seven years old.

"Liquid lasers just open one more class. Whether they are any better or any worse than the others remains to be seen," he comments. ■ ■

Complementary MOS arrays going to market

There are two ways to achieve high-speed switching (above 2 GHz) at extremely low-power dissipation with MOS logic arrays: use either four-phase logic or complementary MOS arrays.

RCA feels that the processing problems associated with the diffusion of complementary MOS transistors are not very serious and that it is easier to overcome them than to put up with the disadvantages of operating four-phase logic. Four-phase, says RCA physicist Dr. Richard Ahrons, is only suitable for ac logic: the clock must be running and data must be moving through the system at all times. Complementary MOS transistors can perform static logic as well as ac logic. RCA will market a complementary MOS dual-input NOR gate in June. ■ ■



Current cannot flow directly to ground in this complementary MOS array. It dissipates 10 nanowatts when idle and 400 microwatts at 100 kHz.

Semiconductor sets charges off safely

A detonator that exploits the thermal-runaway characteristics of semiconductors has been developed by the Sandia Corp., Albuquerque, N. M. The device is said to provide an extremely reliable means of detonation.

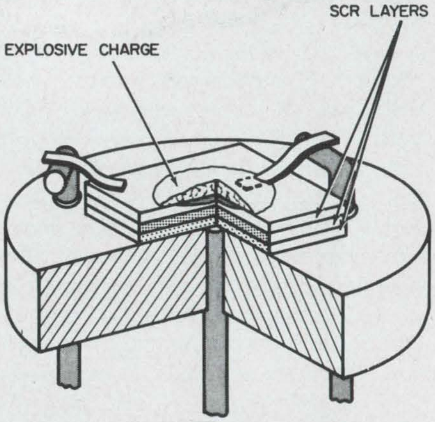
Thermal runaway is obtained by applying the energy signal and the control signal simultaneously. This is ordinarily bad practice in semiconductor design, because resistance decreases, current flows more heavily and the temperature at the main pn junction rises. But in the new detonator the resultant heat is used to set off the explosive charge.

Since this device requires coincidence of two signals, it is far less susceptible to accident than bridge wires or resistance wires, which can be activated by human error, circuit malfunction or radiation fields. An even greater margin of safety can be built in by using three or more signals, Sandia says.

The detonator contains Si layers doped with p- and n-type impurities. The electrodes are mounted axially, like the leads of a transistor.

Several configurations of the multisignal detonator are possible, all of which lead to considerably greater miniaturization than is possible with conventional detonators.

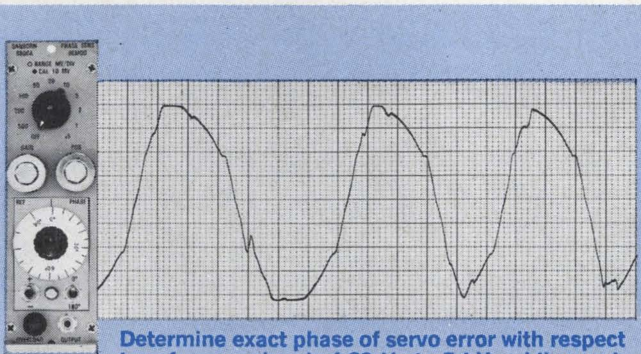
The device was designed and patented by Frank A. Goss, Jr., who is on leave from Bell Telephone Laboratory. ■ ■



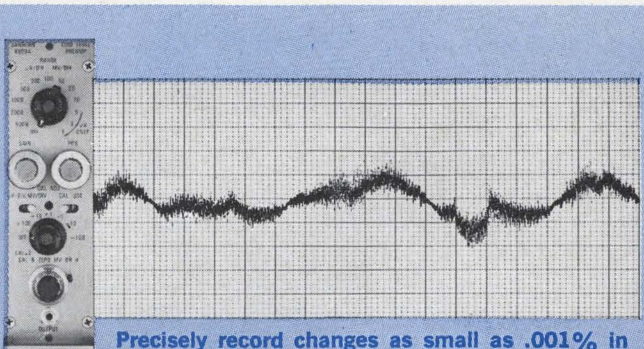
Multisignal detonator uses thermal-runaway properties of a semiconductor to satisfy a logic function.

Bring on your complex, small, noisy, difficult signals.

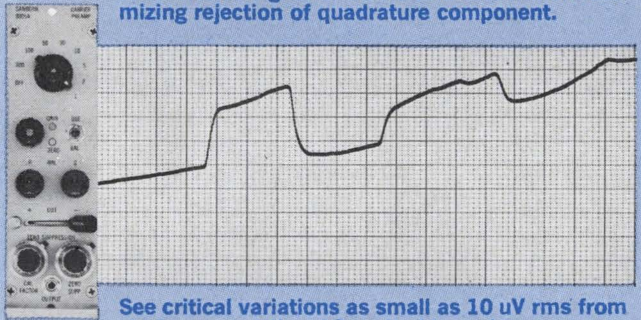
We'll give you traces that show them for what they really are.



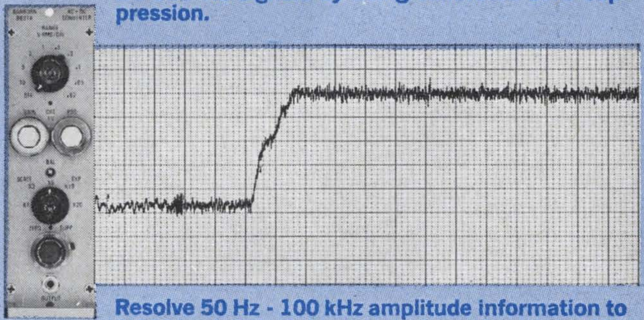
Determine exact phase of servo error with respect to reference signal of 60 Hz to 5 kHz while maximizing rejection of quadrature component.



Precisely record changes as small as .001% in DC-100 Hz signals by using calibrated zero suppression.



See critical variations as small as 10 uV rms from strain gages, other AC-excited transducers.



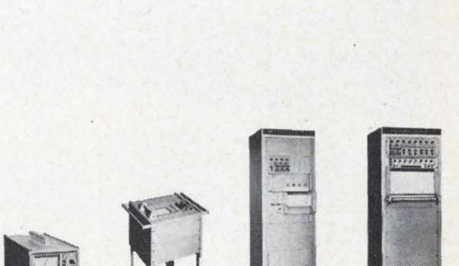
Resolve 50 Hz - 100 kHz amplitude information to 0.02% of full scale signals from 1 volt to 500 volts.

When you need the greatest possible degree of signal-conditioning precision and operational control, Sanborn 7700 Series oscillographs with solid-state "8800" plug-ins will give you chart recordings of *maximum resolution and intelligibility.*

Seven highly versatile signal conditioners offer unique performance capabilities: three DC types with a 1 uV - 250 V dynamic range, floating differential input and calibrated zero suppression . . . an AC-DC Converter with calibrated zero suppression and scale expansion permitting resolution better than 0.1%, 10 ms response and isolated, 1 meg. input . . . a phase-sensitive demodulator with calibrated reference phase shift, 90° calibrated dial with four quadrant selections, and a frequency range of 60 Hz to 5 kHz . . . a carrier preamp with 2400 Hz internal transducer excitation supply, calibrated zero suppression, cal. factor control and conversion gain of 10,000 . . . and a general-purpose DC preamp particularly useful for 100 mm wide chart recording.

Use any of these "8800" plug-ins in the 7700 thermal writing oscillograph matched to your packaging and channel requirements — 4-, 6- and 8-channel 7704A, 7706A and 7708A console types . . . 2-channel 7702A system in rack-mount or mobile cart versions . . . single-channel 7701A wide chart (100 mm) portable system. Every one of these thermal writers will give you permanent, rectangular-coordinate recordings whose resolution and accuracy make all your measurements more useful.

For a new brochure describing the advantages and wide choice of Sanborn thermal writing oscillographs, write Hewlett-Packard Company, Sanborn Division, 175 Wyman Street, Waltham, Mass. 02154.



HEWLETT PACKARD SANBORN DIVISION

ON READER-SERVICE CARD CIRCLE 13

At the Paris Electronics Show

Europe girds for battle with Goliaths of U.S.

France studying plan that aims to make Europe independent of U.S. microcircuit technology

Robert Haavind
Managing Editor

PARIS

European dependence on American financing and expertise in electronics has become a major political issue on the Continent, and nationalistic efforts are under way to counteract the trend.

Both the degree of the present dependence and the European reaction against it were much in evidence at the International Components Exhibition here April 5-10.

The French appear to be making the strongest efforts to develop their own electronic industry. Consideration of a Plan Composants by the Government of Charles de Gaulle was revealed at the show by Marc Colonna, who heads the Industry Ministry's Direction des Industries Mécaniques, Electriques et Electroniques. The plan would be similar to Plan Calcul, which was initiated at the beginning of this year to achieve a completely European-based computer industry. The aim of the new program, show exhibitors said, would be to develop independent microcircuit technology, so that Plan Calcul computers would not have to be built with U.S.-supplied chips.

Comparison of the exhibits here with the IEEE Show in New York in March—or even more significantly with discussions at the Solid State Circuits Conference in Philadelphia in February—reveals what an enormous task Europe faces. One engineer from a large British company in the microelectronics business summed up the situation with a colorful twist of phrase:

"We're just a bit of fur on the top of the beast. We could stand here and hop up and down all day long and no one would notice."

The big difference between European and American electronic progress, this engineer and others indicated, is that American research is almost entirely subsidized by the Government.

"We can't keep up with outfits like TI or Fairchild with all that Government support," the British engineer commented. "In our case the Government market is peanuts. We're going it for the industrial and consumer business."

Microcircuitry on display at the show was primarily based on silicon planar technology. A little MOS developmental work by CSF-Compagnie Générale de Télégraphie Sans Fil was in evidence, while the General Instrument Corp. and Philco-Ford's Microelectronics Div. showed they were ready to market MOS arrays—GI through a Milan subsidiary and Philco-Ford with a master decal approach. The latter approach, to be introduced in May, allows the user to design and fabricate his own circuit configuration.

The promise of electronics for raising the entire economic status of a nation appears to be behind the French urgency to curtail dependency on the U.S. Plan Calcul was initiated to offset investments by the General Electric Co. in Compagnie des Machines Bull in 1964, when Bull was on the verge of going bankrupt.

Appointed to head the European venture in computer design and programing training was Robert Galley, fresh from a major post in the development of a French nuclear capability. As an official in atomic energy, Galley was responsible for organizing French industry to construct a $1-billion enriched-uranium plant. Independent companies have been formed to develop computers (Compagnie Internationale pour l'Informatique) and peripheral gear (Société Sperac).

1968 marketing goal

Galley is expected to have about $130 million over the next four years for computer development and programing training. He will also have a say in all Government computer purchases. Since the French endeavor doesn't expect to have a machine on the market until late '68, IBM and Bull-GE, the largest suppliers here, expect to get a continuing share of the market for some time.

Bad feeling engendered by the Bull-GE maneuver—layoffs were necessary before the company regained its equilibrium—is being felt in the components and semiconductor areas here, according to some French representatives. Other American manufacturers are proceeding much more warily than in

E. Schafer of Depex, N.V., Holland, inspects an amplifier chain for collective antennas, being shown by M. Portenseigne of France.

Don't be manipulated on SCR's—trust IR.

IR's Application Fact Book lets you select only specs that count.

SCR specifications take on a refreshing air of common sense when you read the new IR Application Fact Book. When do premium parameters really affect circuit performance? What do you give up to get a given parameter? What *combinations* of premium parameters are needed *and possible*...and at what price? You get the answers straight from IR, and you make your selection from quality SCR's rated from 4.7 amps to 550 amps RMS—25 to 1300 volts.

Specifying engineers are in the pivotal position today to smooth out production problems, to end delivery dilemmas, and protect performance. How? By writing specs around the parameters actually needed and actually available...off-the-shelf, overnight. Most of the information needed to write such common sense specs can be found right in the book. If your application is farther out, call an IR sales engineer. We are pioneers, too, and know how to help you innovators.

APPLY YOURSELF TO THE FACTS OF SCR DESIGN. Write for IR's Application Fact Book. It's free, and it's packed with data to help you sidestep problems from design to delivery of: regulated power supplies, frequency converters, DC motor drives...*you name it!*

INTERNATIONAL RECTIFIER
(213) OR 8-6281 · TELEX 6-74666 · EL SEGUNDO, CALIF.

ZENER AND REFERENCE ZENER DIODES □ SILICON CONTROLLED RECTIFIERS □ SELENIUM RECTIFIERS □ SILICON ASSEMBLIES

(Paris show, *continued*)

the past, after watching the GE experience.

An exchange of views at a reception given by the American Electronic Industries Association on the second day of the exhibition reflected this wariness.

William T. Ellis of the EIA's international department, reading some remarks in French with a somewhat Americanized pronunciation, expressed the hope that the French electronic industry had benefited by the investments and technical assistance of American companies.

The reply by Charles Legorju, president of the Components Exhibition, was quite pointed:

"You have made allusion to the importance of American investments in France. This concerns a delicate matter, because our country lacks the enormous absorption possibilities that your national marketplace offers, and it's important that competition between companies respects the scale of the differences."

Although some fresh European ideas were apparent at the show, many merely reflected the dominance of U.S. technology. Following is a run-down of some of the more significant products of both types:

A 140-MHz quartz-crystal oscillator shown by the Marconi Co., Ltd., Chelmsford, England, was mounted on a TO-5 header. The oscillator will put out 15 mW at frequencies from 60 to 140 MHz, depending on the crystal chosen. In airborne equipment several oscillators might be kept in an oven to get higher stability, according to Dr. S. S. Fortes, manager of applications engineering for Marconi's Microelectronics Div. The price is $30 to $50, depending on quantity. Multiple standard chips were used rather than a single monolithic circuit, Dr. Fortes explained, because volume did not warrant the expense of making special masks.

A 150-MHz transistor of unique design that has already produced 25-W outputs and is expected to reach 50 W soon was a highlight of the CSF-Compagnie Générale de Télégraphie Sans Fil display. Cosem, the CSF semiconductor subsidiary, is developing the device and expects to market it in 1968.

In structure the device resembles RCA's interdigitated transistor. The unique aspect is the doping profile (shown in the diagram), according to a CSF spokesman.

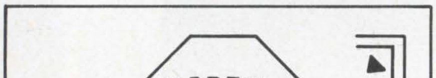
CSF was also showing ferrite waffle-iron memories, based on work at Bell Telephone Laboratories that was reported to the Solid State Circuits Conference three years ago.

Nondestructive readout may be possible with a new technique developed by CSF. In this type of memory a flat ferrite plate has grooves cut in rows and columns. Nickel-iron films are deposited over the resulting checkerboard pattern. The films are isotropic, but the grooves beneath them give an anisotropic effect (preferred directions of magnetization), needed for storage. In the normal destructive type of memory, bits are stored diagonally across an intersection. In the nondestructive mode being studied by CSF, the bits are stored in fields linking vertically adjacent corners.

Cofélec, CSF's magnetics subsidiary, will be marketing a destructive readout memory featuring a 200-ns read-write cycle time. This type of memory operates on small currents; yet it is insensitive to exterior magnetic fields, in contrast with thin-film types. It should be easier to manufacture than core memories, CSF believes.

The company expects applications

(continued on p. 32)



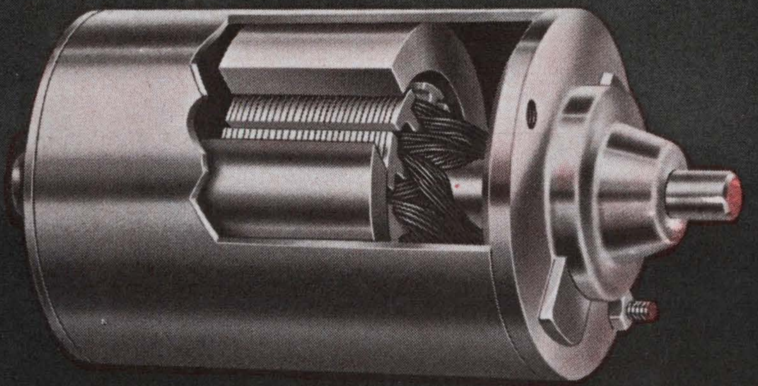
French-made 150-MHz transistor has reached 50 watts output at 150 MHz. It has an interdigitated emitter (top).

Oscillator in a TO-5 can has a quartz crystal (top) mounted over a multichip circuit. The smallest chip in the center is a transistor. The one to the left of it is a resistor network and the two above it are capacitors.

American Bosch

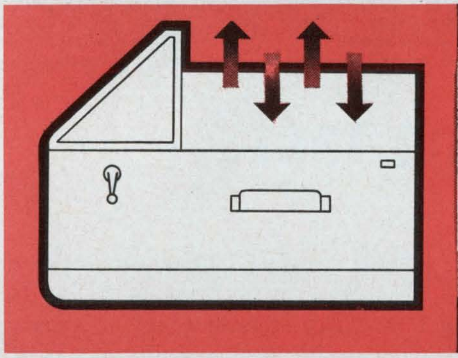
uses Allen-Bradley Oriented Ceramic Permanent Magnets...

because of their uniformity in staying within specifications,
and delivery schedules—though tight—are kept!

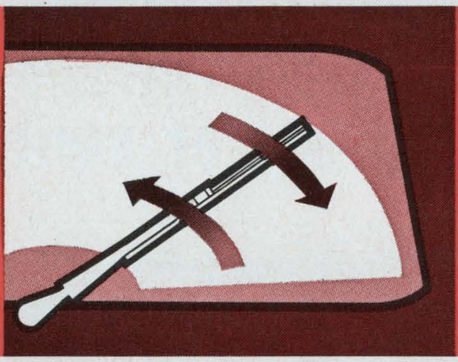


American Bosch
permanent magnet motors
are used for...

power windows



electric windshield wipers

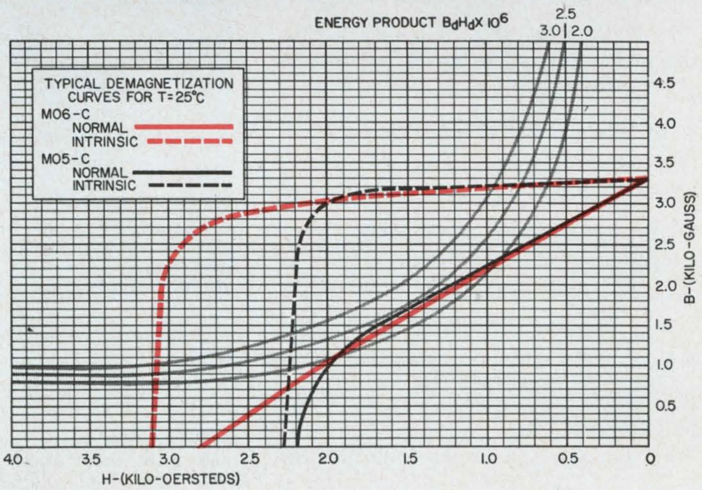


power seats

■ Allen-Bradley's quality control procedures assure the continuously uniform properties—both electrical and physical—that are essential to profitable large volume motor production. The most modern manufacturing facilities in the hands of technically experienced craftsmen produce the highest quality, radially oriented ceramic permanent magnet segments that are presently available.

Allen-Bradley ceramic permanent magnets can be furnished for a wide range of motor sizes—from 3/4" diameter up to a 10 hp motor rating. They are available in a variety of types—having different properties—to satisfy your specific requirements. A-B application engineers will be happy to consult with you in developing your dc motors for maximum motor performance. Allen-Bradley Co., 1344 S. Second St., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Limited. Export Office: 630 Third Ave., N.Y., N.Y., U.S.A. 10017.

Properties of typical Allen-Bradley ceramic permanent magnets



ALLEN-BRADLEY

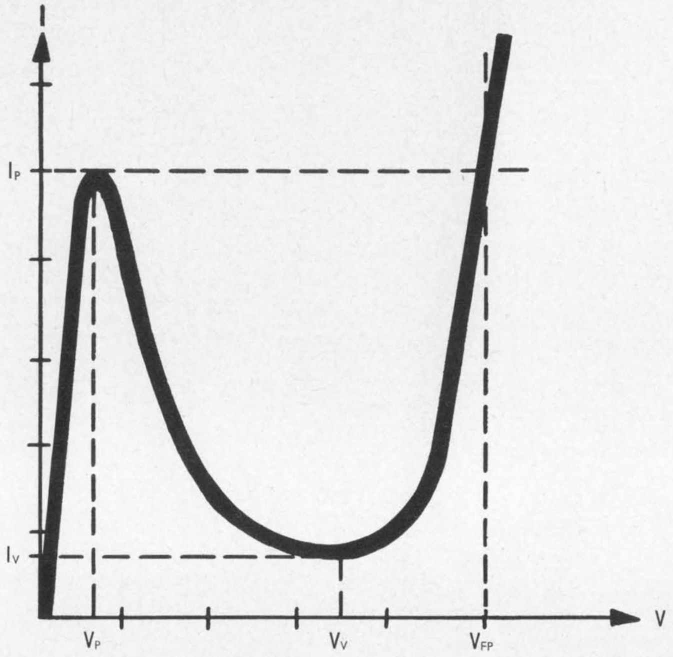
QUALITY MOTOR CONTROL
QUALITY ELECTRONIC COMPONENTS

866-3AB

ON READER-SERVICE CARD CIRCLE 15

ELECTRONIC
INNOVATIONS
IN ACTION

Now tunnel diodes cost as little as 50¢



Hadn't you better switch fast?

If tunnel diode performance at transistor prices sounds impossible, take another look at GE tunnel diodes.

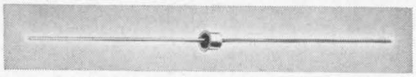
Now you can get a typical switching speed of 1.5 nsec. or better in current ratings from 0.5 mA to 10 mA. Power dissipation is as low as 40 microwatts per unit.

All that performance can cost as little as 50¢.

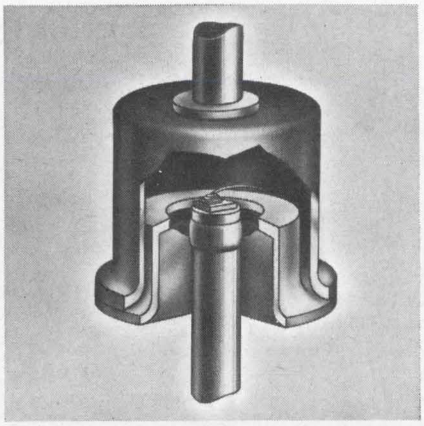
And your circuits will benefit from greater packaging density, lower power consumption, and fewer components to perform a given function.

New General Electric tunnel diodes are available either in axial lead packages, or in pellet form for hybrid integrated circuits.

At the new low prices you can now use GE diodes in many new applications. Why not try them for current or time delay thresholding, high-speed logic circuits, high-frequency oscillators or amplifiers, UHF mixers, or sense amplifiers?



Actual size low-cost GE tunnel diode



Planar and thin film fabrication techniques, used to form the germanium tunnel junction, make lower prices possible.

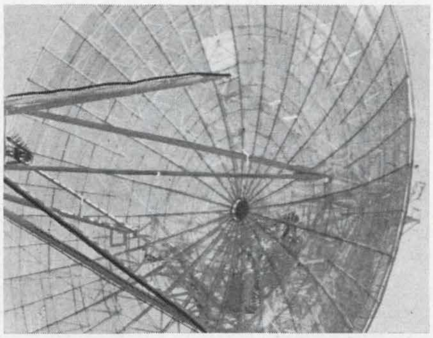
This is just one more example of the low-cost semiconductor leadership and total electronic capability GE offers you.

For further details call your nearest GE engineer/salesman, or semiconductor distributor. Or write to Section 220-50, General Electric Company, Schenectady, N.Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: Electronic Components Sales, IGE Export Division, 159 Madison Ave., New York, N.Y.

SEMICONDUCTOR PRODUCTS DEPARTMENT

GENERAL ELECTRIC

ON READER-SERVICE CARD CIRCLE 811



Wanted: A huge allied network

Washington Report

S. DAVID PURSGLOVE,
WASHINGTON EDITOR

Billion-dollar radio link sought

Over a billion dollars may be involved in developing a common radio communications system to link United States and allied forces on the battlefield. That is the figure used by Defense Dept. officials who are discussing the plan. It will link battle units of the United States, Canada and Australia, and, perhaps later, most NATO countries. The proposal, which may include communication satellites, involves so much money that the U. K. has withdrawn for financial reasons. Pentagon officials are trying to persuade the British to rejoin. Observers believe that any such success may rest on granting the British a large measure of the development and production contracts.

Project Mallard, as the planning phase is called, has received approval from the Director of Defense Research and Engineering, John S. Foster, the No. 3 man in the Pentagon, and has now been sanctioned by Defense Secretary Robert S. McNamara (see News Scope, p. 14).

The system will permit not only allied battlefield commanders to talk to one another, it will also allow communications between the troops of one nation and those of another. Thus an Australian infantry patrol leader could direct U.S. fighter-bombers to tactical targets, or a U.S. company commander could call for support from Canadian tanks previously designated as his back-up.

The hope at the Pentagon is that Mallard will so completely standardize radio equipment and communications practices among the cooperating nations that lower-echelon commanders will be able to talk directly to one another without going through a high-echelon switchboard. The Pentagon has selected Canada and Australia—and hopes to regain Britain—for the early phases of the program because of the common language. Wherever possible, voice communications will be used. Messages between small battle units attached to the same large element will be relayed by portable ground stations, according to present plans. Messages between more widely separated units would be handled by communications satellites.

According to McNamara's announcements, the project will be operated from Fort Monmouth, N. J., under the direction of Brig. Gen. Paul A. Feyereisen. A staff member of the Canada-U.S. Military Cooperation Committee said Canada would be represented in the project by Lt. Col. D. C. Coughtry, and Australia by Lt. Col. L. G. Moore.

The U.S. Defense Dept. hopes to have the system operational by 1975-77. About three and a half years would be allowed for development of working designs. This project-definition phase would cost $40 million, of which the U.S. would provide 60 per cent. The U. K. was to have put up 32 per cent and Canada and Australia 4 per cent each. If Britain cannot be persuaded to rejoin the effort, the U.S. would likely pick up her share.

If the project definition works out on schedule, Pentagon sources say, then a $1-billion production program would follow.

U.S. aid for school computers urged

A Presidential committee has urged that the Federal Government give computer programs in colleges the same degree of financial support that it now gives the schools' libraries—about $60 a student. If the recommendation is followed, the advanced computer facilities now available at a few pioneering colleges and universities would be commonplace by 1971 at nearly all institutions of higher learning in the country.

The suggestion for aid has come from a panel on computers within the President's Science Advisory Committee. The panel contends that computers have become such important learning tools that the Government should support a program to give every college student access to one.

(continued on p. 30)

The committee is headed by Dr. Donald Hornig, the Presidential Science Adviser, and the chairman of the computer panel was Dr. John R. Pierce of Bell Telephone Laboratories, Inc., Murray Hill, N. J. Once a program for Federal aid is under way, the panel suggested, it could be extended to computer programs in high schools.

Post Office R&D gains momentum

A year ago a staff member of the House Science and Astronautics Committee, noting the growing postal research and engineering program, commented that the Post Office R&D budget might easily exceed $100 million a year in about five years. Now he says his estimate was too conservative. That budget was $12 million in fiscal 1966, $16.2 million in 1967, and the request for 1968 is over $23 million.

The biggest part of the budget is given over to electronics. Here are projects in the works:

The Post Office Bureau of Research and Engineering is looking for digital recording equipment that might be applied to "off-line" letter-sorting systems. It would provide a system for "canceling" without touching the envelope or defacing it. Presumably the mail—of a special type—would be numbered, and the digital system would record the numbers as the envelopes passed by. A number used twice would be subject to the same penalty as an attempt to use a canceled stamp.

Companies with experience are being sought to develop a presorting technique that would separate mail addressed in an ordinary way from mail carrying addresses that could be scanned by optical-reading machines. The general concepts have already been laid out by postal R&D specialists; the electronics companies would reduce the concept to hardware and refine it. The system must be better than 95 per cent accurate.

Train controls report published

The long-awaited report is in on the first Government-sponsored study of automatic train controls envisioned for high-speed transportation systems. The Department of Housing and Urban Development, through three urban mass-transportation demonstration grants, supported a test of controls in the San Francisco Bay Area Rapid Transit District.

In a nutshell: All four control systems under evaluation successfully met the "general functional requirements," but no single system was outstanding.

The systems were tested on three laboratory cars over three miles of double track. They were under evaluation for their capabilities in train protection, speed and running-time regulation, and programed precision stopping at stations. The test may have to be repeated on a larger scale, because the propulsion and braking systems of the test cars were themselves developmental and under evaluation, and this may have clouded some of the detailed performance data. Nevertheless the Government believes that the test was valid enough to prove the reliability of fully automatic controls.

World weather forecasting spurred

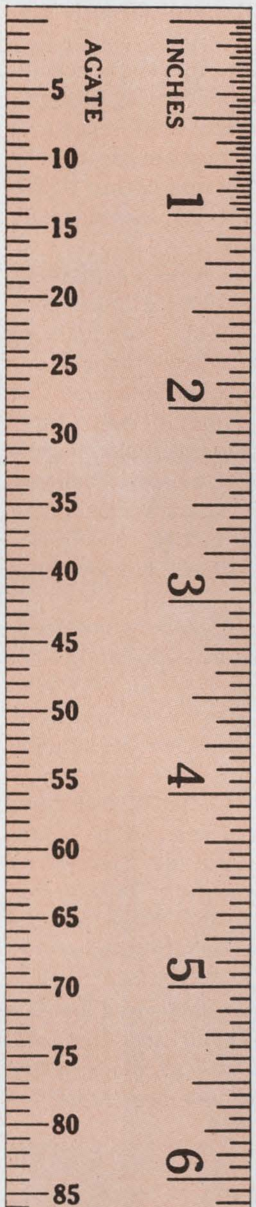
The U.S. plans to contribute approximately $20 million over four years to help poorer nations develop their weather forecasting services. This has been indicated by Robert M. White, head of the U. S. delegation to the Fifth Congress of the World Meteorological Organization in Geneva.

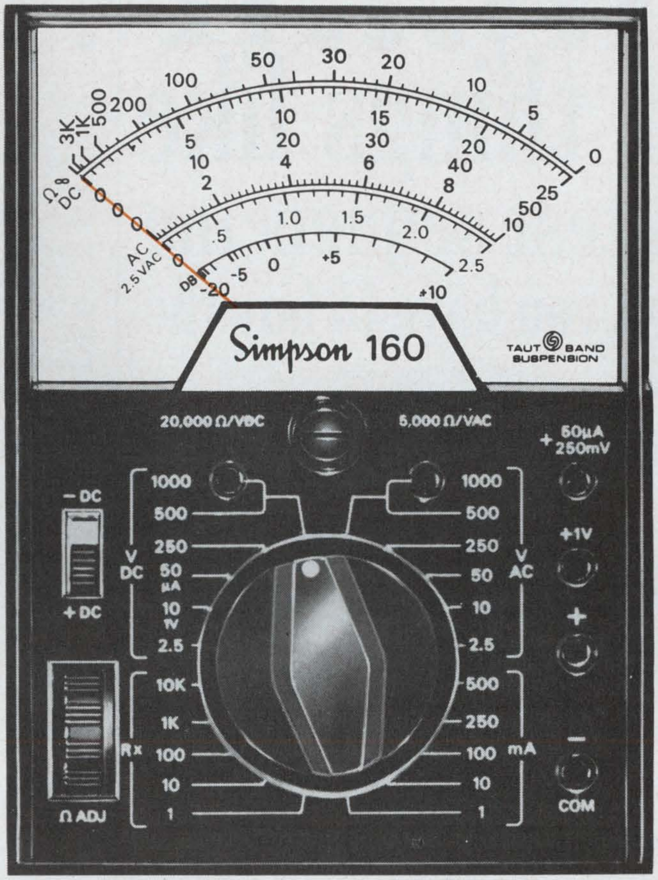
The funds would help the poorer nations participate in the worldwide forecasting network that utilizes satellites, high-speed communications systems and computers.

Electronic patent reform suggested

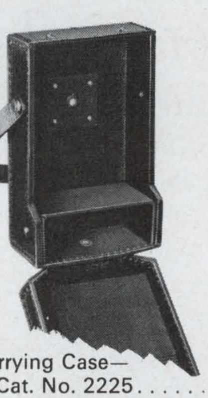
Two representatives of the National Association of Manufacturers have called the U.S. Patent Office the most efficient in the world—"but even so," they add, "it takes them at least two to three years to issue a patent." Writing in *Challenge, the Magazine of Economic Affairs*, Frederic O. Hess and Reynold Bennett of the NAM's Patent Committee say the situation is worse elsewhere in the world. For the inventor who wants international protection, they assert, it is near chaos: he must deal with over 80 different national patent systems. Their remedy: an international patent office, with "high-capacity satellites synchronized with large patent-data-processing and information storage systems." Patent applications could be processed in days, the authors contend.

NOW...a full-sized VOM in a palm sized "package"





160 Volt-Ohm-Milliammeter
Complete with alligator clip leads and operator's manual.
. . . . $50.00



Carrying Case—
Cat. No. 2225 . . . . $ 9.50
Accessory Leads—
Probe Tip Lead—
Cat. No. 2055 . . . . $ 2.75

Simpson 160 Handi-VOM®

Simpson Handi-VOM gives you the ranges, the time-saving conveniences and the sensitivity of a full-sized volt-ohm-milliammeter—yet it's only 3-5/16″ wide, weighs a mere 12 ounces. Recessed range-selector switch never gets in the way . . . polarity-reversing switch saves fuss and fumble. Self-shielded taut band movement assures high repeatability and freedom from external magnetic fields. Diode overload protection prevents burn-out—permits safe operation by inexperienced employees and students. The demand is BIG, so get your order in to your electronic distributor, TODAY!

RANGES

ACCURACY: ±3% FS DC, ±4% FS AC
DC VOLTS: 0-0.25, 1.0, 2.5, 10, 50, 250, 500, 1000 @ 20,000 Ω/v
AC VOLTS: 0-2.5, 10, 50, 250, 500, 1000 @ 5000 Ω/v
DC MICROAMPERES: 0-50
DC MILLIAMPERES: 0-1, 10, 100, 500
DB: −20 to +10, −8 to +22, +6 to +36, +20 to +50
"O" REFERENCE: 1 MW into 600Ω
RESISTANCE: Rx1, Rx10, Rx100, Rx1K, Rx10K (30 Ω center)

AGM DIVISION

Simpson
INSTRUMENTS THAT STAY ACCURATE

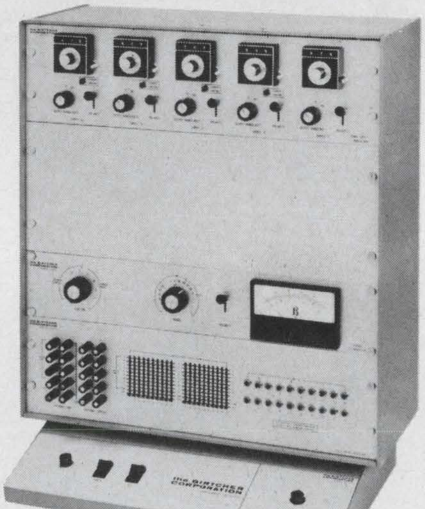
SIMPSON ELECTRIC COMPANY

5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone: (312) 379-1121
Export Dept: 400 W. Madison Street, Chicago, Illinois 60606, Cable, Simelco
IN CANADA: Bach-Simpson Ltd., London, Ontario
IN INDIA: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

Representatives in Principal Cities
. . . See Telephone Yellow Pages

WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

ON READER-SERVICE CARD CIRCLE 16



(**Paris show,** *continued from p. 26*)

in 10^4-to-10^5-bit memories. For smaller memories, it believes semiconductor types will be preferred, because the peripheral circuits can be built in.

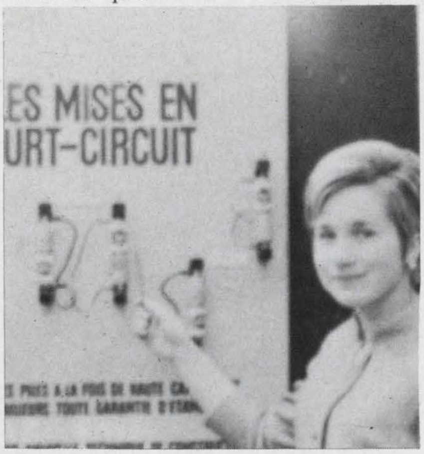
Cofélec will also market a permanent type of memory using Permalloy films. Meanwhile CSF expects to spend a year or more studying the nondestructive version before it will know whether it is commercially producible.

Although there were no displays of working color TVs at the show this year—the show management having decided to rule them out—there was one big announcement in this area: a wire-grid color tube, which the manufacturer, Compagnie Française de Télévision, believes will replace the shadow-mask tube (see News Scope, p. 13).

Among the other developments were these:

- Fluid logic devices by the Plessey Co., Ltd., Ilford, England, were shown in four devices: an OR/NOR gate, a memory device, an amplifier, and a flip-flop based on the Coanda effect.
- A photo of an 800-W molecular CO_2 laser was displayed by Compagnie Industrielle des Lasers, a French laser company. It expected to demonstrate the laser at the French Physics Society's show here last week.

The show was sponsored by five French professional societies and was held under the auspices of the Fédération Nationale des Industries Electroniques. ■ ■



Miss D. de Saint of Pile Wonder, a French battery manufacturer, shows a battery with an O-ring seal that has resisted leakage despite 15 days in a short circuit.

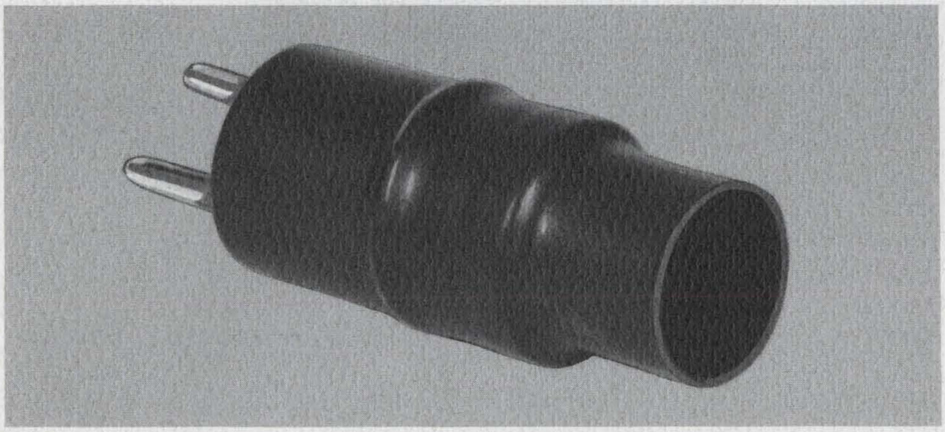
ON READER-SERVICE CARD CIRCLE 300 thru 307 ➤

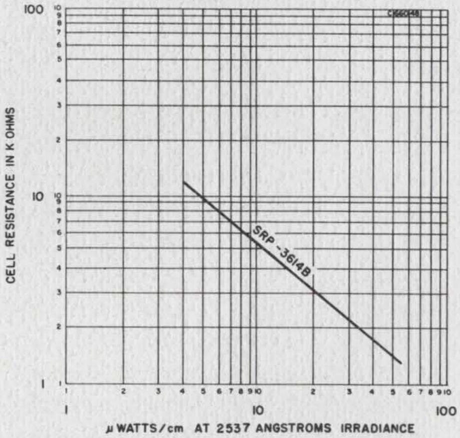
Component and Circuit Design IDEAS

from SYLVANIA Electronic Components Group

PHOTOCONDUCTORS

Now, highly reliable UV detection ...even in IR ambients





Cell Resistance vs UV Irradiance

A shortcoming of many ultraviolet detectors is that they're also sensitive to infrared radiation. Thus it's often difficult, if not impossible, to use them to detect just UV in an ambient containing both infrared and ultraviolet radiation. Last year, Sylvania introduced a UV cell with attenuated infrared characteristics. Now, an improved version of this device has greater sensitivity and shows even better infrared attenuation.

Sylvania's new Type SRP-3614B ultraviolet photoconductor improves further the detection and measurement of UV radiation. Like previous designs, the new device requires only simple low voltage circuits to provide an inexpensive, highly reliable UV detection system. The SRP-3614B does differ from earlier types in two important characteristics: it is less sensitive to IR radiation and uses a more sensitive photocell.

Key electrical ratings for the new unit are a power dissipation rating of 300 mW, an ON resistance of 1,300 ohms at 64 μW/cm^2 irradiance, and a dark resistance of 100,000 ohms. Ascent time is 130 msec (at 64 μW/cm^2) while descent time is 40 msec at the same radiation level.

The SRP-3614B has the proven high reliability of Sylvania's hermetically sealed cadmium-sulfide photoconductors, but with the spectral response characteristic shifted into the ultraviolet region in the range of 2500 to 4000 angstroms.

The excellent electrical character-

(continued)

ELECTRICAL DATA RATINGS (Absol. Max.)

	SRP—3614	SRP—3614A	SRP—3614B
Dissipation			
at 40°C	300mW	300mW	300mW
at 70°C	25mW	25mW	25mW
Temp. Rge.	−40 to +70°C	−40 to +70°C	−40 to +70°C
CHARACTERISTICS			
Cell (Light) Res. (ohms)	2500	5500	1300
Dark Res. (ohms)	1,000,000	1,000,000	100,000
Ascent Time			
at 64 μW/cm^2			130 ms
4 μW/cm^2			720 ms
Descent Time			
at 64 μW/cm^2			40 ms
4 μW/cm^2			260 ms

This issue in capsule

Integrated Circuits — How to prevent unused inputs from degrading IC performance.

CRTs — Eliminate unnecessary tradeoffs when choosing computer displays.

Microwave Diodes—Punch-through varactors, new route to improved harmonic efficiency.

Photoconductors — How photoconductor-lamp assemblies are making music sound better.

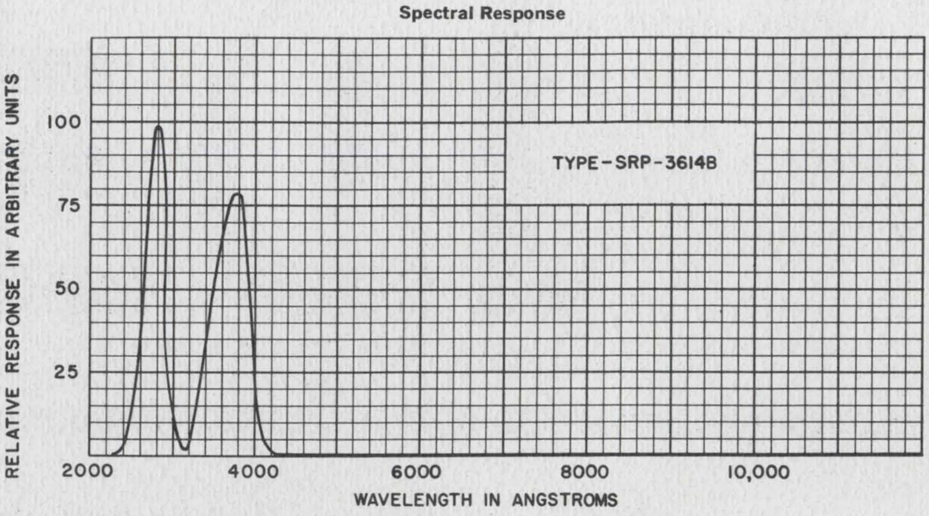
Diodes — With whiskerless diodes, you can get more components on a board.

PHOTOCONDUCTORS *(continued)*

istics of this improved photoconductor are protected by a small, rugged package with a maximum diameter of 0.70″ and a length of 1.625″.

Coupling the small size, long life, analog response characteristic with the simple associated circuit requirements makes the SRP-3164B ideal for applications where UV detection, measurement, control or regulation are needed, such as intrusion and fire alarm systems. The new photoconductor can effectively and economically replace many avalanche or continuous monitoring devices.

CIRCLE NUMBER 300



MARKETING MANAGER'S CORNER

Circuit Designer–IC Manufacturer... Conflict or Complement?

The rapid growth of the integrated circuit industry has given rise to a pertinent question: whether or not there is a functional conflict between the IC manufacturer and the manufacturer of electronic equipments and/or systems. In other words, are we, as IC manufacturers who produce complete functional circuits, overstepping our bounds and infringing on the functions of circuit designers? What about circuit design engineers? Will they become high priced order clerks, purchasing all the circuits they need to build an equipment out of an IC catalogue?

To aggravate the picture, the trend in the IC industry appears to be headed for even greater density. LSI (large scale integration) is now in the horizon, cramming many more and larger circuits into a single package. It may be possible to eventually encapsulate an entire automated operation or computer function into a single IC package. Will this development turn the computer manufacturers into automated factories, whose purpose it will be to merely assemble various combinations of IC packages?

Not at all! On the contrary, as the electronics industry expands, all its constituent components will expand along with it. With standard circuits such as flip-flops, gates, registers, and counters available as packaged items, the design engineer can concentrate on larger and more complex circuit configuration. Furthermore, many circuits required for equipment design have a unique configuration, in one aspect or another, and, therefore, must be designed by the equipment manufacturer; the IC manufacturer only fabricating these "customized" circuits.

With reference to this last point, it should be remembered that in order to work effectively with the integrated circuit manufacturer, the circuit designer must familiarize himself with integrated circuit technology, its advantages, its applications, and its limitations. He should know the IC circuits that are available as "off-the-shelf items." He should also be knowledgeable of the manufacturing process of integrated circuits so that he can design new circuits which are most applicable to the present state of the art. This will result in a reduction of IC costs, a functionally superior IC, and a better working relationship between circuit designers and integrated circuit manufacturers.

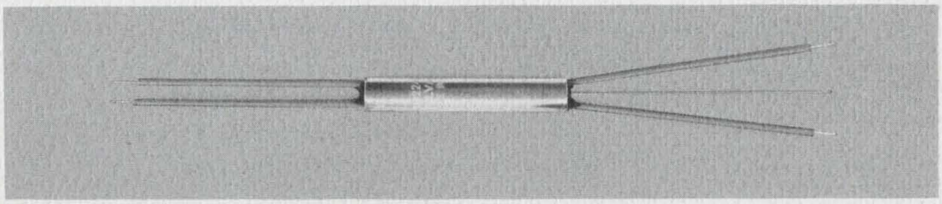
The same situation exists with regard to system designers. No matter how complex and dense ICs become, they will only serve as building blocks for large systems. Furthermore, the systems of today will become the subsystems of tomorrow's larger, more complex and sophisticated systems. Therefore, with the availability of larger and more efficient "building blocks," system design engineers will be able to concentrate on solving the design problems associated with creating larger and more efficient systems.

Finally, it must be noted that the trend toward LSI is not a self-generating movement. IC manufacturers are not simply producing denser ICs just for the sake of cramming more circuitry into a package. This trend, to a great extent, is the result of certain design requirements dictated by military and industrial contractors. The great need for space and weight savings, and the requirement for extended operation reliability within the space program has had a significant effect on IC design. The noise immunity requirements of high frequency circuitry and high speed computers also have dictated the direction which IC manufacturers have had to take. However, when one looks at the total picture, he finds the word that describes the relationship of equipment and systems manufacturers, and IC manufacturers, is "complementary"; each has its own function which complements the other. And the very evident direction of motion is upward. The electronics industry continues to grow; equipment and systems are becoming more complex and sophisticated. Keeping up with this growth in complexity and sophistication is the IC manufacturer.

Roger A Swanson

R. A. SWANSON

How PL assemblies are making music sound better



Photoconductor-lamp (PL) assemblies are being used to produce special musical effects such as tremolo, vibrato and percussion. What makes these units ideal for these applications is the intrinsic characteristics of the photoconductor-lamp combination. It provides noise-free operation because of electrical isolation between control and signal circuitry. This, of course, eliminates the introduction of hum from the control circuit. Result is an effect pleasing to the listener. Here's how a tremolo circuit using a Sylvania PL assembly makes an electric guitar sound more pleasing.

Tremolo effects—subsonic modulation of an audio signal—can be produced easily and reliably by an electric guitar amplifier which uses Sylvania's PL assembly. The circuit shown uses a PL-8224C assembly and a phase shift oscillator to get the tremolo effect. The oscillator output frequency of 40 to 8 Hz is controlled by a 1-megohm potentiometer in one arm of the phase shift network. Output of the oscillator is decoupled by a 330 K resistor into another 1-megohm potentiometer which varies the level of the control signal voltage fed into the PL driver stage.

The on/off switch can ground the arm of the 'Depth' potentiometer to remove modulation from the light source portion of the PL assembly. The dc operating current of the light source is determined by the setting of cathode resistor in the PL driver stage. The ac output of the 'Depth' control is superimposed on this dc level, providing an ac variation in the resistance of the PL. Shunting this ac varying resistance divider across the volume control gives the desired modulation of the audio signal. Depth of modulation depends on the setting of the 'Depth' control and may approach 100 percent.

Basic action of this circuit is that of a volume control being varied around its operating point at a sinusoidal rate with the rate controlled by a low frequency oscillator.

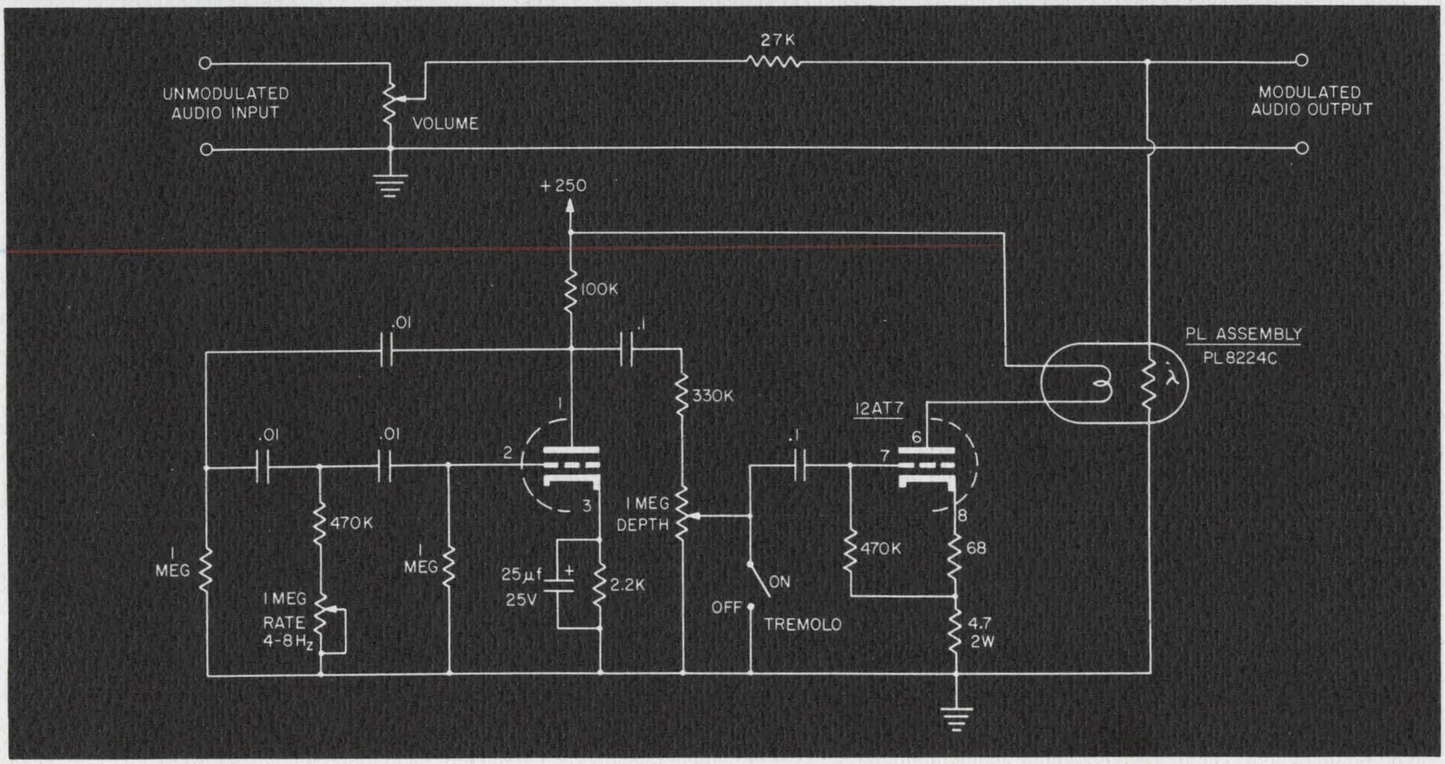
The type PL-8224C assembly used in this application consists of a hermetically sealed cadmium sulfide photoconductor and an incandescent lamp potted in a metal cylinder 1.75 inches long and 0.31 inches in diameter. Its cell voltage is rated at 300 V max and can handle up to 50 mW at 25°C. Cell resistance varies from below 60 K (ON) to above 10 megohms (OFF).

The PL-8224C is just one of many standard and custom PL Assemblies available from Sylvania. These PL assemblies, because they have the characteristics of both a switch and a potentiometer, have many other circuit applications in addition to generating musical effects.

Such applications as: On-Off Switch, Sequential Switch, Logic Functions, Gain/Volume Controls, Electrically Controlled Circuit Functions (Delays, Oscillators, Filters), Linear Amplifiers, Voltage and Current Regulators, Motor Speed Regulators and Modulators.

In all these applications the PL assemblies provide moderate power handling capability, noise-free operation, and high circuit isolation.

CIRCLE NUMBER 301



Preventing unused inputs from degrading IC performance

Frequently, all inputs of an integrated circuit are not required in a particular application. What does the circuit designer do with these unused inputs? They may be left open, but this could degrade circuit operation; or additional components can be added to insure top performance. SUHL™ devices by Sylvania require only simple wiring and no extra components to obtain optimum performance characteristics. Here's the how and why for gates and flip-flops.

The high drive capability of SUHL I and II output networks allows unused gate inputs of these ICs to be tied directly to signal inputs with insignificant sacrifice in speed or static characteristics. In the same way, unused inputs of these SUHL flip-flops can be tied to active inputs or outputs to maintain propagation delay time, clock width, and amplitude. With SUHL gates and flip-flops it's basically a matter of eliminating the effect of the capacitance associated with each of the unused inputs.

In SUHL gates, each input has a capacitance to ground of about 1.2 pF (package and chip). If wiring is also connected to the emitter, then additional capacitance is added. How the capacitance of unused inputs influences circuit operation can be explained by Figure 1. Here, if input A goes to logic "0" and input B is floating, the voltage at B tries to follow the voltage at A. In time, B falls to logic "0." When A rises to logic "1," B is held down until its capacitance charges through the base resistor. This action slows down the recognition of the logic "1" data at A.

To prevent this, unused emitters should be terminated with a voltage greater than the logic "1" threshold voltage. In this way, stray capacitance on the inactive inputs will always be at logic "1" and won't slow circuit operation. There are a number of ways to insure that these gate inputs remain at logic "1."

The unused inputs can be connected to a dc voltage as shown in Figure 2A. For SUHL units, the voltage should never be higher than 5.5 V, the breakdown rating of the inputs. A 5.0 V supply is satisfactory if it never goes above 5.5 V, even during power turn on. Should the supply go above 5.5 V, then a resistor (ranging from 500 to 5000 ohms) is placed between the emitters and the supply as indicated in Figure 2B.

Many emitters can be tied together. One convenient method of supplying the required voltage is to use one NAND gate with its inputs grounded to hold all unused emitters at Logic "1."

A more convenient neutralization technique is to tie unused emitters to one of the signal emitters as shown in Figure 2C. This requires no extra components. Only simple wiring is needed and performance of the system is not degraded. In this approach, when the data signed goes to "0," all capacitance is directly discharged to "0" through the driver. Since this capacitance is small and the drive capability of SUHL is high, there is a negligible effect on speed (about 0.03 nsec/pF). In this configuration, input current is the same as if only one input were used, because the base resistor limits current flow.

In Figure 2C, when the driver rises to logic "1," each input and its capacitance is pulled to a positive voltage. Again, because of the high drive capability of SUHL output networks, pull-up speed is negligibly affected by the small capacitance increase (about 0.4 nsec/pF). The high current capability of the output network of all SUHL elements also means that static characteristics remain constant.

These SUHL output characteristics are shown in Figure 3. Even with many milliamps of loading, logic levels are still high and well above threshold.

In flip-flops, it is extremely important that all inactive inputs be terminated. Not only is propagation delay time effected, but so is clock width, amplitude and the waveform required

Figure 1

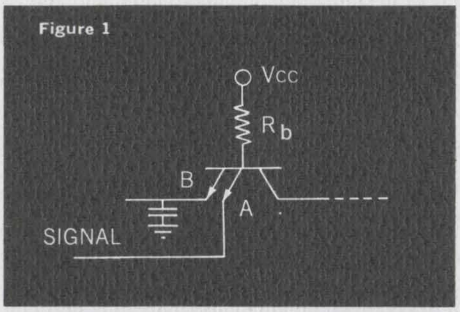


Figure 2A

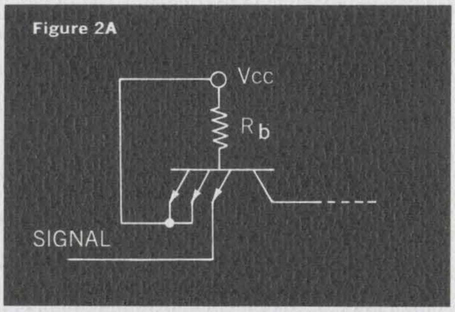


Figure 2B

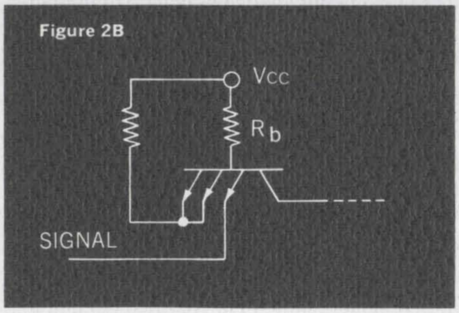


Figure 2C

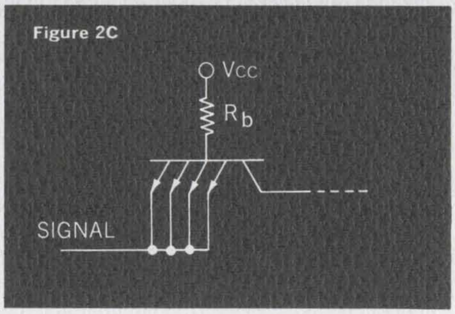
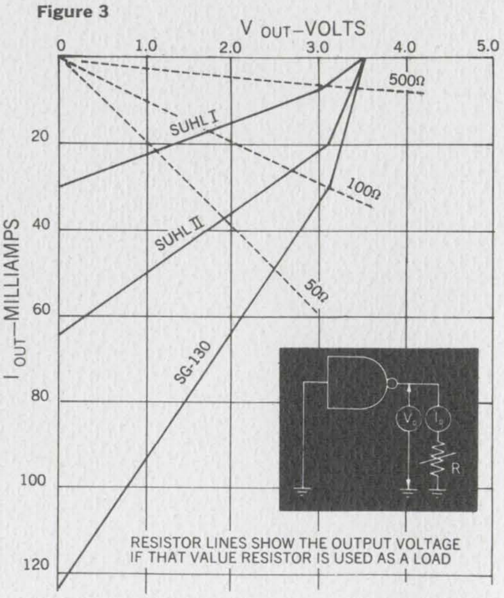


Figure 3



RESISTOR LINES SHOW THE OUTPUT VOLTAGE IF THAT VALUE RESISTOR IS USED AS A LOAD for triggering.

Synchronous or data inputs of flip-flops can be terminated with dc in the same manner as a gate, but for each flip-flop there are signal carrying inputs or outputs to which unused inputs can be connected. Examples are shown in Figures 4 and 5.

Unused asynchronous input terminals (DC Set, Preset, Reset) can also have a degrading effect on performance, particularly if they are connected to wiring or board metalizing which increase capacitance. Even at low frequencies it is important that asynchronous inputs be connected to a positive voltage or terminated in some other way. The same techniques used for gates or those shown in Figures 4 and 5 can be employed.

CIRCLE NUMBER 302

Figure 4

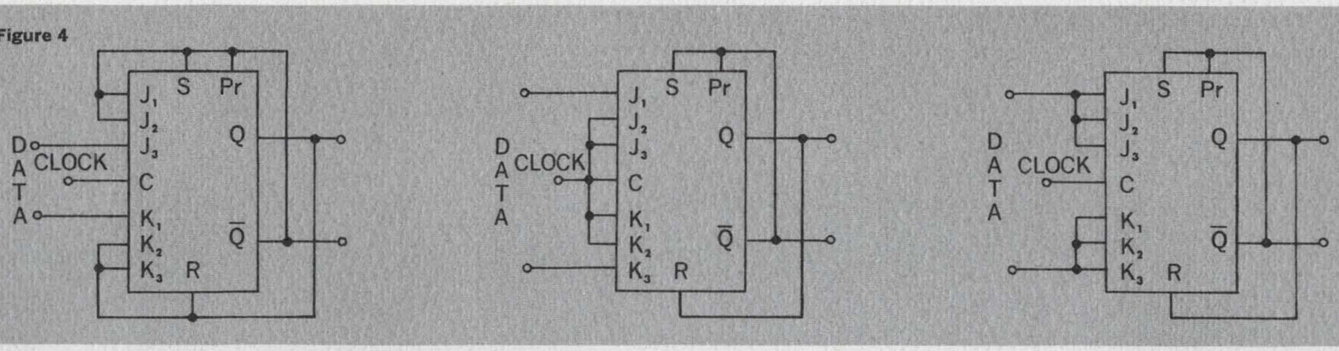
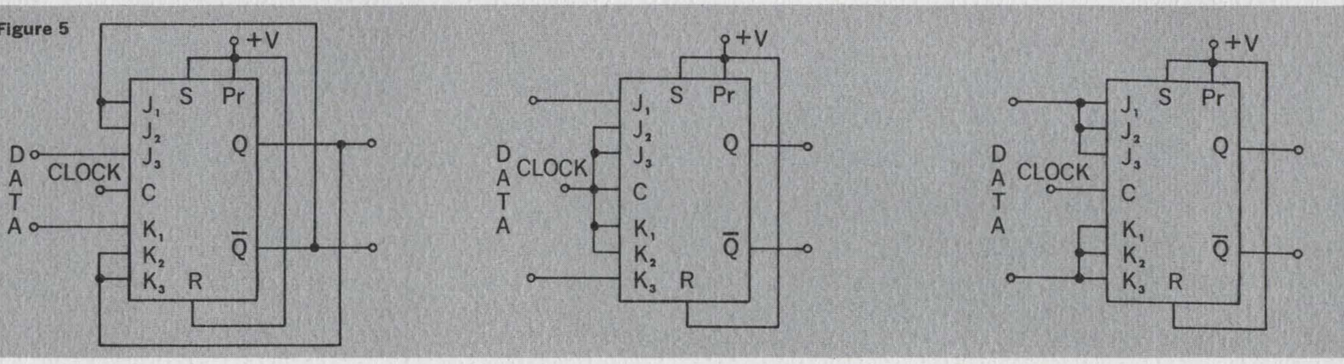
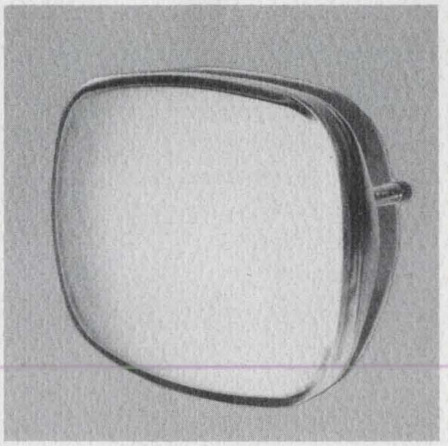


Figure 5



CRTs

Eliminate unnecessary trade-offs when choosing computer displays



The value of a computer often is directly related to how fast the information output can be obtained by the people who need the information. CRTs provide an effective and very fast graphic display of such information. But picking the right tube (and the right tube manufacturer) for computer display applications is not simple. Many factors must be evaluated. A good way to start is to look at the manufacturer's present capability in CRTs for computers.

Years of leadership in CRT technology and display design give Sylvania the full capability needed to meet demands for computer CRTs. This capability is based on a solid background of providing CRTs for the computers of several manufacturers.

These CRT displays offer many advantages. Display of alphanumeric information on a tube face is much faster than waiting for a typed output. A dynamic display also permits on-line program debugging, text editing and revision, and rapid scanning of stored material. Coupled with a camera, these displays can give a hard-copy output. The growing interest in using displays to permit on-line, two-way conversation with the computer opens up a host of applications. For instance, results of calculations can be plotted, and the user can select regions where he wants calculations to be carried out in more detail.

Selecting the optimum tube for such applications can be a difficult chore. Many factors must be considered; such factors as size of display, deflection, focusing method, sensitivity, resolution, brightness, power requirements, and phosphor characteristics. Trade-offs may be necessary. But, at Sylvania these trade-offs are kept at a minimum; because the designer isn't limited to a few off-the-shelf items. Sylvania's wide range of standard and custom tubes permit a better match of tube to application.

TYPICAL COMPUTER TYPES

Basic Type	Deflection Angle	Screen Size	Useful Scan	Overall Length
SC-4649	70°	7"	5-3/4" x 4-3/8"	10"
8QP-	90°	8"	7-3/16" x 5-3/8"	9-15/16"
8KP-	90°	8"	7-3/16" x 5-3/8"	11-15/16"
17DWP-	70°	17"	11-1/8" x 14-5/16"	19-3/16"
21EYP-	72°	21"	19-1/16" x 15-1/16"	23-1/32"

CIRCLE NUMBER 303

Punch-through varactors: new route to improved harmonic efficiency

There's a great deal of confusion in the microwave industry regarding high-order multiplier diodes. Names such as step diodes, step recovery varactors, snap diodes, snap-off varactors, etc. are being used to describe diffused diodes having a varying capacitance-voltage relationship. Sylvania uses the term PTV, or Punch-Through Varactor, to better describe a diode which was developed to have a sharp decrease in junction capacitance, as well as a series resistance at a reverse bias 15 to 20% of the rated breakdown voltage. This deflection point occurs when the depletion width "punches-through" the thin epitaxial layer of high-resistivity silicon.

The Sylvania D-4410 PTV exhibits little capacitive nonlinearity in the reverse bias region, but shows a marked nonlinearity in the forward bias region because of charge storage. The relatively flat capacitance change over a large reverse bias range offers several advantages, such as minimal detuning over the temperature range, simplified tuning procedure, and improved dynamic range. Simplified matching techniques can be employed, and under broad band operating conditions improved operating efficiencies can be realized.

If PTVs are driven into the forward bias region, high conversion efficiencies can be obtained as a result of the marked non-linear capacitance curve. The lower average R_s value over the drive cycle also contributes to better efficiency by reducing the power dissipation. Harmonic generators operating with multiplication ratios as high as 27:1 or as low as 2:1 will yield highly efficient performance at frequencies from VHF to Ku-band. These diodes, made from epitaxial silicon, have diffused junctions tailored for punch-through at a reverse bias voltage which is low relative to the breakdown voltage.

Electrical specifications and typical operation in a multiplier circuit for a Sylvania PTV are given in the table.

Carefully controlled fabrication techniques give Sylvania's PTVs these additional advantages: uniformity of performance characteristics, higher power handling capability, improved circuit stability, higher power, and frequency operating range.

All units are baked at a minimum temperature of 200°C for at least 16 hours prior to final hermetic sealing. Finished devices see these test procedures: centrifugal acceleration of 20,000 G, temperature cycling from −65°C to +150°C; breakdown checking at 150°C; 48 hour burn in at 200°C; and gross and fine leak (Radioflo) testing.

Units in the new PTV series are available in four packages: the 017, 023, 075, and 099.

ELECTRICAL SPECIFICATIONS (Type D-4440)	PERFORMANCE IN MULTIPLIER (Type D-4440)
$V_B = 45$ Volts	$F_{in} = 1$ GHz
$C_j\ (-6V) = 1 - 1.5$ pF	
$T_s = 250$ picosec	$F_{out} = 10$ GHz
$T_L = 60$ nanosec	
$R_s = 0.8$ ohms	$P_{in} = 1$ watt
$I_F = 100$ milliamps	
$R_T = 45°C/watt$ max	Efficiency = 13%

CIRCLE NUMBER 304

PTV DIODES

In a varactor multiplier, power handling capability and conversion efficiency are determined by the breakdown voltage, junction capacitance, junction conductance, and series resistance. Breakdown voltage is determined primarily by the resistivity of the N-type semiconductor material used in the P-N junction. The other parameters are shown in the simplified equivalent circuit of Figure 1.

The nonlinearity of the voltage-variable junction capacitance is the dominant factor in the frequency multiplication process. Junction conductance and series resistance dissipate power, limiting output power and conversion efficiency. The frequency conversion process also depends on the quality factor Q or cutoff frequency w_{co}. These are given by the equations $Q = 1/wR_sC_j$ and $w_{co} = 1/R_sC_j$.

Specifically, frequency conversion depends on the average values of these factors over the drive cycle of the multiplier. Since both R_s and C_j vary with reverse voltage, their values should be kept at a minimum over most of the drive cycle. The nature of these nonlinear parameters can be examined with the aid of the simplified P-N junction of Figure 2. Here, a thin layer of lightly doped, n-type semiconductor of thickness t is grown epitaxially on a substrate of heavily doped, n-type material, and p-type dopant is diffused to a depth X into the n-type layer.

A reverse bias voltage applied to the varactor sweeps mobile carriers out of the lightly doped n-region. These carriers recombine in the p region, forming a depletion region of width W in the n layer. Width of this region varies with applied voltage as; $W = K_1\ (\phi - V)\gamma$. Where ϕ is the built-in voltage of the junction, K_1 is a constant, and V is the applied reverse bias. The term γ varies from 1/3 to 1/2 depending on the type of junction. The depletion region boundaries act as a parallel plate capacitor with capacitance of:

$C_j = EA/w = k_2\ (\phi - V)^{-\gamma}$,

where E is the dielectric constant of the n-type material, A is the junction area and k_2 is a constant. Increasing the applied reverse voltage V increases w and decreases C_j.

Two additional factors determine

Figure 1

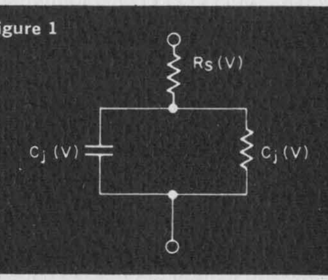


Figure 2

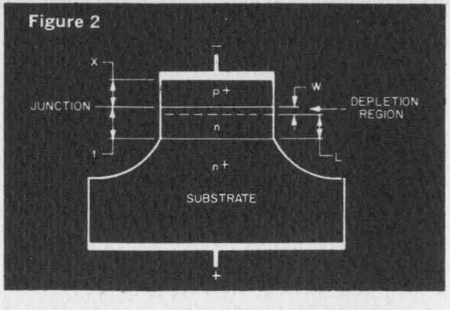


Figure 3

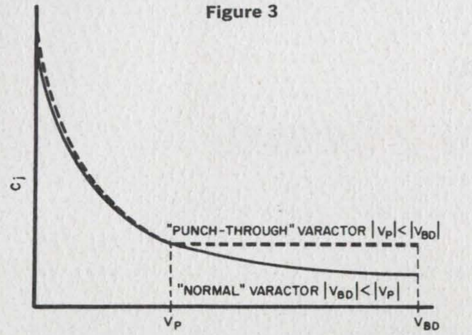


Figure 4

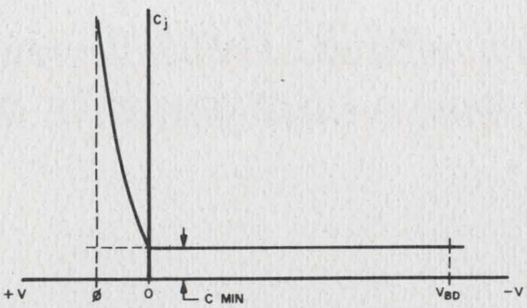
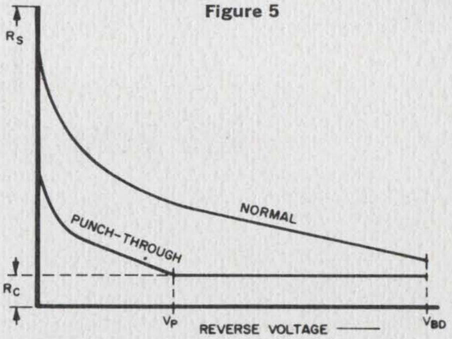


Figure 5



the variation of C_j as V increases. One is the maximum allowable applied reverse voltage, with the reverse breakdown voltage V_{bc}. At V_{bd}, avalanche multiplication takes place and a large current flows through the diode.

The second factor is the thickness t of the n-type layer. Depletion width, w, increases continuously with applied voltage, but it cannot exceed thickness t, because at that point the depletion region boundary is in contact with the heavily doped n^+ substrate. When $w = t$, no further decrease in junction capacitance can occur.

Depending upon thickness and resistivity of the n-layer, avalanche breakdown may occur at a reverse voltage either lower or higher than that at which $w = t$. The voltage at which $w = t$ is the punch-through voltage, V_P. Figure 3 shows the junction capacitance and applied reverse voltage relationship for the punch-through and conventional (or "normal") varactors.

If the punch-through voltage occurs at a voltage which is low with respect to the breakdown voltage, then the overall capacitance-voltage relationship approaches the case where $\gamma = 0$ and C_j is constant for any applied reverse voltage beyond the punch-through point.

While the PTV exhibits little capacitive nonlinearity with a reverse bias, a marked nonlinearity occurs with a forward bias. This is due to charge storage. This charge storage capacitance, sometimes called the diffusion capacitance, is an exponental function of forward voltage, and also depends upon the recombination lifetime of the semiconductor material. For effective charge storage, the recombination lifetime should be large compared to a period of the drive frequency. Figure 4 shows an idealized capacitance-voltage plot ($\gamma = 0$) of a punch-through varactor.

The series resistance, R_s, of an epitaxial varactor consists of a sum of four terms: $R_s = R_p + R_n + R_{n^+} + R_c$. Resistance R_P is that of the p-layer; R_n that of the n-layer; R_{n^+} that of the substrate; and R_c that of the ohmic contacts.

In practice, R_c is usually a few tenths of an ohm at uhf frequencies, but may be higher at high microwave frequencies because of skin effect in the connecting leads. For surface concentrations normally used in epitaxial varactors, R_P is usually negligible compared to R_c and R_n.

Likewise, R_{n^+} is negligible for a highly doped substrate. Thus, the resistance of the epitaxial layer, R_n, is the dominant component of R_s, and is given by $R_n = P_n L/A = P_n(t\text{-}w)/A$. P_n is the resistivity of the epitaxial n-layer, and L is as shown in Figure 2.

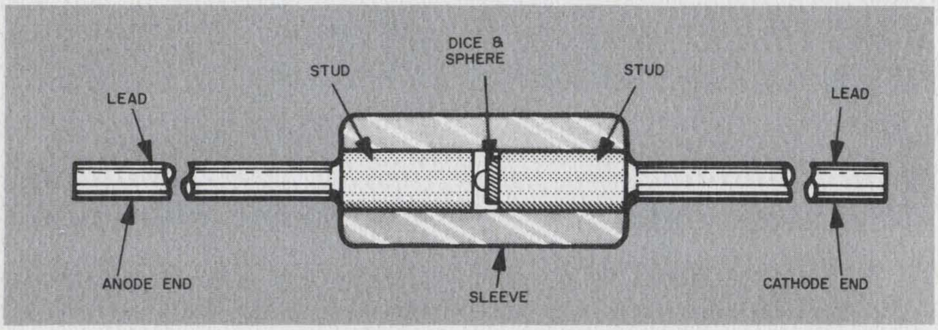
Since w varies with reverse voltage, R_n and R_s also vary with V. As with C_j, if $|V_{bd}| < |V_P|$, then R_s decreases continuously as voltages from zero to V_{bd} are applied. If $|V_P| < |V_{bd}|$, then R_n vanishes at V_p. This is because $w = t$, $L = O$ and the total series resistance is $R_s \approx R_c(|\text{-}V| \geqq |V_P)$. Figure 5 shows the variation of R_s, for the normal and punch-through cases. The change in series resistance with reverse voltage may be quite appreciable. For epitaxial varactors with breakdown voltages of 50 to 100V, the ratio of series resistance at zero bias to that at the breakdown voltage may be greater than 2:1 and up to 10:1 for higher-voltage varactors.

Varactors with the same value of R_s at breakdown may have quite different values of R_s at lower reverse voltages. In the PTV, the R_s is lower at zero bias than in a conventional varactor and reaches its minimum value at the punch-through voltage. The result is a lower average R_s over the drive cycle and higher conversion efficiency than in the normal varactor.

CIRCLE NUMBER 304

DIODES

How whiskerless diodes let you get more components on a board



Designing computers or other equipment which requires fast logic circuits or small signal switching? Here's your chance to get more money for your diode dollar. Use Sylvania's miniature whiskerless diodes to replace DO-7 types, to get significant savings in mounting space, and improve reliability without any increase in cost.

Because Sylvania's miniature dual stud whiskerless diodes are much smaller than DO-7 types, they allow designers to decrease circuit board requirements significantly. Costing no more than their electrical equivalents in DO-7 packages, the rugged whiskerless units have a package volume which is 68 percent smaller. But smaller size is not the only advantage of these newer diodes. The single unit construction makes for higher reliability and for devices able to take shock and vibration environments.

With these 0.075″ dia. by 0.160″ long Sylvania units you get top electrical performance. Typical reverse leakage currents of units in the whiskerless line are a low 15 na. Switching speeds are in the order of 4-10 nsec. Ratings for these silicon epitaxial diodes include average rectified currents of up to 150 mA (with surges of 500 mA) and a power dissipation of 500 mW.

Key construction features of the whiskerless devices are: use of a plated silver sphere to make contact to the junction, dumet studs for good heat conduction away from the junction, and protection of the active area with a soft glass sleeve. What results is a rugged single-piece device capable of taking high-g shocks.

Reliability of this simple structure is enhanced further by the pains taken during the manufacturing process. Sylvania has developed special production techniques to make sure the silicon dice used is more symmetrical and is free from any jagged edges, cracks, or out-of-tolerance parameters.

Sylvania's whiskerless diodes can be used with standard automatic insertion equipment.

CIRCLE NUMBER 305

SILICON EPITAXIAL DIODES

Type	Outline	DO-7 Electrical Equivalent
1N4148	DO-35	IN914
1N4149	DO-35	IN916
1N4151	DO-35	IN3604
1N4152	DO-35	IN3605
1N4153	DO-35	60V IN4152
1N4154	DO-35	IN4009
1N4446	DO-35	IN914A
1N4447	DO-35	IN916A
1N4448	DO-35	IN914B
1N4449	DO-35	IN916B

ABSOLUTE MAXIMUM RATINGS:

Average Rectified Current, Io	75 mA
Peak Forward Current, Ipk	225 mA
Forward Surge Current, (1 sec)	500 mA
Power Dissipation, P_T	500 mW
Junction Temperature, T_J	—65 C to +175°C

This information in Sylvania Ideas is furnished without assuming any obligations.

SYLVANIA
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

NAME____________________

TITLE____________________

COMPANY____________________

ADDRESS____________________

CITY____________________ STATE____________________

Circle Numbers Corresponding to Product Item

300 301 302 303 304
305

☐ Please have a Sales Engineer call

HOT LINE INQUIRY SERVICE

Need information in a hurry? Clip the card and mail it. Be sure to fill in all information requested. We'll rush you full particulars on any item indicated.

You can also get information using the publication's card elsewhere in this issue. Use of the card shown here will simplify handling and save time.

Electronics taught with domino module

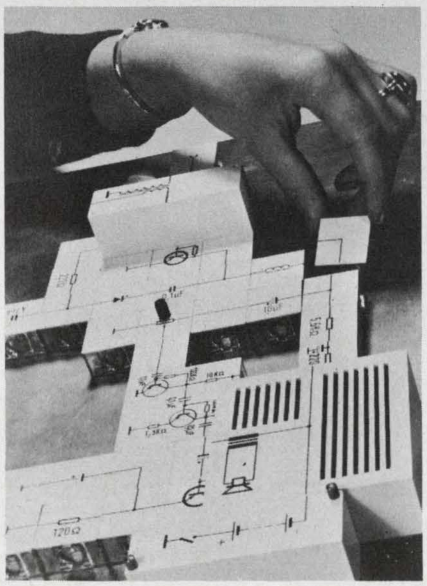
Electronic "domino" modules are helping students learn about electronics without the bother of wiring and soldering components. The modules are quickly snapped together to form a variety of circuits —and just as quickly, they can be taken apart.

More than 90 different electronic experiments are possible with each set, according to the Macalaster Scientific Corp. of Watertown, Mass., distributor of the teaching aids.

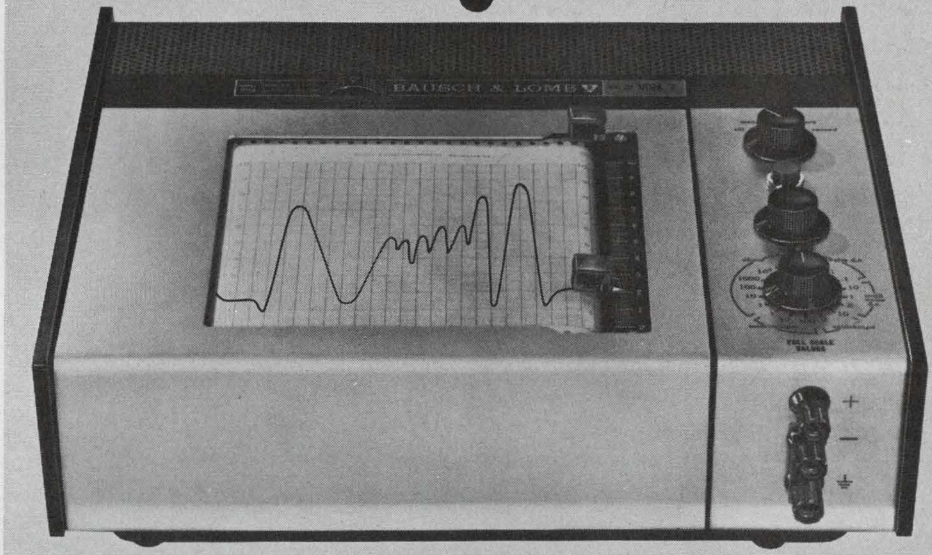
Among the circuits that can be formed, Macalester says, are radio receivers, a fire alarm, a tone generator, a rectifier, and amplifier, a sound-level meter and even an electronic flash unit.

The modules are held together by built-in magnets, which also make an effective electrical contact. This is said to permit the assembly of a transistorized radio receiver in about 10 minutes.

The circuit elements are packaged in transparent plastic boxes, with schematic symbols imprinted on opaque covers. When put together, a complete schematic is formed. The student is able to view both the component and its representation while assembling and checking his experiments. ■ ■



A radio receiver is assembled in an electronic theory class the easy way, by snapping together components packaged as "dominoes."

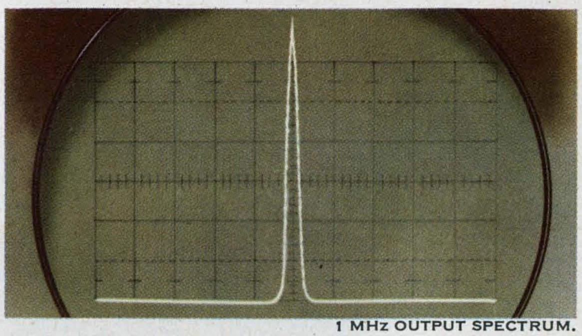


ON READER-SERVICE CARD CIRCLE 19 ➤

Now there's a "4th generation"

# of signal instrumentation

This new Monsanto™ Model 3100A Digital Frequency Synthesizer has a computer-optimized design that creates new standards of stability, purity, precision and value for general purpose signal generators.



1 MHZ OUTPUT SPECTRUM.

Gather 'round and look it over. From its clean, functional, prize-winning* cabinet to its all-solid-state, I/C circuitry, this unique design is all new . . . the first of our "fourth generation" instruments.

The 3100A outperforms all other synthesizers. Select or program any frequency from 0.01 to 1.3 MHz (in 130 million steps). You've never had it so pure—from any signal source. Harmonics are down at least 50 db, and spurious components are down at least 80 db! Stability? 1 part in 10^9/day, by an oven stabilized crystal oscillator.

The output is DC coupled with a ± 2 v offset bias control at a constant 50 ohms, through an accurate 90 db stepping attenuator. There is a flexible dual-frequency internal sweep and external AM, too. For maximum computer-system compatibility, the programming time is less than 20 microseconds. This versatile instrument has more of what you need in a signal source.

Here is the clincher. At $3950, the Monsanto 3100A sells well below old-styled frequency synthesizers. (USA price f.o.b. New Jersey) Write or phone us for the full story. Monsanto Electronics Technical Center, 620 Passaic Avenue, West Caldwell, N.J. 07006 (201) 228-3800.

ON READER-SERVICE CARD CIRCLE 20

Monsanto®
ELECTRONIC
INSTRUMENTS

*First Prize, Enclosures, NEP/CON '67 West.

AUTOMATIC SCANNING FOR EMI MEASUREMENTS

from 20-15,000 Hz

WITH THE APPROVED ONE

*EMPIRE** Noise and Field Intensity Meter

Solid-State, Compact and Lightweight Model NF-315A is preferred by military and civilian government agencies, and major aerospace contractors for rapid and precise EMI measurements. Here's why:

- Three scanning modes: manual, sector, and single sweep over the complete frequency range
- Three separate calibrated scales — peak, average and RMS
- 180 db signal range
- 0.005 µv sensitivity
- 7 or 70 Hz bandwidth selection
- Reliable scanning at maximum sensitivity
- >70 db spurious response rejection
- Internal frequency and amplitude calibrators for on-the-spot checking without disconnecting signal input leads
- Highly stable circuits eliminate recalibration when tuning to new frequencies
- Excellent shock, vibration and temperature characteristics
- Six hours of continuous operation with built-in rechargeable batteries

Write for complete technical data; better yet, call for a demonstration.

*EMPIRE**

*A Trademark of THE SINGER COMPANY

SINGER
INSTRUMENTATION

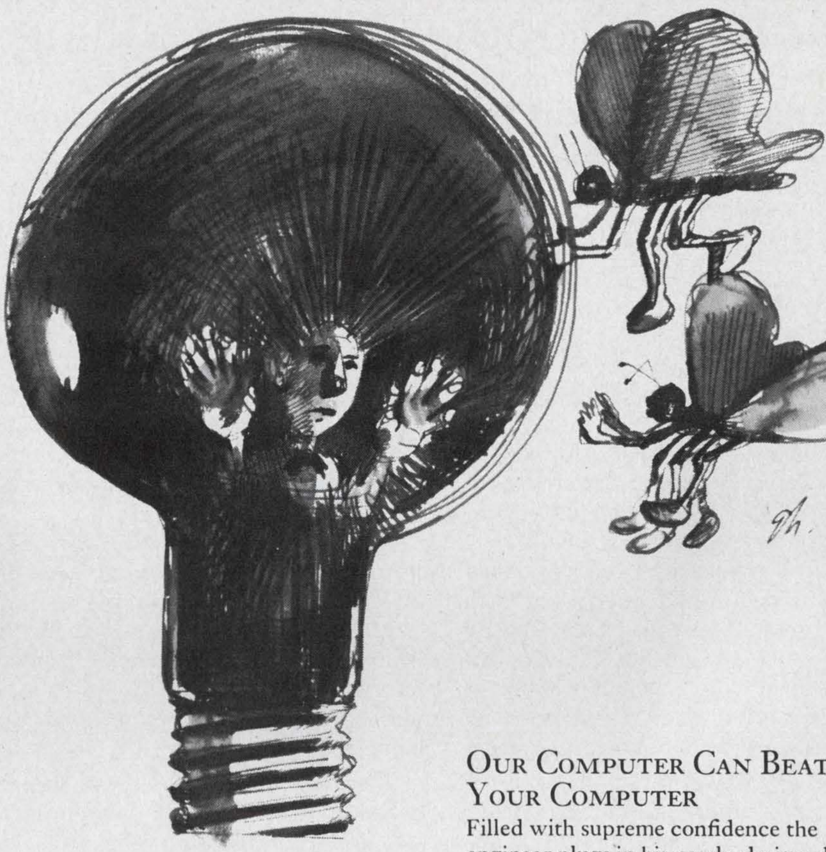
EMC • GERTSCH • PANORAMIC • SENSITIVE RESEARCH

THE SINGER COMPANY, METRICS DIVISION • 915 Pembroke St., Bridgeport, Conn. 06608, U. S. A. • PHONE (203) 366-3201

E-67-1

ON READER-SERVICE CARD CIRCLE 21

Chapter II. ❧ *The Word from GENISCO.*



Let There Be Light
or
Tell me about the Free $50 Switch

It's yours absolutely, unconditionally free. All we ask is that you give us $50 for it. Why do we call it "free" when we are earnest about getting paid for it?
Two reasons:
First of all, when you throw the mechanical switch on, nothing happens until a teeny solid-state device senses that the voltage passes through zero. Then the switch turns the circuit on. When you throw the mechanical switch off and the current passes through zero, the circuit is turned off. That means that the on-off switching is done at the point of minimum energy. And that means no step function voltage to generate high-frequency components. And that means that the switch is *free* from radio frequency interference. *Quad est demonstradum.*

The second reason we call it "free" is we thought that if you thought you could get a $50 switch for nothing you'd probably be greedy enough to read this ad. There appears to be some justification for this assumption.

Circle reader service #121

Our Telemetry Gear will never get off the ground

Because we manufacture only equipment associated with checking out telemetry transmission while the transmitter is still nice and accessible.

For example, our new, compact FM Discriminator for playback in FM/FM telemetry systems. The pulse average design has 0.1% linearity. The Model 71-282 operates on all IRIG channels, 1-21, and A through H, with an input sensitivity of 20 mV. Accommodates any center frequency from 300 Hz to 300 KHz. Each one weighs less than a pound. Disgustingly inexpensive, too.

Circle reader service #122

How We Invented The Sandwich

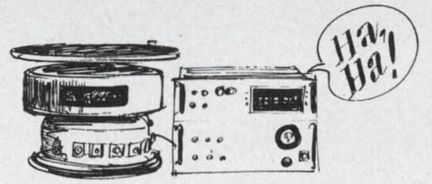
To make the ruggedest possible field portable tape recorder we suspended the entire tape transport mechanism between two parallel flat plates. This gives double support to all members, and as the tape contacts only the primary drive mechanism, reel hubs, two turn rollers and the head surfaces, its oxide coating gets maximum protection.

As you know, the flanges on tape reels are cantilevered members which can be supported against extreme shock and vibration only at the cost of a substantial increase in the rotational inertia of a system. So we got rid of them. The tape can't slip off the reel because hoop tension forces resulting from normal pulling of the tape provide great compressive forces within the reel stack. It would take in excess of 300 g's for slippage to occur.

The result of our Sandwich and Flangeless design approaches (plus a few other neat ideas): a rugged, high performance field portable tape system. Request full information.

Circle reader service #123

Our Rate-of-Turn Table Laughs At Abuse



Our new Model 1147 maintains high precision performance regardless of rough handling and transportation. (One reason it's used as the AGE gyro test table for F-111 Aircraft System.) Hydrostatic bearings give precise dimensional stability, excellent alignment, low runout and eccentricity, low mechanical noise and long life. The bearing is capable of smooth rotation at less than siderial rates (.004°/sec.). And up to 1500°/sec.

The Model 1147's compactness makes it ideal for field or bench checking. Its ruggedness makes it ideal in case you just happen to feel like kicking hell out of a fine piece of equipment.

Circle reader service #124

Our Computer Can Beat Up Your Computer

Filled with supreme confidence the engineer plugs in his newly designed gem of a system. Then discovers that it's too noisy. So off to the supplier for a custom filter. It's expensive and its weird configuration makes it almost impossible to maintain a hermetic seal under the stresses of high pressures and extreme temperature variations.

We can help you avoid the what-me-need-a-filter syndrome. Give us a work statement. For free, we'll crank the system parameters into our computer and it will design the Perfect Filter. It will do the job right, and cost you about 40% less than one that must be produced downstream.

Out of the hundred or so companies in the industry only two or three use computers. We're better at it than they are, and besides our salesmen know good jokes. Come on, give us a break.

Circle reader service #125

GENISCO TECHNOLOGY CORPORATION
18435 SUSANA ROAD
COMPTON, CALIFORNIA 90221

Electronic robot speeds training of doctors

Breathing, heartbeat, even reaction to drugs are simulated in 'patient' and recorded for analysis

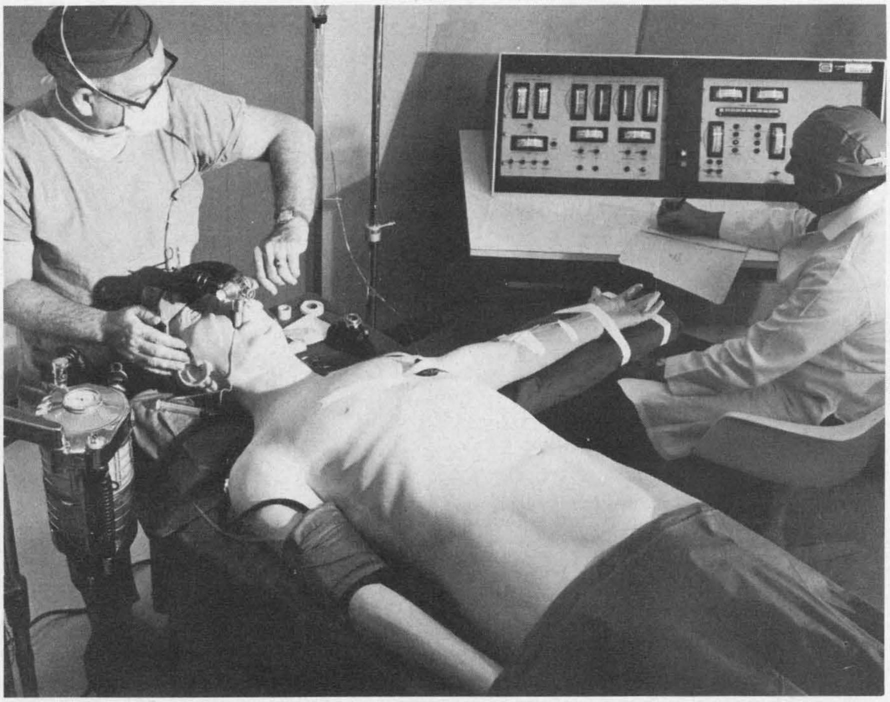
The modern Frankensteinian scientist doesn't slink covertly in an eerily lighted laboratory; he works at a modern industrial plant with the help of university professors and a U.S. grant. His robot doesn't look or act like Boris Karloff; it looks like a hospital patient and acts very much like one. And no bolt of lightning is needed to get the robot moving; electronic circuitry and a computer do the job nicely.

Such a robot has been developed to train doctors in operating-room procedures. It is called Sim One by its creators—engineers of the Aerojet-General von Karmon Center in Azusa, Calif., and researchers of the University of Southern California in Los Angeles.

Working under a $272,130 grant from the U.S. Office of Education, the research team devised a "patient" that has soft, plastic skin; a jaw that opens on a full set of teeth, a tongue, vocal cords, a windpipe and other vital structures; eyes that open and close; carotid and temporal pulse beats; blood pressure; a moving diaphragm and chest, paced by the breathing apparatus; and such physiological reactions as muscles that can freeze in paralysis, a brow that can wrinkle and eye pupils that dilate and constrict when different drugs are administered.

Dr. J. S. Denson of the University of Southern California School of Medicine, co-director of the project with Dr. Stephen Abrahamson, says that Sim One is sufficiently lifelike to be truly representative of a human on an operating table awaiting surgery.

The school hopes the simulator will cut drastically the time needed to teach anesthesia procedures to students (see ED 4, Feb. 15, 1967, p. 68). For example, it now takes about two months to teach a student to insert an air tube delicately into the windpipe without damaging tissue. With Sim One, it is hoped this time can be slashed to two days.



Electronically controlled manikin exhibits all the physical properties of a real patient. Student anesthesiologist is adjusting the oxygen flow while the instructor monitors the procedure from the control console.

To develop Sim One, Aerojet engineers reduced all of the physiological responses desired to mathematical equations.

A general-purpose computer with 4000 24-bit words of memory and a 10-μs add time is used to control the electropneumatic system that activates the manikin's physical reactions.

A computer-controlled typewriter printout makes a permanent record of everything the student doctor does to the "patient" and the time it takes the doctor to respond. A strip chart records the action of all vital physical signs as they occur.

Monitored by instructor

The instructor, seated at a control and display console, monitors the student's actions and the simulated physiological data. The instructor can insert emergency situations, such as severe spasm and closing of the larynx, a block in either the right or left bronchial tube or bucking—an attempt to cough the air tube out of the throat. Heart arrest and even vomiting can be induced.

The robot was manufactured by the Sierra Engineering Co., of Sierra Madre, Calif.

One of Aerojet's biggest problems was to devise a simple way to detect the quantity and kind of drugs administered. This was eventually solved by magnetically coding the needle on each syringe used for injections. In normal surgical procedures, a needle and cup device is inserted into the patient's arm before the surgery begins, and all drugs are administered through this cup. In Sim One a magnetic sensing coil has been placed in the cup to detect which magnetically coded needle is inserted. A piston in the patient's arm is displaced by the drug (which is actually water). The piston operates a potentiometer to indicate the quantity injected. ■ ■

ON READER-SERVICE CARD CIRCLE 23 ➤

Tantalum Swings

KEMET C-Series Solid Tantalum Capacitors. In the swing with today's on-the-go electronics products.

Who says you can afford tantalums? We do. Because these KEMET C-Series low-leak, low-dissipation-factor capacitors are competitive in price with ordinary commercial electrolytics. So you can bring tantalum reliability to such mass-produced products as portable phonographs, home appliance controls, electronic musical instruments, radios, televisions.

Where specs call for 0.1 to 220 microfarads, 6 to 50 vdc, with environments from −55° to +85°C—remember, you no longer have to be rich to buy tantalums.

And remember the unique Union Carbide delivery plan: ultra-fast or staged deliveries of any quantities from thousands to millions—assured.

Move up to tantalum. It swings. Mail the coupon, or see our representative.

Clip, fill in name and title, attach to letterhead.

Union Carbide Corporation
Components Department
Dept. ED-44
270 Park Avenue
New York, N. Y. 10017

UNION
CARBIDE
ELECTRONICS

Please send details on C-Series KEMET Solid Tantalum Capacitors

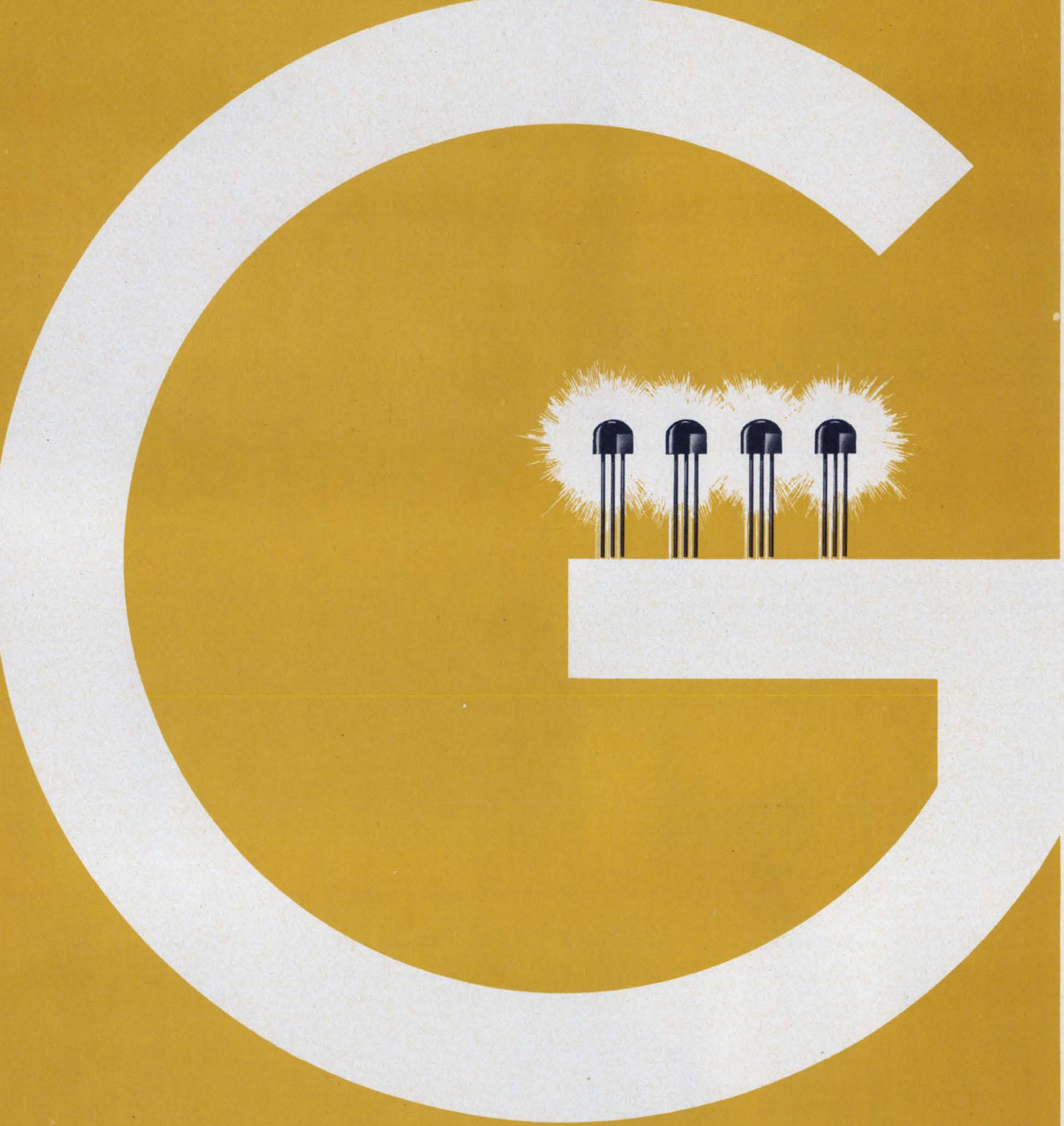
Name____________________________

Title____________________________

KEMET is a registered trade mark of Union Carbide Corporation.

REGIONAL SALES OFFICES. New England: T. J. Roper, 300 First Ave., Needham Heights, Mass. Phone: 617-444-5400. **Mid-Atlantic:** R. H. Robecki, 1341 Hamburg Turnpike, Wayne, New Jersey 07472. Phone: 201-696-2710. **Mid-West and South:** K. S. Collart, P. O. Box 6087, Cleveland, Ohio 44101. Phone: 216-221-0600. C. F. Fields, 2 Talcott Road, Park Ridge, Ill. 60068. Phone: 312-825-8189. **West Coast:** D. Purcell, 701 East Whittier Boulevard, Whittier, California 90605. Phone: 213-698-8077. C. E. Volpe, 2680 Bay Shore Frontage Road, Mountain View, California 94041. Phone: 415-969-9390. **For Overseas Inquiries contact:** J. G. Egan, 1341 Hamburg Turnpike, Wayne, New Jersey 07472. Phone: 201-696-2710.

GOING PLASTIC?



GO low cost, high quality with ......

TRANSITRON INDUSTRIAL DISTRIBUTORS

Alabama, HUNTSVILLE
M G Electronics & Equipment Co., Inc.,
(205) 534-0608

Arizona, PHOENIX 85016
Kimball Electronics, Inc.,
(602) 264-4438

California, CULVER CITY 90230
Avnet Corporation, (213) 870-0111
GARDENA 90247
Bell Electronic Corp.,
(213) FAculty 1-5802
MENLO PARK 94025
Bell Electronic Corp.,
(415) DAvenport 3-9431

MOUNTAIN VIEW 94040
Avnet Corporation, (415) 961-7700

NORTH HOLLYWOOD 91601
Richey Electronics, Inc.,
(213) 877-2651

REDWOOD CITY 94063
Fortune Electronics Corp.,
(415) 365-4000

SAN DIEGO 92111
Avnet Corporation, (714) 279-1550

SAN DIEGO 92111
Bell Electronic Corp., (714) BR 8-4350

Florida, PALM BEACH GARDENS 33403
Industrial Electronics Associates, Inc.,
(305) 848-8686

Georgia, ATLANTA 30308
Specialty Distributing Co., Inc.,
(404) TRinity 3-2521

Hawaii, HONOLULU 96810
Industrial Electronics, Inc., 506-095

Illinois, CHICAGO
Radio Distributing Co., Inc.,
(312) 379-2121
FRANKLIN PARK
Avnet Corporation, (312) 678-8160
SCHILLER PARK
Pace Electronic Supply
(312) 678-6310

Indiana, SOUTH BEND 46624
Radio Distributing Co., Inc.,
(219) 287-2911

Iowa, CEDAR RAPIDS
Iowa Radio Supply Co.,
(319) EM 4-6154

Kansas, WICHITA 67201
Radio Supply Co., Inc.,
(316) AMherst 7-5214

Louisiana, NEW ORLEANS
Radio Parts, Inc., (504) 522-0217

Maryland, BALTIMORE 21211
Kann-Ellert Electronics, Inc.,
(301) TUxedo 9-4242

ROCKVILLE 20850
Pioneer Standard Electronics, Inc.,
(301) 427-3300

Massachusetts, BURLINGTON
Avnet Corporation, (617) 272-3060

CAMBRIDGE 02139
R & D Electronic Supply Co., Inc.,
(617) UN 4-0400

WATERTOWN
L. L. Schley Co. Inc., (617) 926-0235

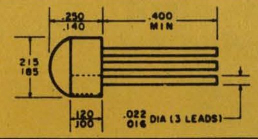
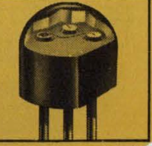
TRANSITRON ELECTRONIC CORPORATION, 168 ALBION STREET, WAKEFIELD, MASSACHUSETTS 01880

Transitron plastic-packaged silicon planar transistors offer an excellent combination of performance, reliability and low, low price.

Both NPN and PNP types are available. They are encapsulated in a TO-18 size package with leads hermetically sealed. Each package has a locating flat, and leads which will fit the TO-18 standard socket without preforming.

A broad range of types is available for fast delivery from Transitron stock.

PLASTIC-PACKAGED SILICON PLANAR TRANSISTOR FAMILIES

APPLICATION	TYPE	PLASTIC-PACKAGED FAMILY	SIMILAR TO-18 FAMILY
High gain, general purpose amplifier	NPN	**2N3709**	2N929
	NPN	**2N3710**	2N930
	PNP	**2N4288**	2N2604
	PNP	**2N4289**	2N2605
General purpose high frequency amplifier and driver	NPN	**2N4140**	2N2221
	NPN	**2N4141**	2N2222
	PNP	**2N4142**	2N2906
	PNP	**2N4143**	2N2907
High frequency logic	NPN	**2N4274**	2N744
	NPN	**2N4275**	2N2369
	PNP	**2N4121**	2N3248
	PNP	**2N4122**	2N3249
VHF/UHF unit for high frequency oscillator and amplifier service	NPN	**2N3563**	2N918
			

....Transitron

TRANSITRON INDUSTRIAL DISTRIBUTORS (Continued)

Minnesota, MINNEAPOLIS
Northwest Electronic Inc.,
(612) 331-6350
ST. PAUL 55104
Radio Distributing Co., Inc.,
(612) 645-0631
Missouri, KANSAS CITY 64106
Burstein-Applebee Co.,
(816) BAltimore 1-1155
ST. LOUIS 63130
Ensco Distributing Corp.,
(314) PA 6-2233
New Jersey, CHERRY HILL
Valley Electronics, Inc.,
(609) NO 2-9337

New York, BINGHAMTON 13902
Federal Electronics, Inc.,
(607) Pioneer 8-8211

BUFFALO
Radio Equipment Corp., (716) 856-1415

BUFFALO 14202
Summitt Distributors, Inc.,
(716) 884-3450
LONG ISLAND CITY 11106
H. L. Dalis, Inc., (212) EMpire 1-1100
NEW YORK 10013
Milo Electronics Corp., (212) BE 3-2980
WESTBURY, L.I.
Avnet Corp., (516) 333-8650

North Carolina, WINSTON-SALEM 27108
Kirkman Electronics, Inc.,
(919) 724-0541
Ohio, CINCINNATI
Hughes-Peters, Inc., (513) 381-7625
CLEVELAND 44115
Radio & Electronic Parts Corp.,
(216) UTah 1-6060
COLUMBUS 43211
Hughes Peters, Inc., (614) 294-5351
DAYTON
Stotts Friedman Co., (513) 224-1111
Oklahoma, TULSA 74119
Radio, Inc., (918) LUther 7-9124

Pennsylvania, McKEESPORT
Barno Radio Co., Industrial Electronic
Div., (412) 462-7575
PHILADELPHIA 19106
Radio Electric Service Co. of Pa., Inc.,
(215) WAlunt 5-6900
Texas, DALLAS 75207
Contact Electronics, Inc.,
(214) ME 1-9530
DALLAS
Solid State Electronics of Texas,
(214) FL 2-2601
EL PASO
Mc Nicol, Inc., (915) 566-2936

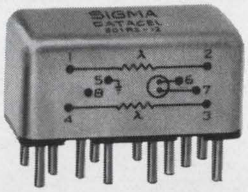
HOUSTON 77019
Busacker Electronic Equip. Co.,
(713) JAckson 6-4661
Utah, SALT LAKE CITY 84104
Kimball Electronics, Inc., (801) 328-2075
Washington,•SEATTLE 98121
Kierulff Electronics, (206) 725-1550
In Canada contact MONTREAL 9
E T R Supply Company, Ltd.,
(514) 735-2471
DON MILLS, ONTARIO
Western Components Supply Ltd.,
(416) 445-2340
VANCOUVER 9
L. A. Varah Ltd., (604) 736-6411

TRANSITRON ELECTRONIC CORPORATION, 168 ALBION STREET, WAKEFIELD, MASSACHUSETTS 01880

ON READER-SERVICE CARD CIRCLE 24

THIS IS SIGMA'S NEW SOLID-STATE DATACEL®.

An opto-electronic switching device that provides input-output circuit isolation.



Solid-state and opto-electronic switching benefits are combined in low-cost Sigma Series 301 Datacels.

Electrically Isolated Input-Output Circuits: Light-beam coupling to 1, 2 or 4 photocells provides isolation resistance on the order of 10^9 ohms and smooth turn-on, turn-off.

AC-DC Capability: Both input and output circuits can handle either AC or DC signals. Cell loads may range from millivolt to 250-volt levels.

Application Versatility: Functions include high isolation interface switching, logic switching (and/or gate, inverter, latch circuits), audio switching, multiplexing, data sampling, feedback gain control, noiseless potentiometer.

Compact Construction: 1, 2 and 4 pole versions all designed for high-density printed-circuit packaging. Also socket conversion to solder terminal mounting. In addition each unit visually indicates its on-off state to aid system trouble-shooting.

We'd like to give you a new solid-state Sigma Datacel—or any of our standard relays. It's the best way we know to prove what we say about Sigma performance. Just circle our reader service number on the reader service card. We'll send you the new Sigma catalog and a "free" request form. Return the form to us and your Sigma representative will see that you get the sample you need.

Need fast delivery? Opto-electronic Datacels are available off-the-shelf from your Sigma distributor. Call him today.

SIGMA DIVISION SIGMA INSTRUMENTS INC
Assured Reliability With Advanced Design / Braintree, Mass. 02185
Sigma Instruments (Canada) Ltd., P.O. Box 43, Toronto 18

ON READER-SERVICE CARD CIRCLE 25

transistors

Siemens Semiconductors:
Germanium Transistors
Silicon Transistors
Germanium Diodes • Tunnel Diodes
Silicon Diodes
Silicon Zener Diodes
Photo Diodes • Photo-Voltaic Cells
Negative Temperature
Coefficient Thermistors
Positive Temperature
Coefficient Thermistors

Siemens Transistors for transformerless output stage with complimentary pairs

Write for further information, or tell us your application and we will suggest specific items.

SIEMENS AMERICA INCORPORATED
Components Division • 230 Ferris Avenue, White Plains, N. Y. 10603

ON READER-SERVICE CARD CIRCLE 26

Scanner converts maps for EDP storage

An automatic scanner that converts maps into binary data for computer processing is helping the Canadian government manage land resources.

Surveys of natural resources covering vast expanses of terrain are being stored in computer memories or on tape for convenient reference when needed. More than 30,000 such maps have been made in Canada in the last 40 years, according to government sources.

The maps contain information on such points as these: land being used for farming that is unsuitable for this purpose; land unsuitable for farming that is desirable for forestry; land suitable for forestry that should be protected for its wildlife and recreation potential.

Until the introduction of the computer technique, there was no way of bringing all this information together conveniently.

The cartographic scanning system being used by the Canadian Agricultural Rehabilitation and Development Administration was built by the International Business Machines Systems Development Div. at Kingston, N. Y. It consists of a motor-driven drum, a lens-fiber optic array, an amplifier and register, magnetic-tape and control logic units and a clock.

Specially prepared maps up to 50 inches by 50 inches are rolled around the 16-inch drum and held by vacuum. When the drum is rotated, the eight-channel optical head is set to travel down the length of the drum. This action forms a spiral scan over the map. Each fiber optic channel views a four-mil-square area and is pulsed to eliminate overlap. If at least half the area seen by each channel is black when the pulse is received, a "one" bit is generated. If not, a "zero" bit is formed. The "ones" and "zeros" from each pulse are recorded in groups of eight bits—called bytes—on magnetic tape.

IBM spokesmen say the eight-channel, parallel-to-serial method of scanning simplifies the data transfer to magnetic tape and decreases scanning time. Bytes are produced at tape speed, they say; so a 16-square-foot map (of 18 million bytes) can be scanned in less than 11 minutes.

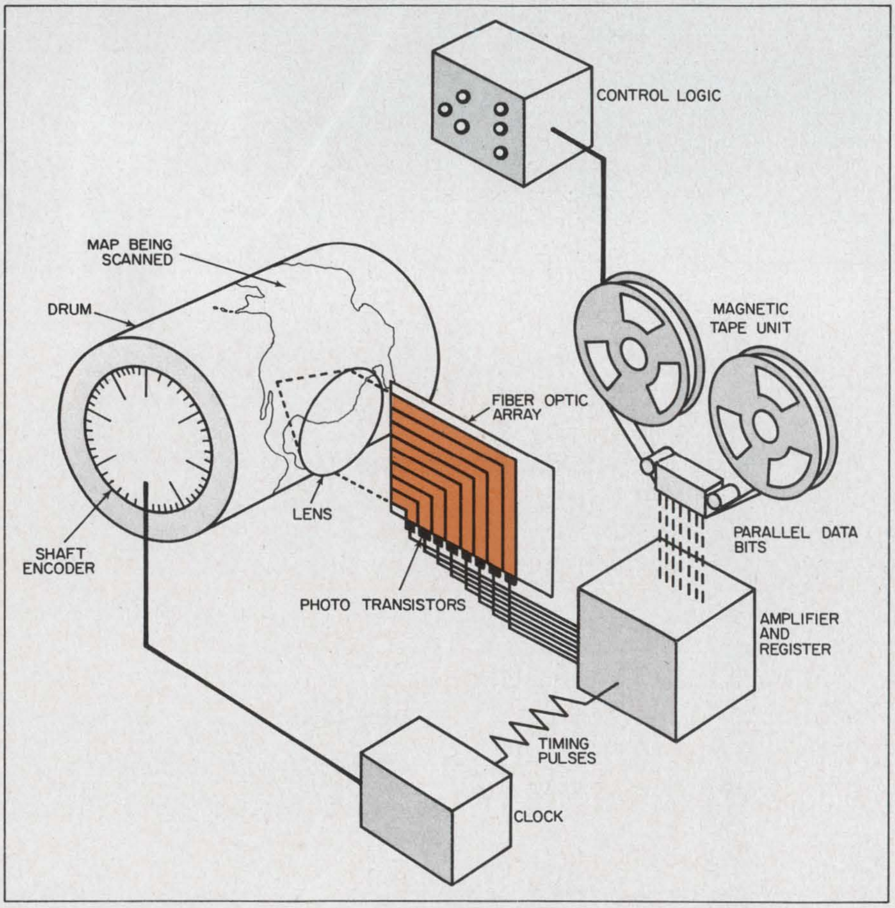
The scanner is used "off line" with an IBM 2401 magnetic tape unit.

Maps to be scanned must be specially prepared to meet minimum standards for contrast, line width and line separation. One way, IBM engineers suggest, is to place a white-coated sheet of transparent plastic over the source map. A stylus is then used to trace the boundaries of the map onto the plastic sheet. As it traces, the stylus removes an eight-thousandths-inch-wide strip of the white coating. When the traced map is placed over the black drum surface, the boundaries appear as high-contrast lines.

After a map has been completely scanned, the tape unit shuts off and the scan head is returned automatically to the starting position. The map can then be removed. IBM says that it takes less than a minute to mount a new map.

The complete geographic information system, which includes the scanner, will use an IBM 360 computer model 65 to create the "data bank."

Information obtained from the Canada Land Inventory program could, according to IBM, be extremely valuable to pulp and paper companies seeking the best possible sites for locating their mills. ■ ■



An IBM cartographic scanner uses an eight-channel fiberoptic array to scan eight 4-by-4-mil spots for parallel-to-serial conversion. Phototransistors convert optical signals from maps into bits for recording on magnetic tape.

An Ace on every Mission

Mark up another score when a Licon® environment-free sealed switch is specified. You get the same reliability and long life on a light plane panel as you do when you've got a hot jet dropping its landing gear or dropping its ordnance. A whole line of military approved and performance tested switches are detailed in this new book.

Take a look at it.

Send for your copy now.

strike hard with LICON... the fastest growing line of ENVIRONMENT-FREE SEALED SWITCHES

Strike hard with LICON... fastest growing full-line switch supplier

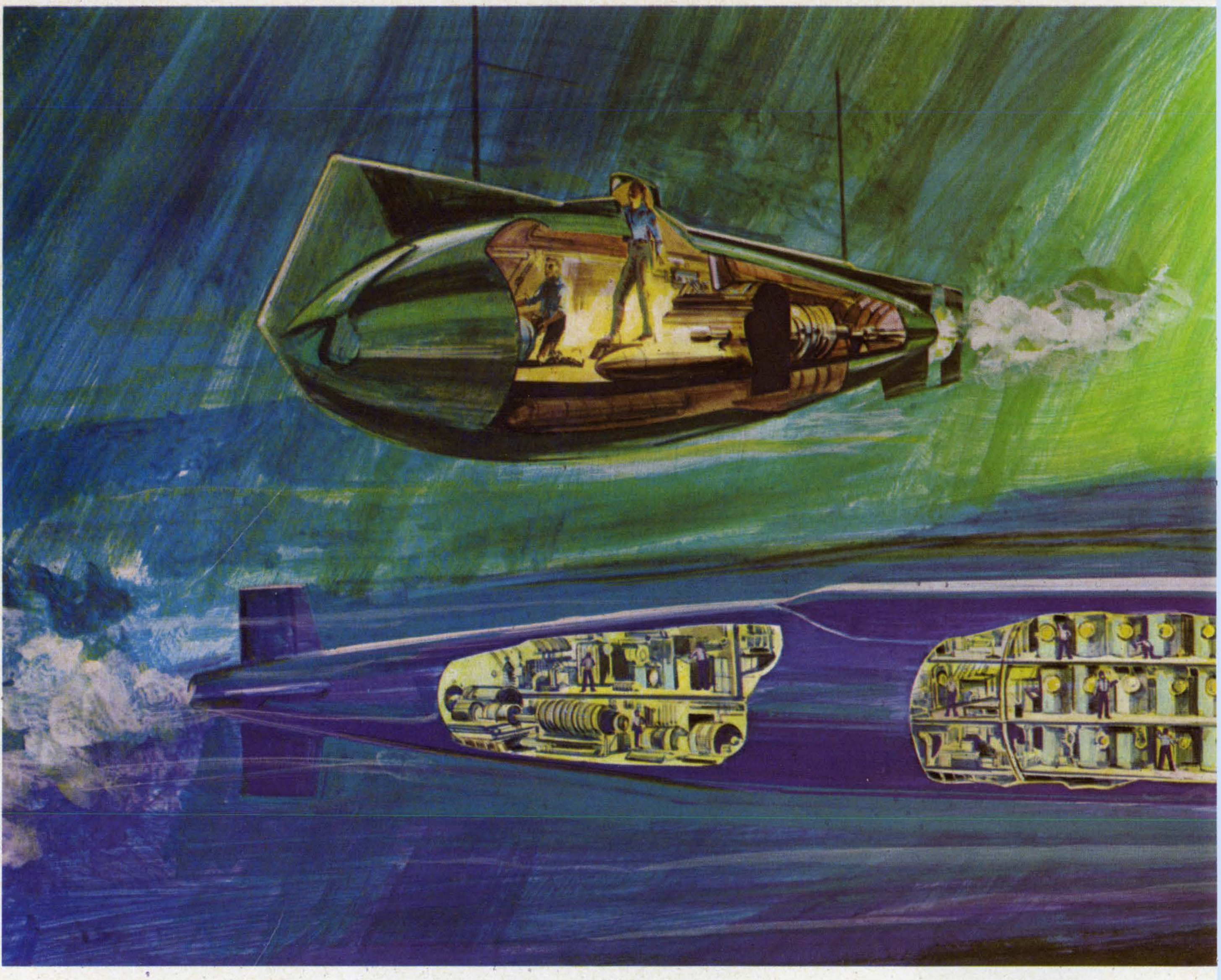
LICON

DIVISION ILLINOIS TOOL WORKS INC.
6615 WEST IRVING PARK ROAD — CHICAGO, ILLINOIS 60634

"Remember, you're never more than a few feet away from a product of ITW"®

A McDonnell Phantom photo

ON READER-SERVICE CARD CIRCLE 27



The Kind of Knowledge that makes progress possible...

During the 1890's, a Paterson, N. J. schoolteacher named John P. Holland was busy perfecting a submarine. It was the ninth underwater vessel he had built in over thirty years, and his eight previous attempts had taught him well. This ship was motor-driven and carried torpedos within its hull. It could travel submerged for fifty miles. In 1900, the U.S. Navy not only commissioned the vessel, but honored its inventor by naming it after him.

Since the *Holland*, men have piled fact upon fact in an unending scientific quest to improve the materials, the propulsion, the range, the striking power, the defenses and the livability of submarines. Today's nuclear-powered submarines are marvels of engineering, controlled by a maze of intricate electronic

IS THE KIND OF KNOWLEDGE YOU GET FROM KESTER

systems. They can launch missiles while submerged. They can roam the seas for months without resurfacing, while their crews live in a cleaner atmosphere than do most city dwellers. The modern submarine is an amazing example of man's application of accumulated knowledge.

This knowledge of experience is the kind of knowledge you get from Kester. Even before the Holland sub was commissioned, Kester Solder products and soldering knowledge were serving industry. And as technology accelerated, Kester kept pace.

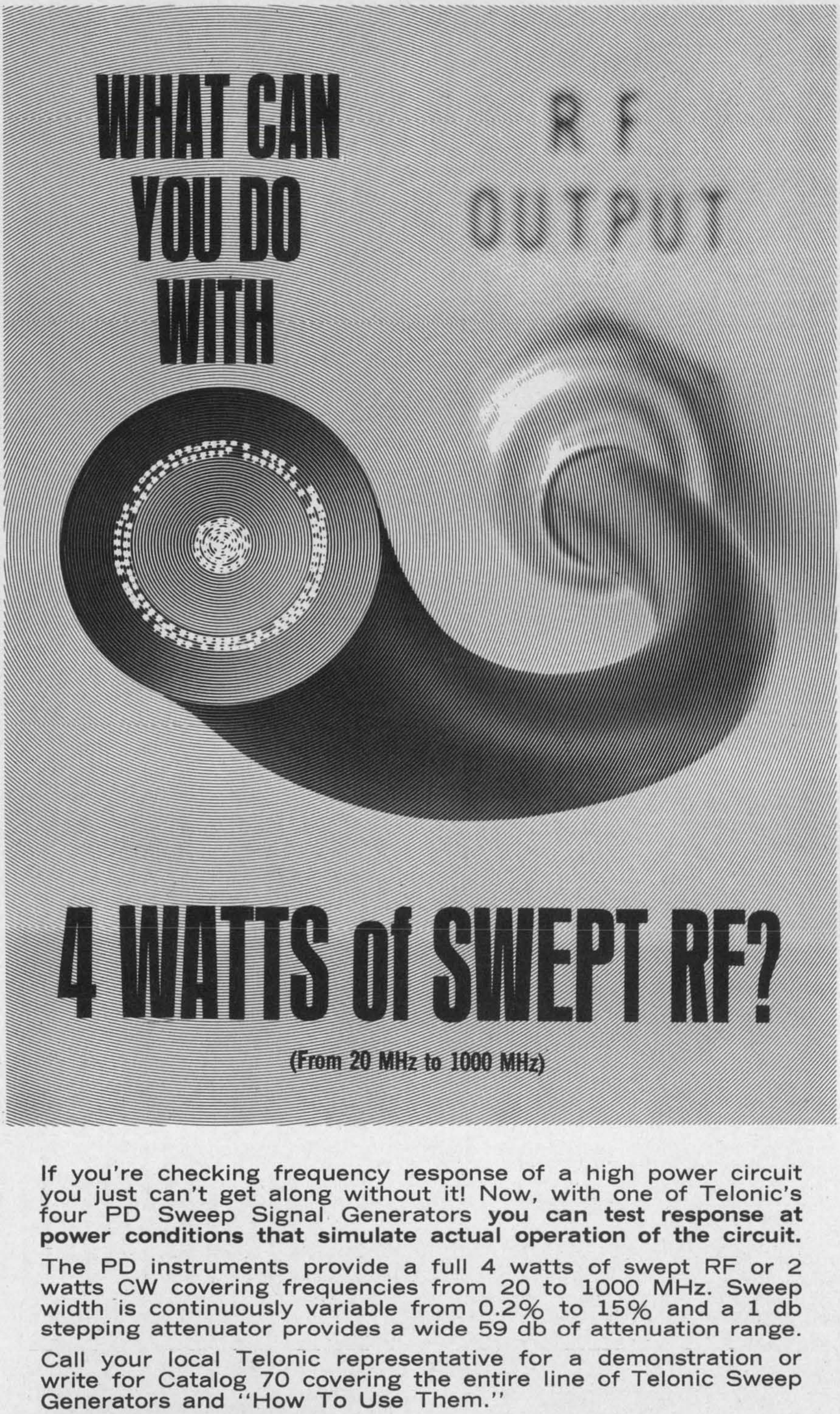
Today, after 67 years of working with development engineers in the technology of solders, fluxes and their applications, Kester stands ready to serve you. Write, phone or wire for specific information.

KESTER SOLDER COMPANY

4201 Wrightwood Avenue, Chicago, Illinois 60639 • Newark, New Jersey 07105 • Anaheim, California 92805 • Brantford, Ontario, Canada

1899-1966—67 years devoted to production of products of the highest reliability—solders and fluxes

ON READER-SERVICE CARD CIRCLE 28



Device measures minute distance

An ultrasensitive instrument that accurately measures extremely short distances—10^{-3} to 10^{-6} cm—with an accuracy of about 10 parts per million has been developed by a National Bureau of Standards scientist.

The accuracy of the instrument, according to its developer, Dr. Russell Young, is limited only by available calibration techniques.

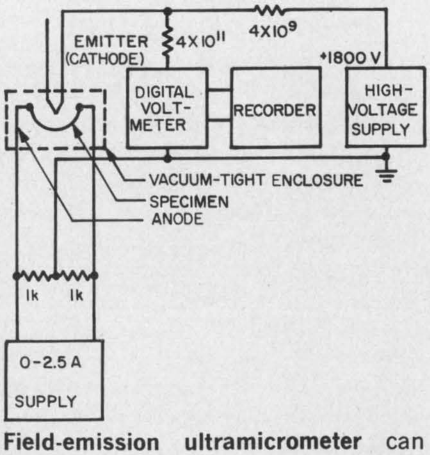
Called a field-emission ultramicrometer, the instrument is basically an arrangement of field-emission electrodes enclosed in a vacuum chamber.

The electrodes are connected to a constant-current electrical circuit (see diagram) such that a precise digital voltmeter indicates a voltage directly related to the spacing between the electrodes. The current source ensures a constant electron flow through the emitter to the anode.

Available devices of limited use

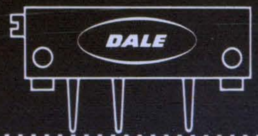
Devices for precise measurement of short distances have been available, Young noted, but are limited in two important respects:

- They involve delicately balanced bridges and mechanical or optical



Field-emission ultramicrometer can measure distances in the 10^{-3}-to-10^{-6}-cm range with a reproducibility said to be within 1 part in 10^5. In the experimental setup above, the tantalum strip serves as the anode. The recorded voltage is directly related to the spacing between the emitter and anode.

You name it.



Dale's new ½ watt trimmer—costs less than $1.00

Win $500.

This great new trimmer starts our 2300 commercial series. Give it the right trade name and you'll win $500.

Remember these 3 important tips:

1. *It costs less than $1.00*.*

2. *It is interchangeable with other one inch commercial models.*

3. *It has excellent setting stability.*

One thing more, it's a direct descendant of Dale's Mil-Style trimmer line and uses many similar design and production techniques. Go ahead. Send us the name you like best on the reply card. It could earn you an easy $500. There's nothing to buy—unless you're looking for a better source for ½ watt commercial wirewounds—for less than $1.00*.

**In 1,000 quantities*

Send this postpaid entry card today.

Complete contest details on reverse side.

DALE®

DALE ELECTRONICS, INC.
1300 28th Avenue, Columbus, Nebraska 68601
In Canada: Dale Electronics Canada, Ltd.

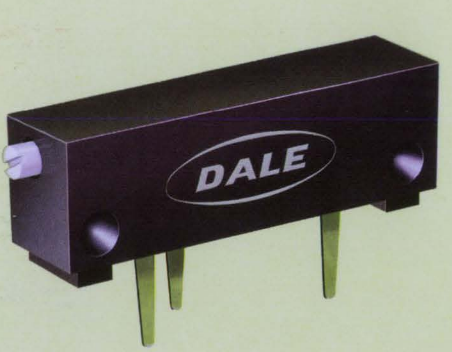
FIRST CLASS
PERMIT NO. 503
Columbus, Nebr.

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

Postage will be paid by

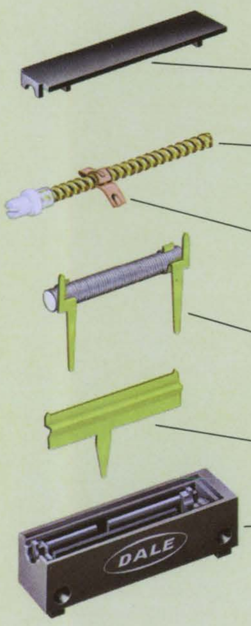
DALE ELECTRONICS, INC.
Dept. 88600, P.O. Box 609
Columbus, Nebraska 68601

Win $500.



Name Dale's new ½ watt commercial trimmer – costs less than one dollar

Read before entering. These details can help you choose a good trade name for Dale's 2300 Series. They can also acquaint you with a better source for low cost trimmers.



- Lid ultrasonically welded for excellent protection against dust and dirt.
- Lead screw with shockproof insulated nylon head. Installation method generates ample torque for good setting stability.
- Exclusive Dale Mil-Style wiper arm provides positive settings. Idles at either end to prevent overtravel damage.
- Integral element and P.C. terminal assembly provides simple, reliable termination. Both P.C. terminals and hook-type solder lugs are standard.
- Collector bar and P.C. terminals are gold plated for good conductivity.
- Precision molded case made for use with production soldering processes.

SPECIFICATIONS

Standard Resistance Range: 10 ohms to 50K ohms

Resistance Tolerance: ±10% standard

Resolution: .18% to 1.82%

Power Rating: 0.5 watt at room temperature to 0 watt at 85° C

Operating Temperature Range: −55°C to 85°C

Mechanical Adjustment: 15 turns nominal

Mechanical Stops: None. Clutch mechanism permits overtravel without damage

Dimensions:
1.0" L x .36" H x .28" W

Terminals:
P.C. terminals (Model 2387)
Hook-type solder lugs (Model 2389)

I think Dale's 2300 Series Trimmers should be trade named:

____

☐ Send me additional information on the 2300 Series

My job function:

☐ Design Engineering
☐ Specification
☐ Procurement

NAME ____________________________

TITLE ____________________________

COMPANY ____________________________

ADDRESS ____________________________

CITY ____________________________

STATE ____________________ ZIP ________

Card must contain all requested information in order to qualify for contest.

Enter today!

It's easy - just fill out & mail this postcard.

Make it short! Something that quickly describes 2300 advantages. Examples are "Cost-Trim" or "PC-Pot".

Nothing to buy – but if you want to call for a price on the 2300 Series, our number is 402-564-3131.

CONTEST RULES

Send the return postcard at left or a similar form containing identical details to Dale Electronics, Dept. 88600, Box 609, Columbus, Nebraska 68601. Submit only one name per card. Entry must be postmarked by midnight, June 15, 1967, and must be received by Dale by June 22, 1967. Anyone living in the United States or its possessions is eligible except employees of Dale Electronics, affiliated companies, advertising agencies and their families. All entries become the property of Dale Electronics and entrant relinquishes all claims for use of proposed trade name submitted. Entries will be judged solely on the basis of their usefulness as a trade name describing Dale 2300 Series Trimmer Potentiometer. Judges decision is final. In case of duplication, winner will be determined by earliest postmark. Winner will be notified by mail approximately 30 days after contest closes. No other correspondence will be entered into. Winner assumes all tax responsibility for prize. Contest void where prohibited by law.

For complete information circle 181

SEE OUR SPECIFICATIONS IN V·S·M·F THE MICROFILM CATALOG FILE

DALE ELECTRONICS, INC.
1300 28th Avenue, Columbus, Nebraska 68601
In Canada: Dale Electronics Canada, Ltd.

DALE®

Printed in U.S.A.

levers that are sensitive to high temperatures.

- They have to be in physical contact with the object that is to be measured.

The field-emission ultramicrometer overcomes these limitations. It is particularly suited to measuring curved surfaces where errors may be introduced by depressions or scratches, the scientist said. The simplicity and small size of the sensor is another advantage cited by Young.

The ultramicrometer is expected to have a variety of applications. These include uses as a strain gauge to measure the deformation of structural materials, as a differential thermal expansion cell, as a contact-free delineator of surface profiles and contours, and as a means for measuring the diameters of balls and holes.

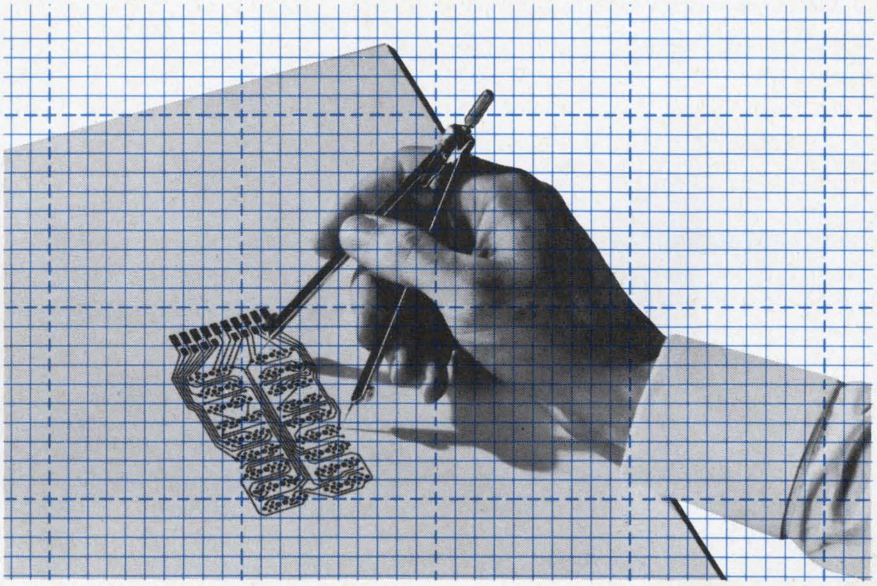
Operation similar however used

The operation of the instrument for the various applications is essentially the same. For example, as a delineator of surface profile, a field-emission tip serves as one electrode (at a high negative voltage) and the surface to be measured as the other. As the field emitter moves across the surface, recorded changes in voltage indicate changes in profile. Equations fix the relationship between the voltage and the distance from the emitter to the surface.

The accuracy of the minimum detectable displacement, Young said, depends on solutions of Laplace's equation, the precision of the voltmeter, the stability of the constant-current source, and the mechanical stability of the components. These factors, Young said, can all be evaluated without recourse to any form of experimentation.

The field-emission ultramicrometer has already been used in several applications at the NBS Institute for Basic Standards (U.S. Dept. of Commerce). NBS has decided not to patent the device but has put it in the public domain. Consequently, a number of outside manufacturers have expressed great interest in it.

One company, according to Young, plans to use it to detect the surface roughness of steel balls. Another foresees uses in measuring the curvature of optical surfaces. ■ ■



◄ ON READER-SERVICE CARD CIRCLE 135

IBM Circuit Design and Packaging Topics

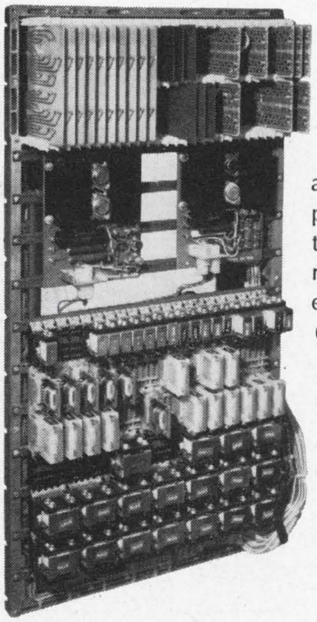
☐ **packaging cost reductions**
☐ **high-speed switching**
☐ **reed switch application data**

☐ packaging cost reductions

Performance Measurements Co., Detroit, Michigan, reports significant savings in packaging their new electronic recording system. The packaging method previously employed required two gates to mount the components in the main console. Now, with IBM's modular packaging as pictured below, only one gate is needed. That's because the IBM technique makes the most efficient use of console space with compactly mounted and connected circuit boards, relays and hardware.

Mounting time has been saved too. Pluggable components, low-cost card receptacles and interlocking card guides have so simplified the packaging job, that Performance Measurements now saves 70% on the cost of mounting hardware. Fewer and shorter wires are needed in the compact console — eliminating three feet of 1½-inch cable and shortening a second cable by eight inches. The modular chassis gave designers freedom to experiment freely with various mounting configurations. It also permits easy access for servicing and diagnostic analysis.

The same design freedom, plus significant hardware and labor savings are available in many applications.



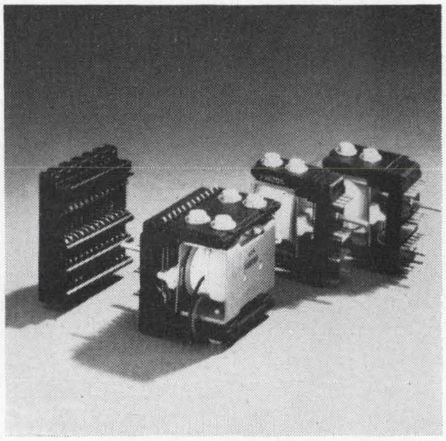
IBM components and packaging can help you in timing control, digital logic testing, telemetering, process or numerical control.

☐ high-speed switching

IBM wire contact relays were originally designed for data processing use. Now they are being used extensively in machine tool and assembly applications. One of these assembly applications is a numerically-controlled component insertion machine. It sequentially inserts random combinations of up to 24 different types of axial lead resistors and diodes into printed circuit boards. Such machines have been widely used, often on a round-the-clock, three-shift basis, in IBM's electronic assembly operations.

Insertion rates range from 3,000 to 4,500 components per hour, depending upon the type of components being inserted.

Instructions from an 8-channel punched paper tape provide the logic input to the relay gate. The gate employs three rows of 6- and 12-pole IBM wire contact relays. These relays control the movement of each printed circuit board through the X and Y axis positioning of the board for each component insertion. They also control the component feed, component insert, and cut-and-clinch cycles for each insertion operation.

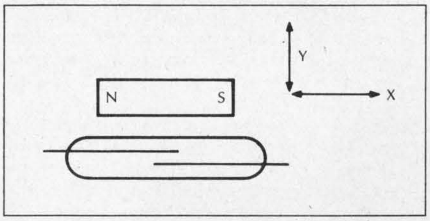


IBM wire contact relays can perform in excess of 200 million operations with an operate speed as fast as 4.5 ms, a release time of 5 ms maximum. The product line includes 4-, 6-, and 12-pole Form C relays, 4- and 6-pole latch models, all with compact, solderless, pluggable mountings—with coil-voltages up to 100 VDC.

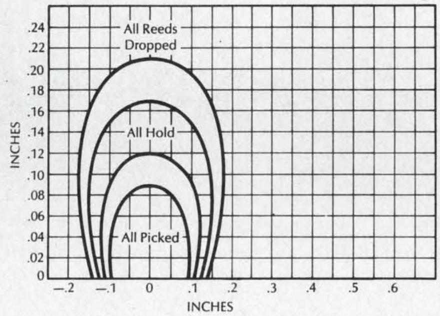
☐ reed switch application data

Data on the magnetic switching characteristics of miniature dry reed switches is available to design engineers on request. The data was compiled from extensive tests conducted by IBM to help the design engineer use these switches most effectively. It can also help him determine the motion and position of the magnet required.

Simply described, a miniature dry reed switch operates under the influence of a permanent magnet. When the magnet is adjacent to the reed switch, the flux of the magnet flows through the cantilever beams, as illustrated. While this magnetic flux is being carried by the beams, a polarity exists across the beams. Look at the overlap area of the beams. The north pole of one beam and south pole of the other beam are in proximity. Since unlike poles of a magnet attract each other, when the magnetic force becomes great enough to overcome the physical mass of the beams, they "snap" together, thus switching.



On the graph the X axis represents the displacement (in degrees for rotary motion, inches for lateral motion) of a magnet's center with reference to the center of the reed switch. The Y axis represents displacement (in inches) of the magnet from the outer edge of the dry reed switch glass envelope. Dimensions shown along both axes represent displacement from the center of the magnet in alignment with the center of the reed switch.



There are some "gray areas" where performance varies due to minor differences in the characteristics of each switch. In these areas the status of each switch is not completely predictable.

Assume the zero point on the X axis is the magnetic center of an IBM reed switch. The magnet is positioned with its center at +.5 on the X axis, and .04 inches above the glass envelope. If the magnet is set in motion along the X axis toward the center of the switch, some reeds will pick when the center of the magnet reaches the point +.12 on the X axis. (The magnet has then reached the "gray area"). If motion is continued toward the center of the switch, *all* reeds will pick when the center of the magnet reaches the point +.09 on the X axis.

IBM Industrial Products Marketing Dept. T1
1000 Westchester Avenue
White Plains, New York 10604

☐ **packaging cost reductions**
☐ **high-speed switching**
☐ **reed switch application data**

name____________________________

position____________________________

company____________________________

address____________________________

city______________**state**__________**zip**________

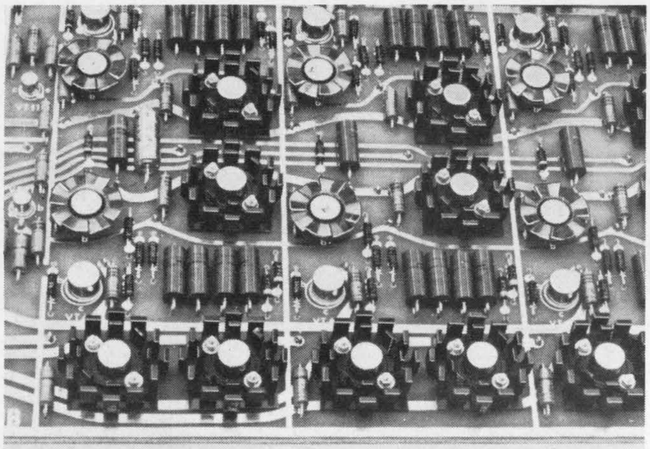
IBM®
INDUSTRIAL
PRODUCTS

ON READER-SERVICE CARD CIRCLE 31

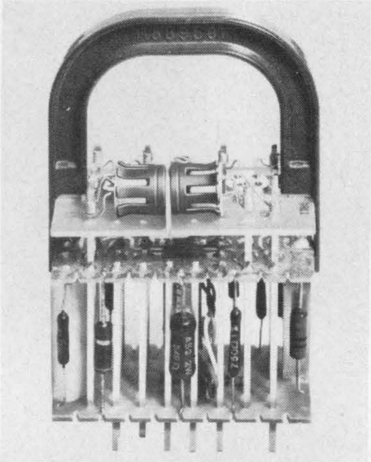
No. 2 of a Series

Tips on cooling off hot transistors

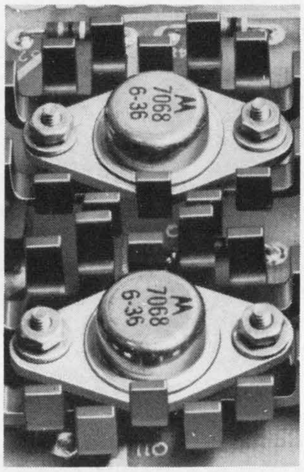
See how circuit designers use IERC heat dissipators to protect semiconductors... improve circuit performance and life.



A 2N1837 transistor mounted only to a p-c board with IERC's unique LP dissipator can be operated at 5 watts with a junction temperature of only 153°C. The LP's clamping method makes good thermal contact on both surfaces of the transistor flange, minimizing thermal resistance from transistor to dissipator.

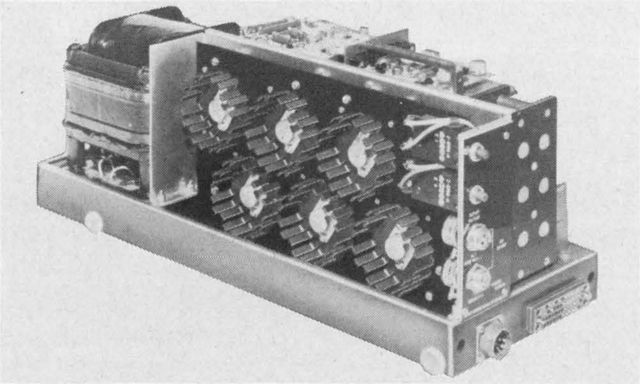


Mounting matched transistors for thermal stability so electrical characteristics stay identical is simple with back-to-back Therma-Link dissipators/retainers. Also used as heat sinks.

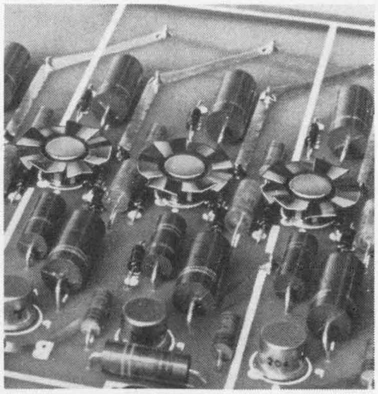


New dissipator for TO-66 transistor uses only 1.7 sq. in. of board space. IERC's unique, staggered-finger design dissipates 9 watts with case temperature of less than 150°C.

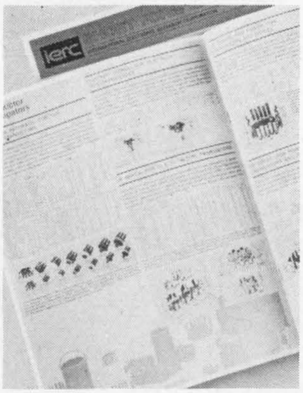
Heat from power transistors or diodes is quickly dissipated with IERC's HP dissipators. Large finger area maximizes efficiency in natural convection or forced air environments. Staggered-finger design which prevents finger surfaces from "looking at each other," radiates heat to the ambient, not back to the dissipator.



Fan-top dissipators increase transistor performance levels, permit use of cheaper transistors. Note how design needs no board space, permits other components to be positioned close by.



Free 8-page catalog gives complete pictorial and ordering data on IERC dissipators, retainers and tube shields, also prices. Send for a copy.



Send for test reports. The most thorough test reports in the industry are available on IERC Heat Dissipators. These are multipage reports complete with graphs showing case and junction temperatures vs. power dissipation for transistors in several mounting conditions. Please indicate which test reports you wish—LP, UP, HP or Therma-Link. On your company letterhead, please.

ierc

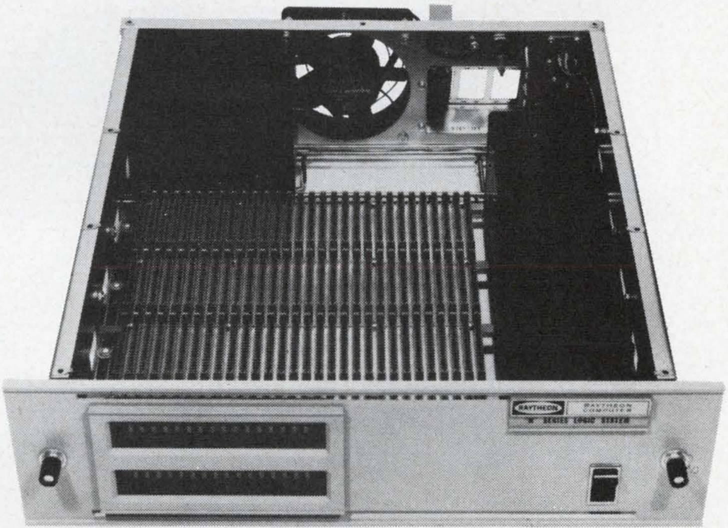
SEMICONDUCTOR HEAT DISSIPATORS

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION • A corporate division of Dynamics Corporation of America DCA 135 West Magnolia Ave. • Burbank, Calif. 91502

ON READER-SERVICE CARD CIRCLE 32

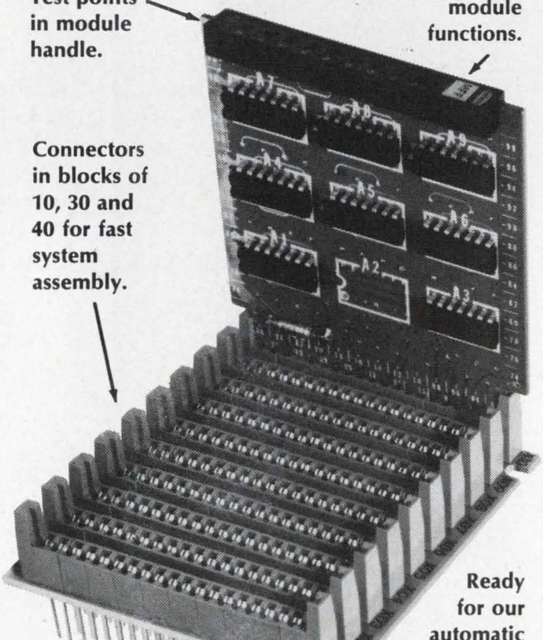
The Unbeatable IC System:

Your logic design and Raytheon Computer modules and hardware.



Indicator lights display system operation.

This case holds
120 modules. There's
also one for 40;
another for 400.



Test points in module handle.

Color-coded module functions.

Connectors in blocks of 10, 30 and 40 for fast system assembly.

Ready for our automatic wire wrap service.

Laminated power bus bars installed and wired in each module case. Reduces noise, eliminates power inter-connections, cuts hours from assembly and test time.

Raytheon Computer's M-Series — more than 30 modules—connectors, cases, power supplies and power distribution are so thoroughly engineered you can concentrate on logic and electronic design, not mechanical details. Every step—design, assembly, test, check-out, troubleshooting—is easier than you thought it could be.

We'll even help you design your logic. Call or write today for a visit from a helpful applications engineer or for the whole story in print. Ask for Data File M-136. Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif., 92705, Phone: (714) 546-7160.

RAYTHEON

ON READER-SERVICE CARD CIRCLE 33

Letters

FBI affirms interest in computer fingerprinting

Sir:

I am concerned about the misinformation appearing in the "Washington Report" by S. David Pursglove published in the March 1, 1967, issue of ELECTRONIC DESIGN [ED 5, p. 31]. His inaccurate comments regarding the study undertaken to develop a computer program for FBI fingerprint files tend to discredit the efforts of our own and the automatic-data-processing industry personnel.

The facts are that a request for a quotation was submitted to the industry on Dec. 16, 1966. The closing date for proposals in response to this request was set at Feb. 20, 1967. As an indication of the industry's interest, it is noted that representatives of more than 30 companies attended a preproposal conference held on Jan. 12, 1967, at FBI Headquarters. A number of proposals have been received and are currently being studied.

The entire law enforcement community is eagerly awaiting this milestone development in the war on crime. In view of the widespread importance of the study and in the interest of fairness and accuracy, I want to bring these facts to the attention of your readers.

J. Edgar Hoover

Director
Federal Bureau of Investigation
Washington, D. C.

Correspondent's reply

Much misinformation in reportorial coverage of the FBI stems from that agency's unhealthy compulsion toward secrecy extending even to its purchases of office stationery and supplies.

When we heard of the request for proposals to which Mr. Hoover refers, our Washington Office telephoned a public-relations official at the FBI for details. He replied that

(continued on p. 60)

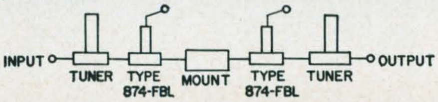
With a little ingenuity...

Type 874-BBL Basic Connector (locking) for use on $^9/_{16}$-inch-ID, rigid, 50-ohm air lines.

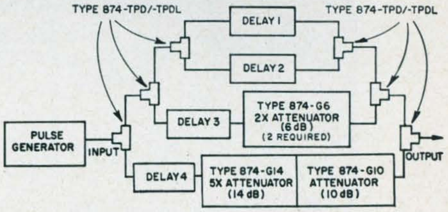
you can interconnect GR874-equipped coaxial elements to form countless unique "instruments" or special-purpose circuits that are both practical and inexpensive. Experimentation with various setups is greatly simplified by the sexless design of the GR874 connector; any two connectors mate, whether they are locking or non-locking types.

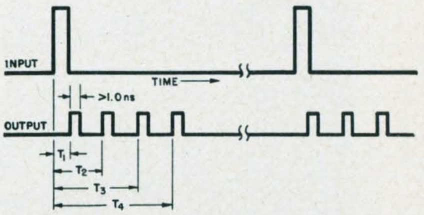
The GR874 connector is the keystone of a versatile coaxial system that includes a wide variety of elements and components . . . power dividers, air lines, trombones, tees, elbows, pads, terminations, adaptors, etc. Typical VSWR of a pair of locking-type, rigid-air-line connectors is less than 1.02 to 6 GHz and about 1.06 at 9 GHz. Pulses are passed faithfully by the connector without ringing or deterioration of rise/fall times.

You can build a simple one-transistor amplifier operable to 5 GHz with two tuners (each comprising a GR874 tee and a GR874 adjustable stub), two bias insertion units (Type 874-FBL), and a transistor mount (one of eight types available) arranged as follows:



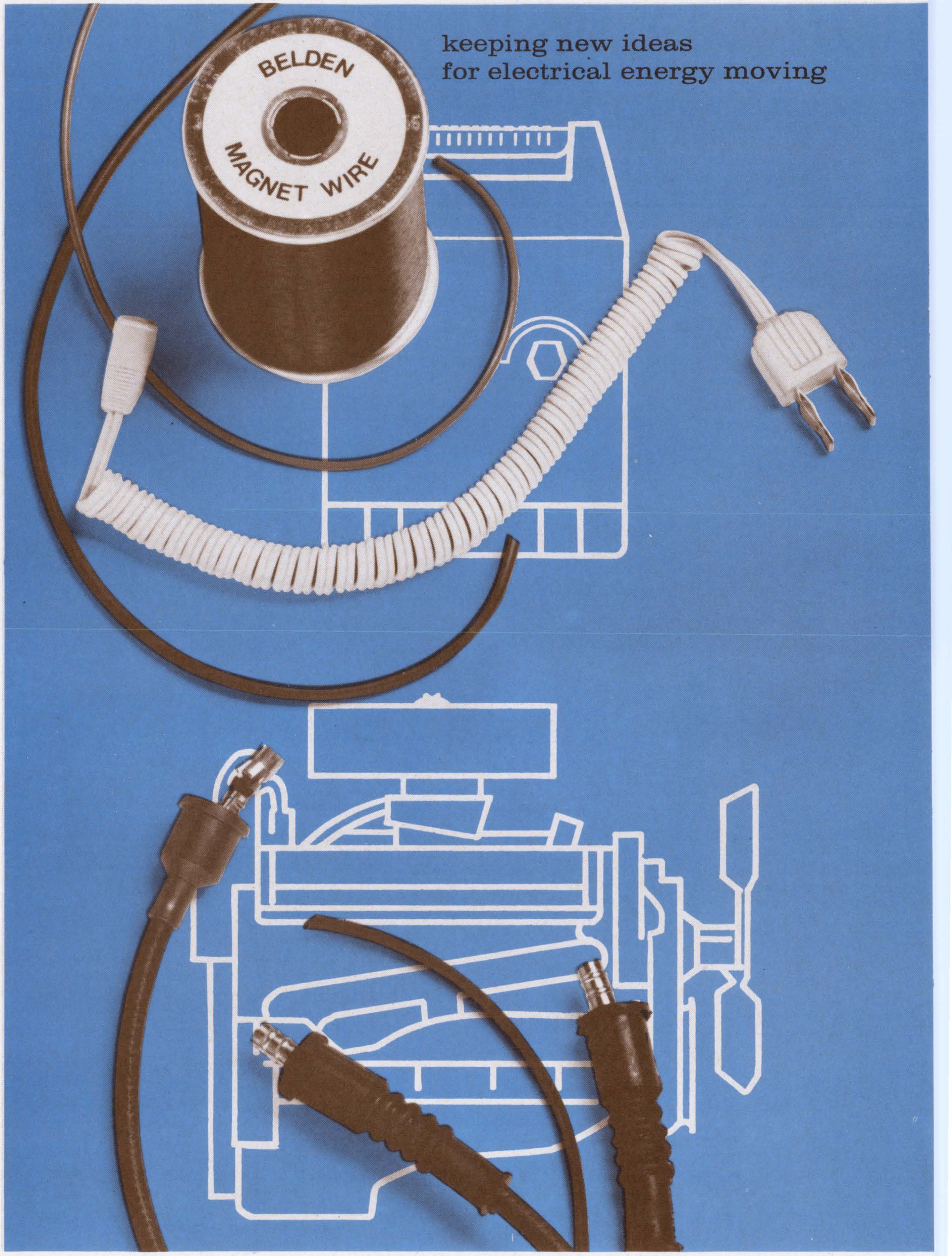
As another example of GR874 versatility, the components shown below can be used to produce bursts of high-rep-rate pulses from the output of a low-frequency, sub-nanosecond-rise-time pulse generator. The delays (up to 1 ns per section) are provided by GR874 air lines.

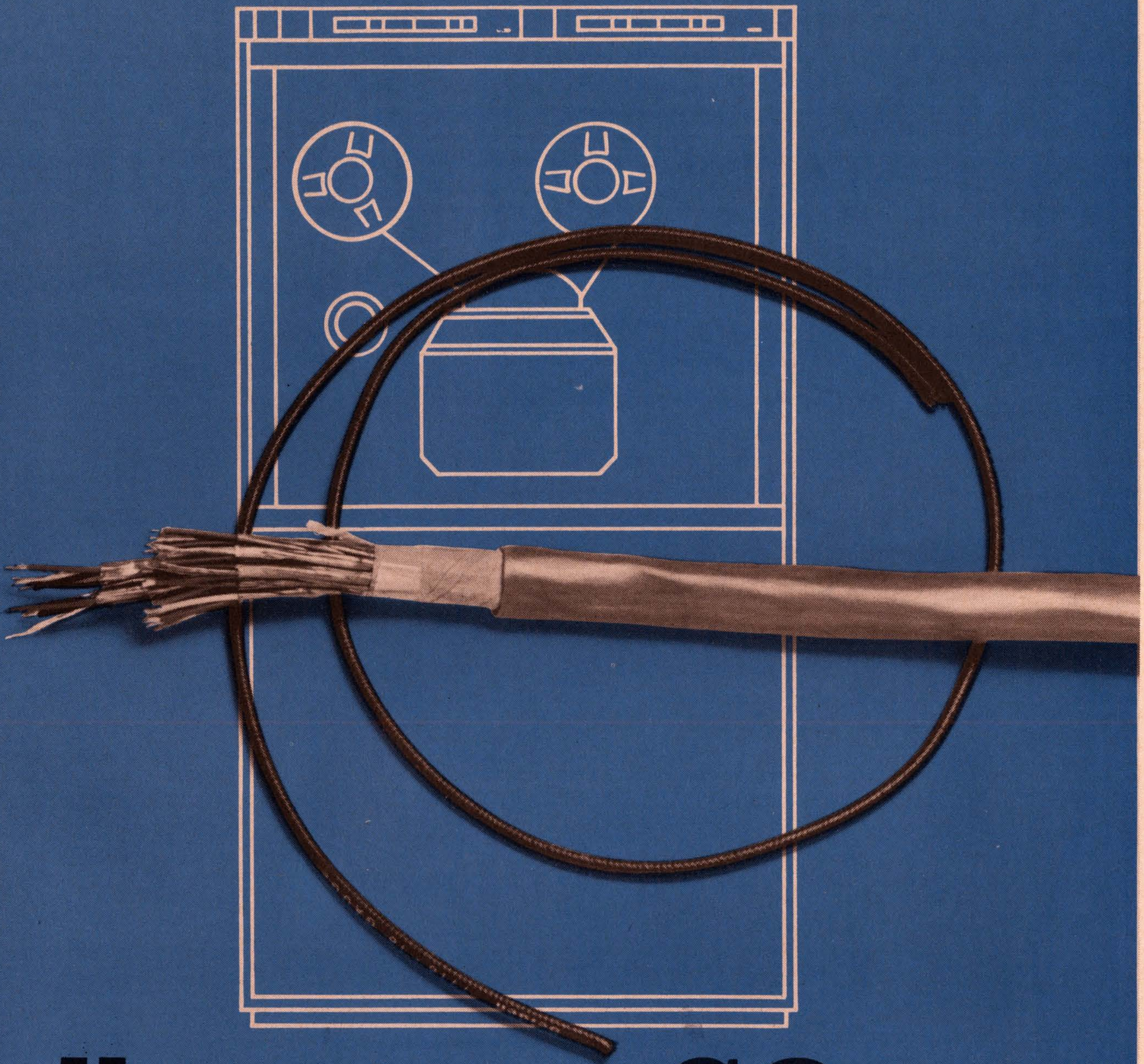




For complete information on the GR874 line, write General Radio, W. Concord, Massachusetts 01781; telephone (617) 369-4400; TWX 710 347-1051.

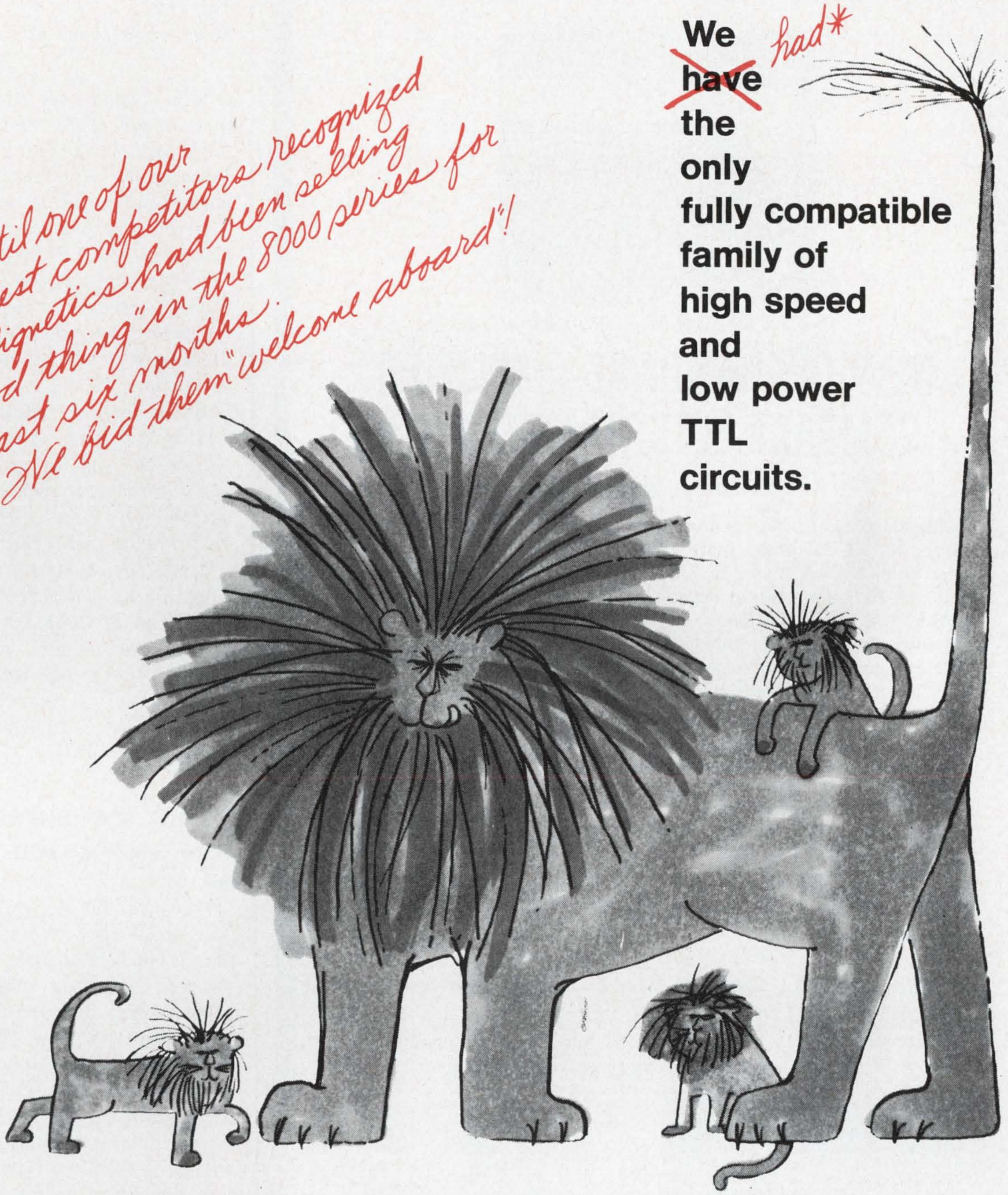
GENERAL RADIO


keeping new ideas
for electrical energy moving
BELDEN
MAGNET WIRE



We ~~have~~ had*
the
only
fully compatible
family of
high speed
and
low power
TTL
circuits.

*...until one of our smartest competitors recognized that Signetics had been selling "a good thing" in the 8000 series for the past six months. We bid them "welcome aboard"!



You can go wild with Signetics new Designer's Choice 8000 Series: it gives you the widest selection of design trade-offs in speed, power, noise immunity and price ever offered in a TTL family. The family consists of a very high speed set (the 8800's) and a fully compatible but slower low power set which offers very high AC noise immunity. Now TTL system designs can be optimized without laborious calculations, unusually expensive and time-consuming special ground-plane designs, or extensive use of outboard discrete components in areas where the highest possible speed is not required. All you do is follow the published S8000-series usage rules. All circuits are compatible over the full MIL temperature range of −55°C to +125°C and are available off-the-shelf in Signetics 14-lead glass-Kovar flat pack. Hunt up your local Signetics distributor. For further information on the Designer's Choice 8000 Series, write Signetics, at 811 E. Arques Avenue, Sunnyvale, California 94086. ■ At the IEEE Show, be sure to check into Rooms 3000A & B at the New York Coliseum, for latest Signetics news.

TYPE	DESCRIPTION
S8416	Dual 4-Input Nand Gate
S8417	Dual 3-Input Nand Gate
S8424	Dual AC Binary Element
S8440	Dual Exclusive-Or Gate
S8455	Dual 4-Input Buffer/Drive
S8480	Quadruple 4-Input Expander
S8806	Dual 4-Input Expander
S8808	8-Input Nand Gate
S8816	Dual 4-Input Nand Gate
S8825	DC Clocked J-K Binary Element
S8826	Dual J-K Binary Element
S8840	Dual 4-Input Exclusive-Or Gate
S8855	Dual 4-Input Power Gate
S8870	Triple 3-Input Nand Gate
S8880	Quadruple 2-Input Nand Gate

SIGNETICS INTEGRATED CIRCUITS
A SUBSIDIARY OF CORNING GLASS WORKS

ON READER-SERVICE CARD CIRCLE 38

LETTERS

(continued from p. 54)

details would be forthcoming as soon as he could contact the technical authorities. Later in the day, however, he informed us that no information would be made available. Following a discussion—sometimes heated on both sides—he said that the internal activities of the FBI including procurement plans extending even to office supplies were privileged matters, not public information.

We therefore followed time-honored journalistic practice and bypassed the official spokesman. The story that was published was the outcome of talks with officials involved with the technical problems.

Mr. Hoover could ensure accurate coverage of the FBI by the simple expedient of cooperation with the information media, making available to the public facts from his office.

S. David Pursglove
Washington, D.C.

Meter measures forward-biased diodes

Sir:

George L. Snider's article, "Measure capacitance and resistance" [in ED 4, Feb. 15, 1967, pp. 92-95], certainly offers one approach to forward-biased diode measurements. The Hewlett Packard 4815A vector impedance meter, however, will eliminate all the tedium of building the suggested bridge circuit. After biasing the diode with a dc supply or battery, the vector impedance is measured simply by placing the probe across the diode. Thus the vector impedance is found at any frequency from 500 kHz to 110 MHz with a meter type of instrument. The 4815A injects a constant signal of 4 μA rms and measures the voltage, which is directly proportional to impedance.

James A. Brockmeier
Sales Engineer
Hewlett Packard Co.
Rockaway, N. J.

The author replies

Sir:

James Brockmeier indicated in his letter that measurements could

(continued on p. 66)

OHMICONE®
SILICONE-CERAMIC
COATED AXIAL LEAD
RESISTORS

two Choices from OHMITE

1

MOLDED

SERIES 88 • MOLDED OHMICONE®

Coating is uniformly thick, dense and smooth. Meets 1000 VAC insulation test. Consistent form and size make these resistors highly suitable for rapid automated assembly techniques and also permit firm mounting in clips for significant heat-sink advantages. Available in commercial, military, precision, and non-inductive types. Can be provided to meet new Char. U of MIL-R-26. Solderable or weldable leads. **(Bulletin 101)**

Wattages (Commercial): 1.5, 2.25, 3.25, 6.5, 9, 11 watts at 25°C.
Resistances: 0.1 to 226K ohms.
Tolerances: To 0.05%; standard commercial, 3%.
Low Temperature Coefficient of Resistance: 0 ± 20 ppm/°C, 10 ohms and above.

2

CONFORMAL

SERIES 44 • CONFORMAL OHMICONE®

Same basic high quality wire-wound resistor as above, but with a conformal coating (1000 VAC rating). While it does not have the uniform shape and dimensions of the molded Series 88, the Series 44 is available with the same close, standard tolerance and low TC. It is supplied in commercial and high precision types. Can also be furnished to meet MIL-R-26 requirements. **(Bulletin 109)**

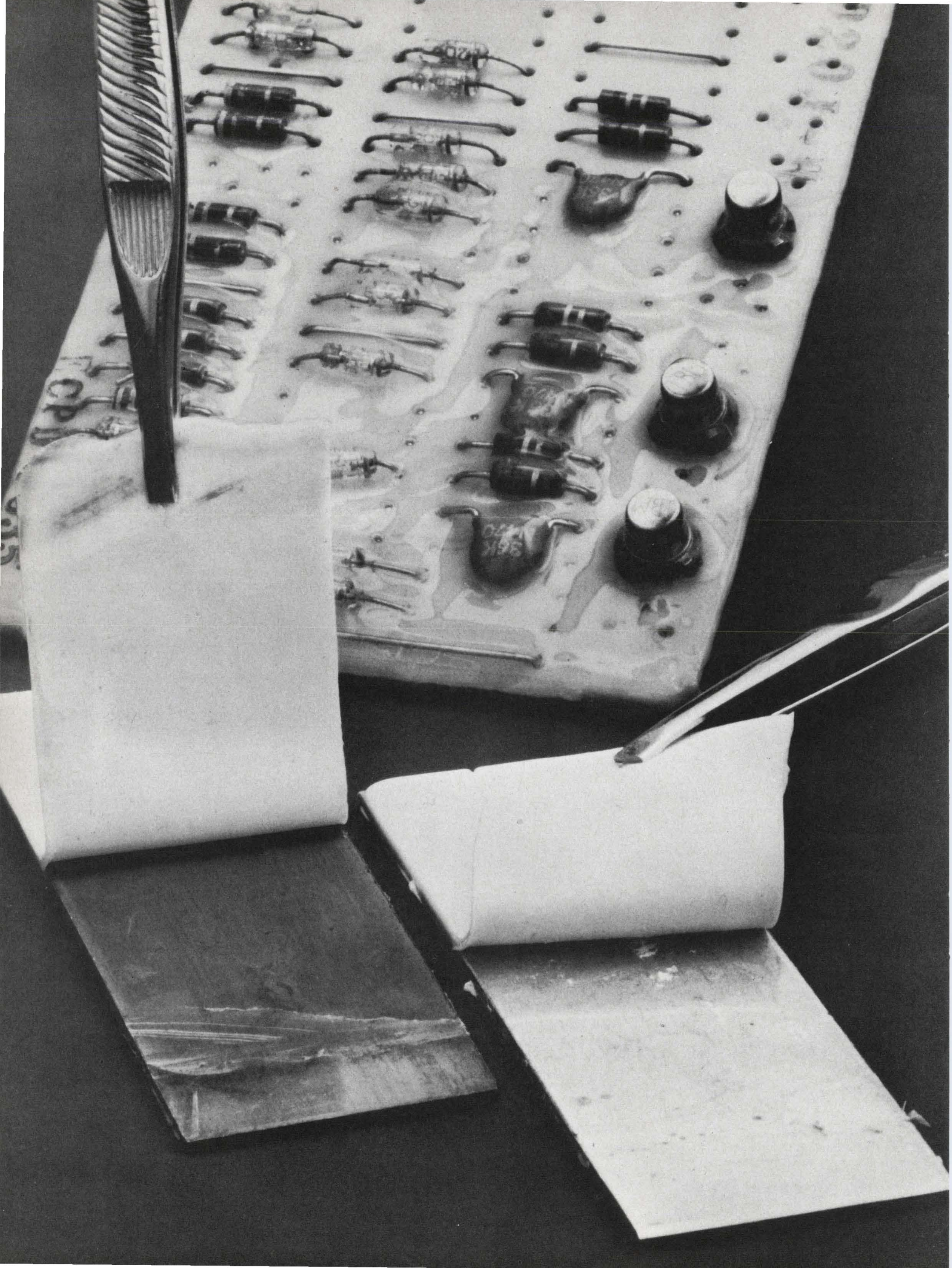
Wattages (Commercial): 1.5, 3.25, 6.5, 11 watts at 25°C.
Resistances: 0.1 to 442K ohms.
Tolerances: To 0.05%; commercial, 3% for values above 1 ohm.
Low Temperature Coefficient of Resistance: Standard is 0 ± 20 ppm/°C for 10 ohms or more.

OHMICONE Silicone-Ceramic—Not just a conventional silicone coating, but rather silicone combined with a ceramic compound. Blending the two materials provides a coating which has the best characteristics of each. Developed and patented by Ohmite, *Ohmicone* envelopes a wire-wound resistor in an unusually tough, resilient jacket that has high moisture resistance and excellent dielectric properties, plus good stability and low temperature coefficients. Choose either the molded or conformal coating in accordance with your requirements.

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS • SEMICONDUCTOR CONTROLS • R.F. CHOKES

OHMITE MANUFACTURING COMPANY
3643 Howard Street • Skokie, Illinois 60076
Phone: (312) ORchard 5-2600

ON READER-SERVICE CARD CIRCLE 40



New, noncorrosive one-part RTV... tough silicone protection

Dow Corning® 3140 RTV coating and 3145 RTV adhesive/sealant are designed to be used in corrosion-sensitive equipment without harm to delicate electronic circuits and components.

Both are products of new silicone technology.

Dow Corning 3140 RTV coating is ideal for conformal protection of printed circuits . . . encapsulation of circuits, components and connectors. It is tough, translucent, self-leveling. Clarity of the coating allows easy visual inspection, identification, and faulty component removal. Repairs in the coating are easily made without loss of dielectric integrity.

Dow Corning 3145 RTV adhesive/sealant has high cured strength . . . is opaque, nonflowing . . . withstands long term exposure to temperature of 250 C — to 300 C for short periods. This *tough* material is excellent for bonding wires and terminals, mounting resistors, sealing electronic enclosures and providing a flexible adhesive for glass, ceramics, plastics and silicone rubber.

Dow Corning leads the way in making materials for the job you have at hand. For complete information on Dow Corning 3140 RTV coating and Dow Corning 3145 RTV adhesive/sealant, write Dept. 3916, Electronic Products Division, Dow Corning Corporation, Midland, Michigan 48640.

DOW CORNING

We're a materials producer exclusively. Let us tailor a material to your need.

ON READER-SERVICE CARD CIRCLE 41


GUARANTEE
of Quality
This GUDEBROD Lacing Tape is Manufactured under strict Quality Control. Complete test data is on file for your protection under
Lot #18861
LOT NO. 18861
GUDEBROD LACING TAPE
ROUTINE QUALITY CONTROL
MFG.
LAB.
QUANTITY

LETTERS

(continued from p. 60)

easily be made with the Hewlett Packard 4815A meter. The measurement procedure apparently involved only biasing the diode with a dc supply or battery, and measuring the impedance by placing the instrument probe across the diode. In making the measurement by this method, there are several questions that occur:

- What is the effect of stray capacitance and inductance due to the wiring necessary to connect the diode to the voltage source?
- If there is no isolation between the dc supply and the diode, will not the impedance reading include the effects of power supply impedance?
- What is the effect of probe residual impedance on measuring low-capacitance diodes (<2 pF)?

I have attempted measuring forward-biased diode parameters with the Model 8405A vector voltmeter in the manner suggested in an article by Fritz K. Weinert of Hewlett Packard. The arrangement used was that suggested for measurement of a complex impedance. I found, however, that the meter was extremely sensitive to stray capacitance and inductance, and above 15 MHz it was impossible to obtain repeatable results. I concluded that it was impossible to get repeatable measurements without the need to resort to carefully fabricated "plumbing" fixtures.

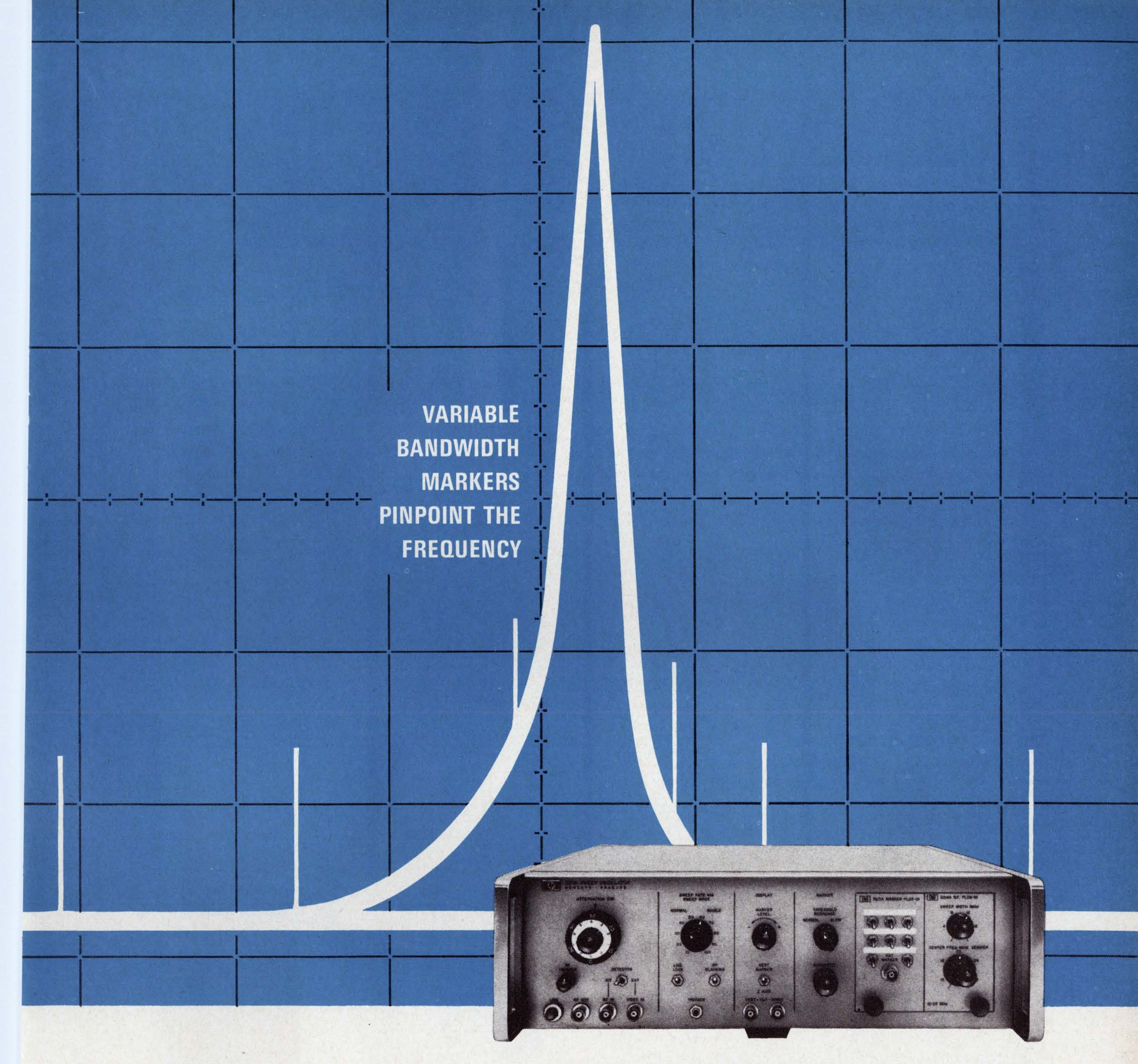
The method that I suggested in my article in ELECTRONIC DESIGN does have certain advantages:

- The circuitry is inexpensive to build—$150 for parts and labor. This is far less than the cost of the RF vector impedance meter—$2650.
- The accessory equipment required is available in any electronics laboratory.
- The readout is direct. No computation is required to obtain the resistance and capacitance values.

The method has also been used to measure transistor junction impedance under forward-bias conditions and the source-drain impedance of field-effect transistors as a function of gate voltage.

Moreover I have been able to extend the range of the method to resistance values of 200 kΩ and ca-

(continued on p. 72)



Sweep Oscillator gives top performance in the 100 kHz to 110 MHz range

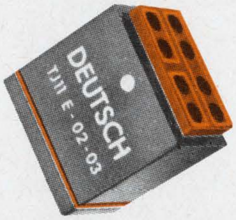
All solid-state Hewlett-Packard 3211A Sweep Oscillators with RF and marker plug-ins meet virtually all of your swept frequency testing requirements. Variable bandwidth markers permit accurate, well defined marking under a variety of test conditions.

The main frame of the 3211A contains everything you could hope to find in a sweeper. RF plug-ins operate at fundamental frequencies with good linearity and spurious mixing products are eliminated. Plug-in markers offer not only variable bandwidth, but also Z-axis or pulse-type marking. An accurate 59-db attenuator makes the unit a valuable tool for testing both high- and low-gain circuits.

The 3211A is ideal for general testing in the video to VHF range where flat, linear output and an accurate marking system is required. Typical applications are: alignment, calibration and design of FM tuners and receivers and testing filters, amplifiers, transformers, resonant circuits and IF sections of TV receivers, radar and communications systems. For complete specifications, contact your local Hewlett-Packard field engineer or write Hewlett-Packard, Green Pond Road, Rockaway, N.J. 07866.

HEWLETT hp PACKARD
measuring instruments
for science and industry

NEW DEUTSCH SYSTEM OBSOLETES



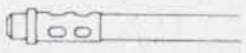
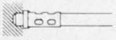
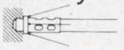
THE TERMINAL JUNCTION

A new system for point to point wire connection and integration

This newest, most flexible system releases today's engineer from the limitations usually associated with interconnection. One wire or thousands of wires may be connected by this simple, reliable method that:

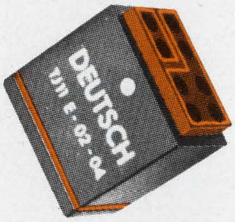
- Replaces terminal strips and binding posts
- Does away with contact damage
- Eliminates splices and solder
- Uses standard crimp tools
- Uses **one** fail-safe, expendable assembly tool
- Uses **one** fool-proof assembly procedure
- Is self-locking
- Is modular
- Saves weight and space
- Connects and disconnects instantly
- Protects connections without potting
- Meets or exceeds MIL-C-26482 where applicable, and exceeds most user specifications

The Terminal Junction system is the ultimate in simplicity.

- The wire termination is ruggedized so that it can't bend, break, bind or gall .
- Crimping the terminal to any wire is done with standard tools, and provides strong, reliable termination . When inserted in the modular block, the terminations are interconnected instantly in a variety of hook-up patterns .
- The low-resistance connections are secured by self-locking retainers that defy vibration, shock and high pulling loads .

System build-up, breadboarding and all processes where one must patch, bus, splice or feedthru can be vastly simplified with this flexible, "people oriented" system. Its simplicity, combined with total reliability, makes possible immediate conversion without special training of assembly personnel . . . and, with the move to Terminal Junctions come the benefits of efficiency and upgraded connections.

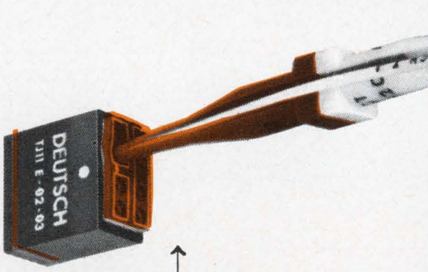
The following columns describe how you can save time, space and circuits. Read on . . . let your own ingenuity dictate how you can benefit by using this revolutionary system.



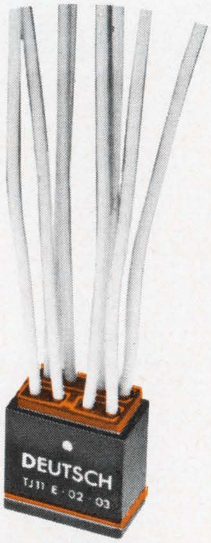
TIME SAVER

The Terminal Junction system eliminates wasted time and motion in all phases of equipment design, breadboard, prototype, assembly, checkout and maintenance.

Quick, reliable crimp termination of wires with standard tools.



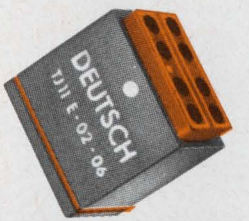
Instant connection (or disconnection) requires one, fail-safe, expendable tool which is small enough to be stored with wire harnesses.



One Terminal Junction module, with eight wires that have been connected in a fraction of the time required by other methods.

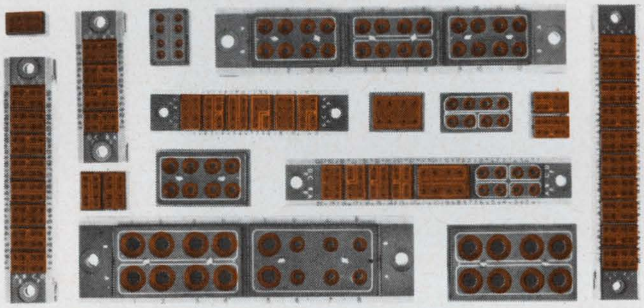
*Terminal Junction modules shown are model TJ11E-02** which connect wire sizes AWG 20 through AWG 24.

EXISTING CONNECTION METHODS

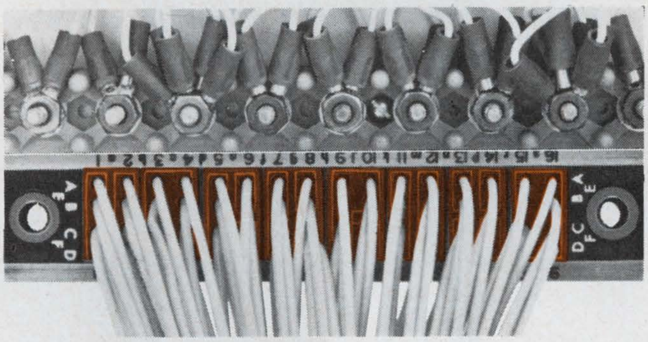


SPACE SAVER

Terminal Junctions occupy a fraction of the space formerly needed for an equal connection capacity. And, there is no limit to the number of modules and multi-module assemblies that may be used to form high density interconnection panels and systems.



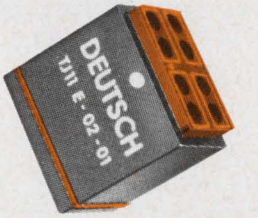
Typical module and multi-module assemblies for space-saving connection and integration. Standard units shown will handle wire sizes AWG 24 through AWG 4. White lines on each module outline points of common connection.



Sixty four size AWG 20 wires perfectly connected and fully protected in a fraction of the space previously needed. Compare the amount of space saved in this case... the terminal strip handles only 28 wires, and affords them no protection.

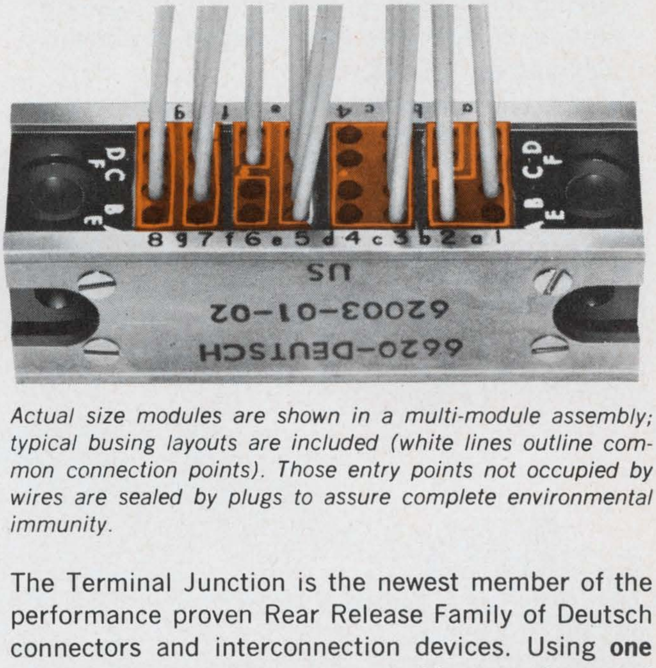
Use Feedthru Terminal Junctions for all through-connection applications; use them as high density, lightweight, fully environmental connectors; or, use multi-module assemblies for patchboard and through-panel applications.

The **JIFFY JUNCTION**® *is a fully environmental single conductor connector. Use it as a replacement for splices or any one-wire connection problem.*



CIRCUIT SAVER

Circuit and equipment failures due to the breakdown of exposed or poorly protected junctions and splices are eliminated by Terminal Junctions. All connections in each module are protected from mechanical damage by solid dielectric material; shorting caused by moisture and contaminants is prevented by resilient silicone rubber sealing glands at each wire entry point; the positive locking retention system resists shock, vibration and high pulling loads to assure perfect continuity in each circuit. Dielectric separation between circuits exceeds military specifications, and because the tool used for connection and disconnection is of dielectric material the shorting possibility normally associated with checkout and maintenance is reduced to a minimum.



Actual size modules are shown in a multi-module assembly; typical busing layouts are included (white lines outline common connection points). Those entry points not occupied by wires are sealed by plugs to assure complete environmental immunity.

The Terminal Junction is the newest member of the performance proven Rear Release Family of Deutsch connectors and interconnection devices. Using **one** type of crimp tooling, **one** assembly procedure, and **one** fail-safe insertion/removal tool, any interconnection system may be upgraded to modern levels of efficiency and reliability. For more information about Terminal Junctions contact your local Deutschman, or write today; ask for Data File TJ-3.

DEUTSCH

ELECTRONIC COMPONENTS DIVISION • Municipal Airport • Banning, California

ON READER-SERVICE CARD CIRCLE 46

Varian powers world's largest private microwave system.

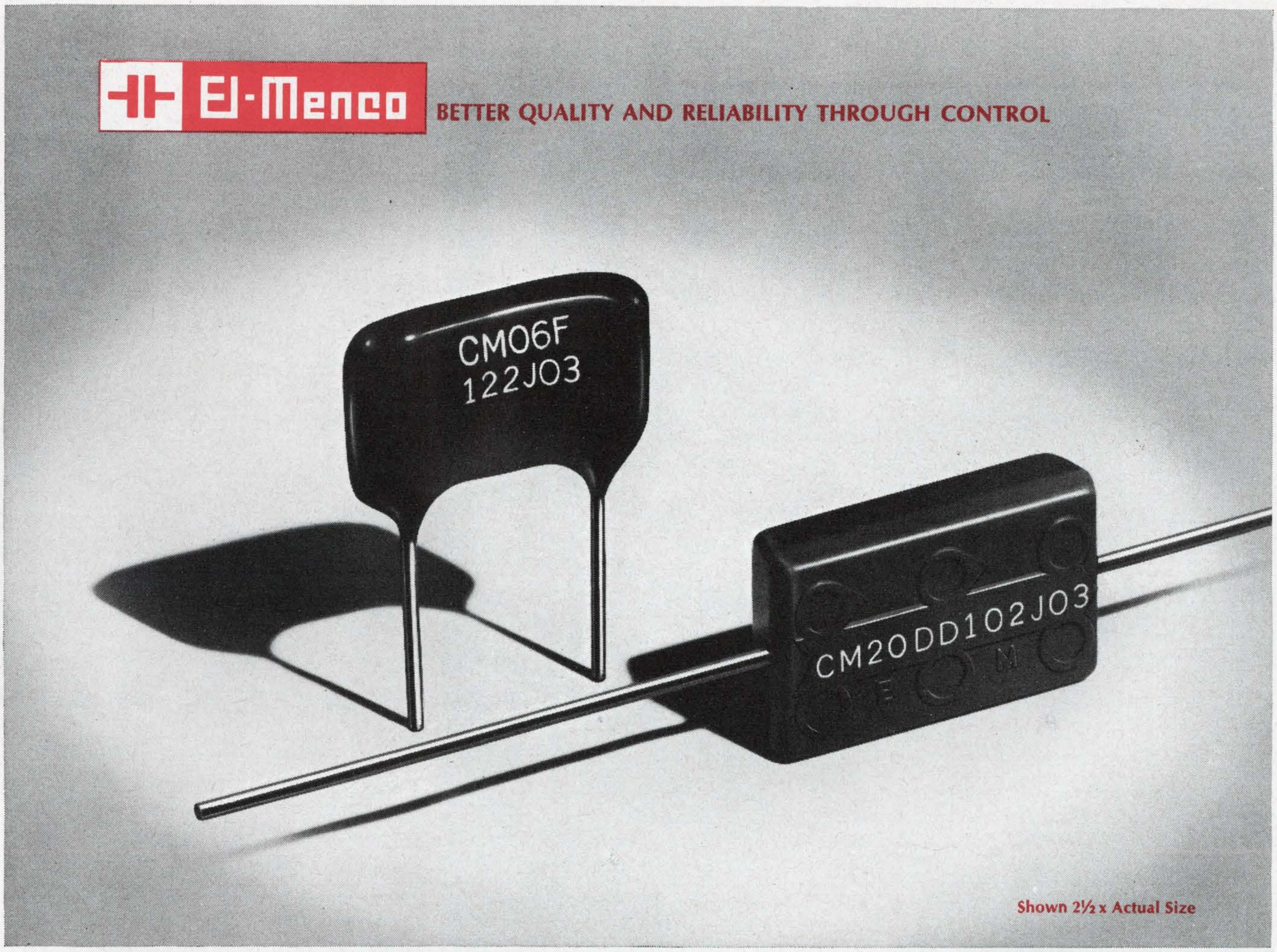
The largest privately owned microwave system was built, installed, and is maintained by the General Electric Company for use by the Southern Railway System. One of the major features of this system is its total capability for handling all kinds of communication: graphic, voice-(including telephone) tone signals, block signals, control VHF radio, and signals from "hot box" detection equipment. This modern communication system links the Southern Railway network with 3744 path miles, 1,000,000 total channel miles, 4256 channel ends, and 221 microwave stations.

Over 1,600 Varian Klystrons and almost 500 Traveling Wave Tubes are used in this unique system—with outstanding records for long life, linearity, and stability. Over a recent 24-month period the VA-244 and VA-259 klystron oscillators used in this system accumulated 1000 years of experience with less than 1 day of downtime, including all failures.

For your copy of the complete story of this remarkable system and more information about the long life microwave tubes described above, write: Palo Alto Tube Division, 611 Hansen Way, Palo Alto, California. Or write Varian of Canada, Ltd., Georgetown, Ontario. In Europe: Varian A.G., Zug, Switzerland.

varian

ON READER-SERVICE CARD CIRCLE 47



Shown 2½ x Actual Size

Capacitor Problems That Require A Lot Of Self-Control...Chemically Speaking

Problem 1: How to make sure the silver paste composition used for electrodes provides the best results for each electrical parameter in a given capacitor design?

Problem 2: How to improve the recognized moisture reliability of our dipped mica capacitors without adversely affecting life reliability?

Problem 3: How to upgrade the reliability of molded mica capacitors to equal that of dipped mica capacitors so designers can take advantage of body uniformity and axial lead design?

Solution: Chemical self-control! To do this we operate our own chemical manufacturing plant where we formulate silver pastes, phenolic dipping compounds, and epoxy molding compounds — all under strict controls.

Result: Dipped mica capacitors and molded mica capacitors of equally high reliability that operate up to 150°C. Send for technical literature and always insist on El-Menco brand capacitors . . . your assurance of better quality and reliability through control.

THE ELECTRO MOTIVE MFG. CO., INC.

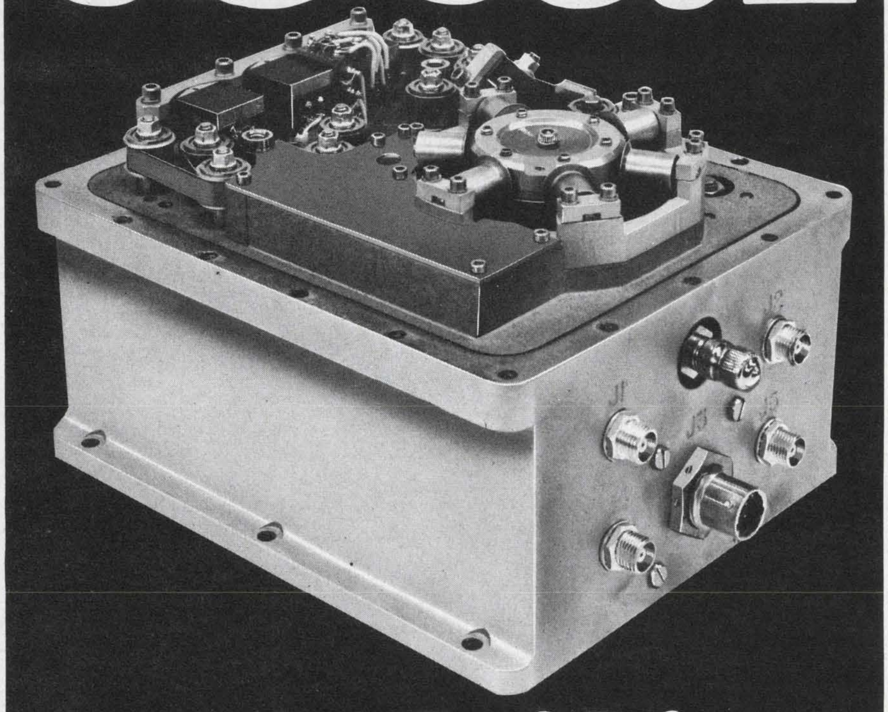
WILLIMANTIC, CONNECTICUT 06226

Dipped Mica • Molded Mica • Silvered Mica Films • Mica Trimmers & Padders
Mylar-Paper Dipped • Paper Dipped • Mylar Dipped • Tubular Paper

Exclusive Supplier to Jobbers and Distributors in the U. S. and Canada:
ARCO ELECTRONICS, INC., Community Drive.
Great Neck, L. I., New York

West Coast Manufacturers contact:
COLLINS & HYDE CO., 900 N. San Antonio Rd.,
Los Altos, California 94022
1250 E. Artesia Avenue, Long Beach, California

ON READER-SERVICE CARD CIRCLE 48



(continued from p. 66)

pacitance values as low as 1 pF through modification of the circuit and test procedure.

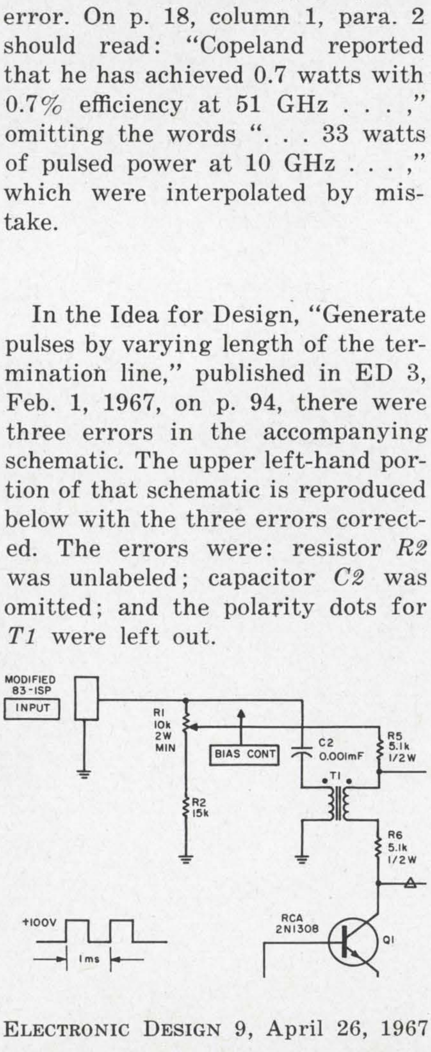
Since I have an RF vector voltmeter at hand, any advice on its possible use in this area of measurement would be appreciated. Of particular value would be suggestions about methods of fabricating test fixtures and about means to eliminate or compensate for stray capacitance and inductance.

George L. Snider
Senior Engineer
Arinc Research Corp.
Santa Ana, Calif.

Accuracy is our policy

In "New technology keys Solid-State Circuits show," ED 5, March 1, 1967, pp. 17-20, John Copeland of Bell Telephone Laboratories, Inc., calls attention to a typographical error. On p. 18, column 1, para. 2 should read: "Copeland reported that he has achieved 0.7 watts with 0.7% efficiency at 51 GHz . . . ," omitting the words ". . . 33 watts of pulsed power at 10 GHz . . . ," which were interpolated by mistake.

In the Idea for Design, "Generate pulses by varying length of the termination line," published in ED 3, Feb. 1, 1967, on p. 94, there were three errors in the accompanying schematic. The upper left-hand portion of that schematic is reproduced below with the three errors corrected. The errors were: resistor *R2* was unlabeled; capacitor *C2* was omitted; and the polarity dots for *T1* were left out.

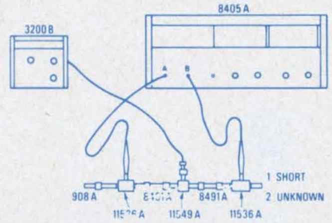


NUMBER 3 IN A SERIES

Measurement of Complex Impedance

with the HP 8405A Vector Voltmeter

The measurement of complex impedance in the 1 to 1000 MHz range using slotted line or bridges has always been a time-consuming and cumbersome process, particularly when determining phase angle. Now, with the HP 8405A Vector Voltmeter, faster and simpler techniques are possible.



Below 100 MHz, the method illustrated above is especially convenient. Signal power is equally split, and the voltage drop across the unknown impedance is compared against the drop across the known. Results are easily entered on the Smith Chart for rapid determination of impedance.

From 100 MHz to 1 GHz, impedance is measured in the form of Reflection Coefficient, using a new, extremely wideband dual directional coupler as in the set-up shown below. The 8405A Vector Voltmeter measures incident and reflected voltage and their phase angle, allowing quick entry into the Smith Chart.

Free Application Data

Application Note 77-3 discusses "Measurement of Complex Impedance". For your copy write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, Calif. 94304; Europe: 54 Route des Acacias, Geneva.

You can appreciate the wide-range of the 8405A from these brief specifications; match them to your measurement requirements. And call your HP field engineer for complete information on this wideband, 2-channel RF millivoltmeter-phasemeter.

Major Specifications, HP 8405A Vector Voltmeter

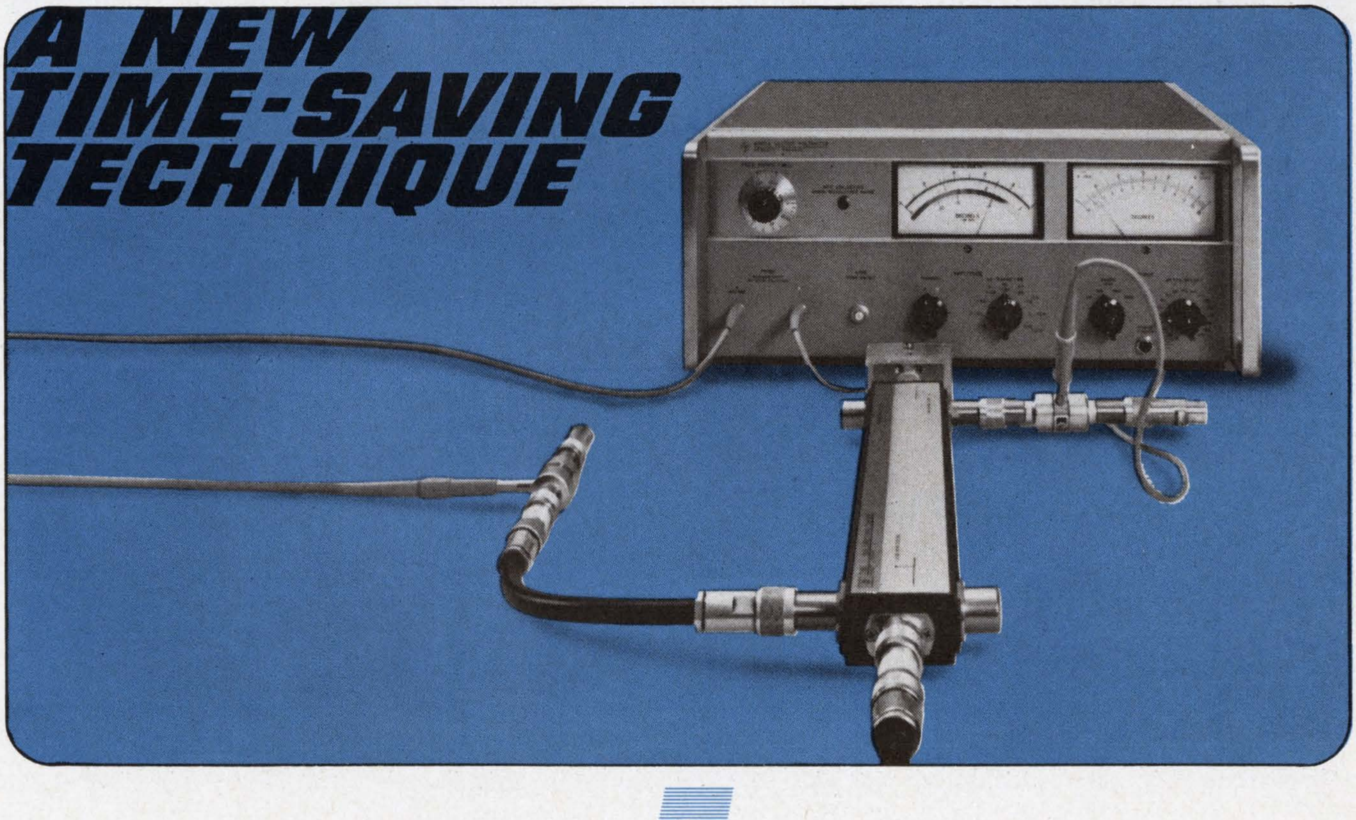
Frequency Range is 1 to 1000 MHz in 21 overlapping octave bands; automatic tuning within each band.

Voltage Range for Channel A (synchronizing channel), 300 μV to 1 V rms (5-500 MHz), 500 μV to 1 V rms (500-1000 MHz), 1.5 mV to 1 V rms (1-5 MHz).

Voltage Range for Channel B (input to Channel A required), 100 μV to 1 V rms, full scale. Full-scale meter ranges from 100 μV to 1 V in 10 dB steps. Both channels can be extended to 10 V rms with 11576A 10:1 Divider.

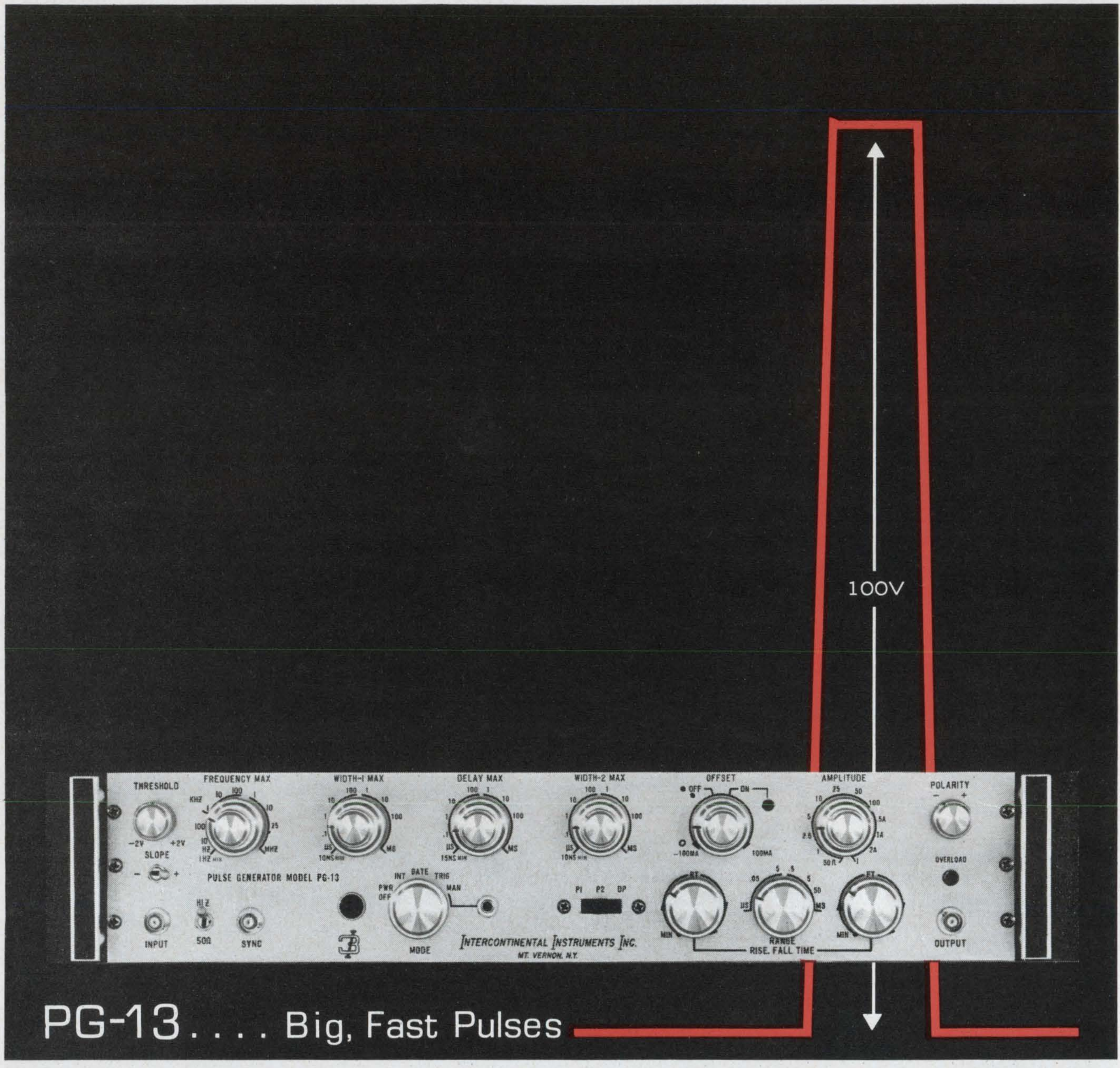
Phase Range of 360° indicated on zero-center meter with end-scale ranges of ±180°, ±60°, ±18°, ±6°. Phase meter OFFSET of ±180° in 10° steps permits use of ±6° range for 0.1° phase resolution at any phase angle.

Price: $2750.



HEWLETT hp PACKARD

ON READER-SERVICE CARD CIRCLE 50



PG-13 . . . . Big, Fast Pulses

With our new PG-13 you can get ±100V or, as a current source, ±2A pulses. And 10 ns rise and fall times; repetition rate 1 Hz to 25 MHz; duty cycle 50% at 1A out with a pulse width to 5 ms. No hedging. The specs are real specs: when we say ±100 volts we mean ±100 volts; 10 ns rise time means 10 ns rise time, worst case, at 100 volts. So if you need a truly fast high-output pulser for, say, magnetic core testing, radar pulse simulation or similar applications you would do very well to consider the PG-13.

This is why, in brief part:

The PG-13 is all solid-state (rack height 3½"). Operates in either voltage or current modes; in the voltage mode the range is ±100 mV to ±100V from a 50 ohm source; in the current mode it is ±50 mA to ±2A from a 1K, min, source. PRF, 1 Hz to 25 MHz. Single or double pulses plus sync. Instantaneous overload protection and a front panel warning light. Can be gated or triggered up to the max rep rate. Manual one-shot. DC-offsets either direction to 100 mA. Independently variable rise and fall times, 10 ns to 50 ms. PRF, rise, fall, amplitude, width (of either pulse independently), offset and delay are all variable continuously.

The PG-13 is one of the 3-I/Chronetics new generation pulse generators.

We'll be glad to whisk a PG-13 to your lab for a demonstration. And there's a new catalog on the new generation pulse generators. Please write or 'phone for either or both.

Intercontinental Instruments Inc, an affiliate of CHRONETICS

CHRONETICS

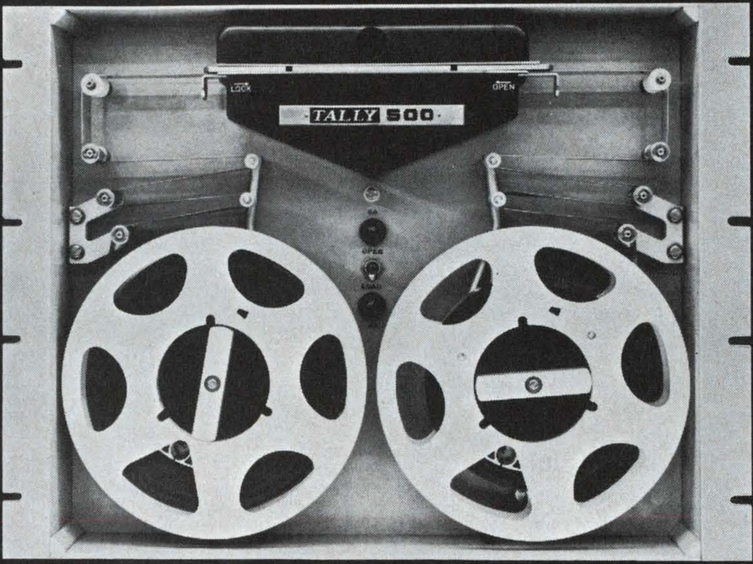
U.S.A.: 500 Nuber Avenue, Mt. Vernon, New York (914) 699-4400 TWX 710 560 0014
Europe: 39 Rue Rothschild, Geneva, Switzerland (022) 31 81 80 TELEX 22266

ON READER-SERVICE CARD CIRCLE 51

ON READER-SERVICE CARD CIRCLE 52 ➤

New Tally 500 series photoelectric tape readers work up to 1000 characters per second.

That's not unique.



But working without pinch rollers, friction brakes, clutches, or solenoids – that is!

There's no point in Number 1 introducing just another "me too" product. Just to give you an idea of how good the new line is, in a recent life test, one photoelectric reader ran for 15,000 hours at maximum speed without a failure. You can see why we say these new readers represent genuine "state of the art" achievement. Adding them to the Tally line rounds out the broadest line of perforated tape equipment on the market today.

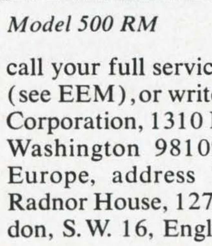
The 500R, 500RF, and 500T.

These three readers operate at up to 200 characters per second asynchronously (stop on character), up to 500 char/sec in the synchronous or free running mode (stop before next character), and 1000 char/sec in the wind/search mode. All feature printed motor direct capstan drive, and bi-directional reading and winding. The Model 500R (recess mounted) and the Model 500RF (flush mounted) are reader and spooler combinations, while the Model 500T comes without the reel servo system. For tape handling only, two spoolers using printed circuit motors and proportional reel servo are offered, one with 8 inch reels, the other with 10½ inch reels.

MIL-SPEC reader, Model 500RM and "ruggedized" reader, Model 500RF/10

Fully militarized, the Model 500RM is the first high speed reader that meets all applicable military specifications without exception. Featuring the same basic design as other Series 500 photoelectric readers, this unit will work in environments of −40°F to +145°F, in humidities of 100%, and take more than 15 g's shock. Pertinent RFI specs are met. MTBF is 5,000 hours. Expected life is 10,000 hours minimum.

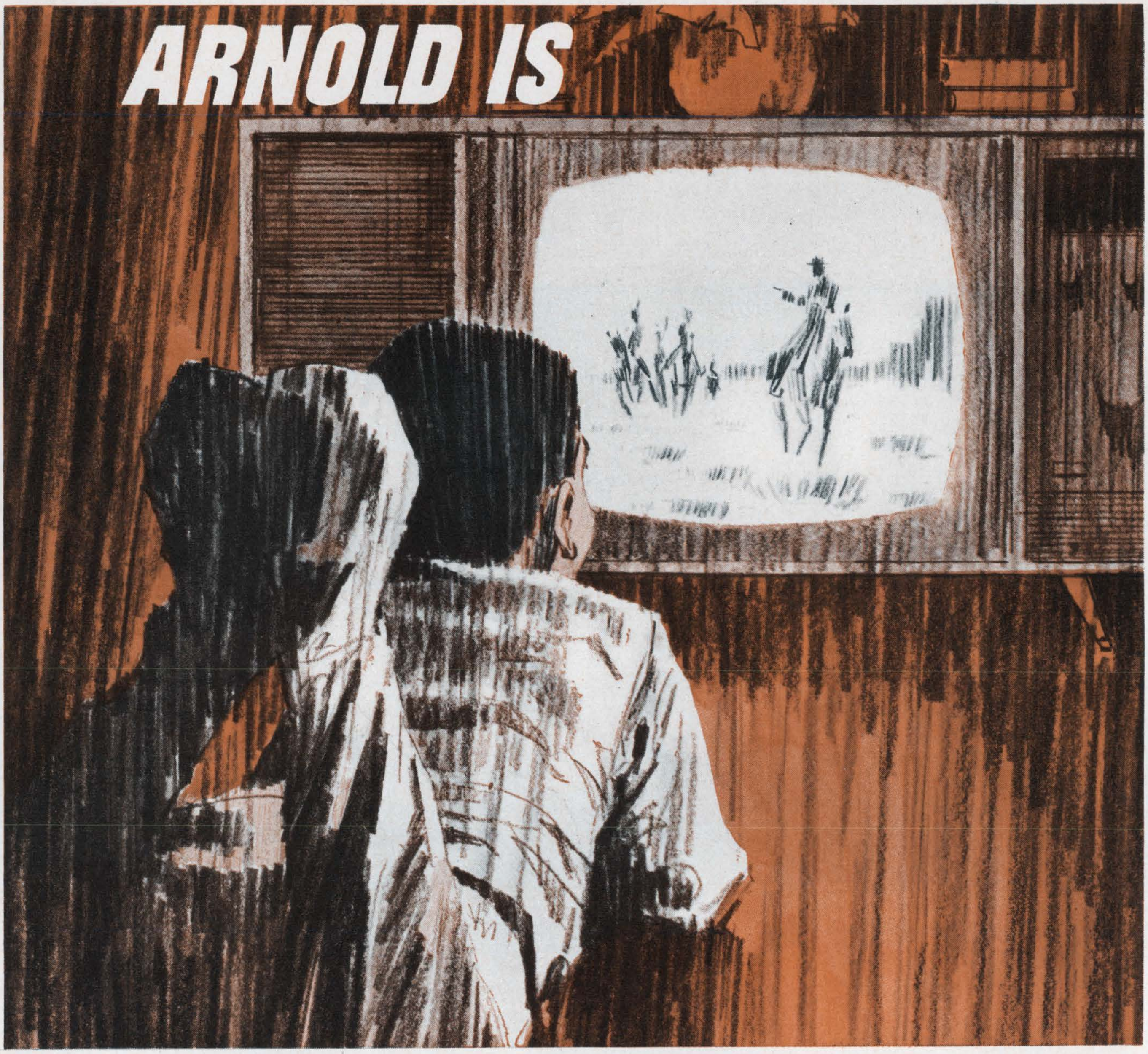
Where severe environmental conditions are not encountered, the Model 500 RF/10 will perform with the same accuracy and life for about half the cost. Reading speeds for both readers are 150 char/sec asynchronously, 500 char/sec synchronously, and 1000 char/sec wind/search.



Model 500 RM

Full disclosure. For all the facts, call your full service Tally sales engineer (see EEM), or write Ken Crawford, Tally Corporation, 1310 Mercer Street, Seattle, Washington 98109. In the U.K. and Europe, address Tally Europe, Ltd., Radnor House, 1272 London Road, London, S.W. 16, England.

TALLY®


ARNOLD IS

Co-Publishers
James S. Mulholland, Jr.
Robert E. Ahrensdorf

Editorial Director
Edward E. Grazda

Editor
Howard Bierman

Managing Editor
Robert C. Haavind

Technical Editors
Peter N. Budzilovich
Maria Dekany
Frank Egan
Roger K. Field

News Editors
Ralph Dobriner, Chief
Richard N. Einhorn

East Coast Editor
Neil Sclater

West Coast Editor
Ron Gechman

Copy Editor
Peter Beales

New Products Editors
David H. Surgan
Daniel R. Butterly

Washington Editor
S. David Pursglove

Editorial Production
Dollie S. Viebig
Karen L. Sherman

Art Director
Clifford M. Gardiner

Art Assistant
William Kelly

Technical Illustrators
Cheh Nam Low
William Alvarez
Sheila F. Ward

Production Manager
Thomas V. Sedita

Asst. Production Manager
Helen De Polo

Production Assistants
Bernard Wolinsky
Robert B. Lichtig

Circulation Manager
Nancy L. Merritt

Reader Service
Diane Mandell

EDITORIAL

They just keep rolling along . . .

Eight years ago, after careful investigation of the diode market, we became alarmed at the rising numbers of devices being produced and the difficulty facing the design engineer who has to choose the right diode for his application. And so, in the June 10, 1959, issue of ELECTRONIC DESIGN we published an editorial. In it we warned that diode types had increased from 2500 to 4000 in one year; we urged the industry to take steps toward meaningful standardization of diodes.

Today there are more than 30,000 diode types on the market!

Of the many lessons that may be drawn from this development, these seem at least fairly reasonable: nobody cares what is said in an editorial; industry doesn't care about the problems of design engineers; engineers don't care that industry doesn't care—they welcome punishment on the job.

We keep wondering how much time the design engineer spends to keep track of all these devices, their latest specs, exact test-method descriptions, sources of supply and other pertinent facts. We doubt that any designer patiently searches for just the right device; we suspect he settles for the types he's used before.

A comparable situation is shaping up for transistors. ELECTRONIC DESIGN has just completed its fifteenth annual Semiconductor Directory. It's fatter than last year's. Close to 3200 JEDEC-registered transistor types are listed, compared with 2600 in 1966. There are now almost 1900 IC types, against 1100 a year ago.

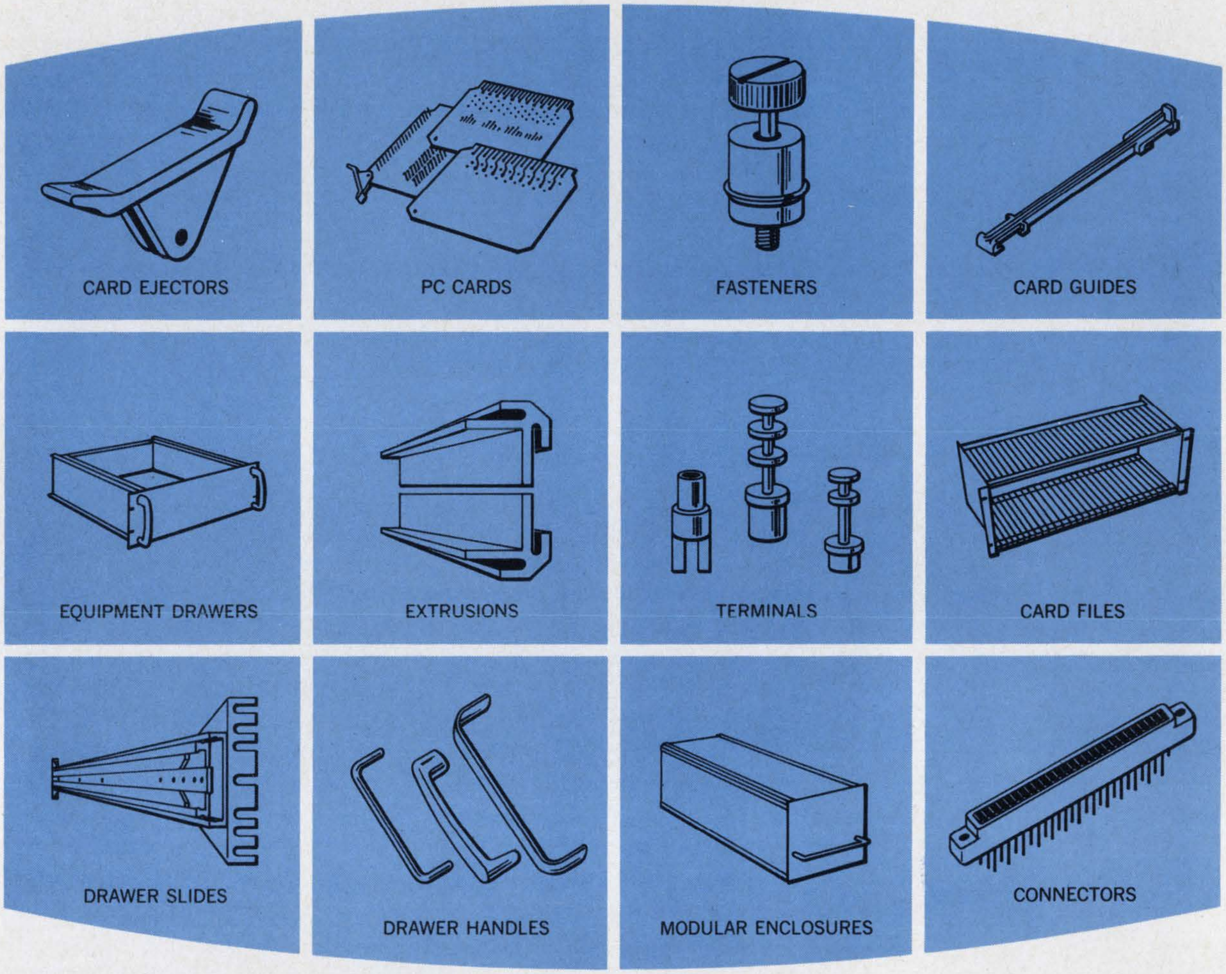
We have never criticized the introduction of new types that offer improvements in equipment performance; they're needed and welcome. But we continue to oppose "new" devices that offer slight parameter improvements at the cost of almost hopeless confusion for the designer who attempts to evaluate the selection.

Roger Field and Peter Budzilovich, the editors responsible for ELECTRONIC DESIGN's applications-oriented Semiconductor Directory, join us in urging semiconductor manufacturers to increase their efforts to standardize device packages, test methods and specification data formats. Let's work to bring ICs under control before the list gets out of hand.

In the meantime, if you're a designer, you'd better check the Semiconductor Directory, which starts on page 81. It's the best aspirin around to ease your headache.

HOWARD BIERMAN

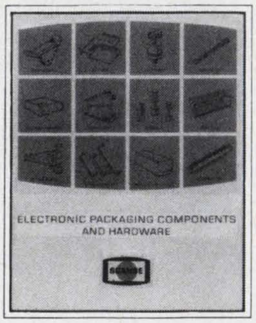
Who makes a complete line of electronic packaging hardware?...Scanbe does!



Exclusive from Scanbe

■ SINGLE SOURCE SERVICE ■ COMPLETE AND WIDEST SELECTION OF HARDWARE ■ OFF-THE-SHELF AVAILABILITY ■ EXPERIENCED DESIGN ASSISTANCE ■ PRECISION MANUFACTURING ■ RIGID QUALITY CONTROL

Save money and time without sacrificing performance—contact Scanbe, *the* specialist in electronic packaging hardware. *Write for Scanbe's new electronic packaging hardware guide.*

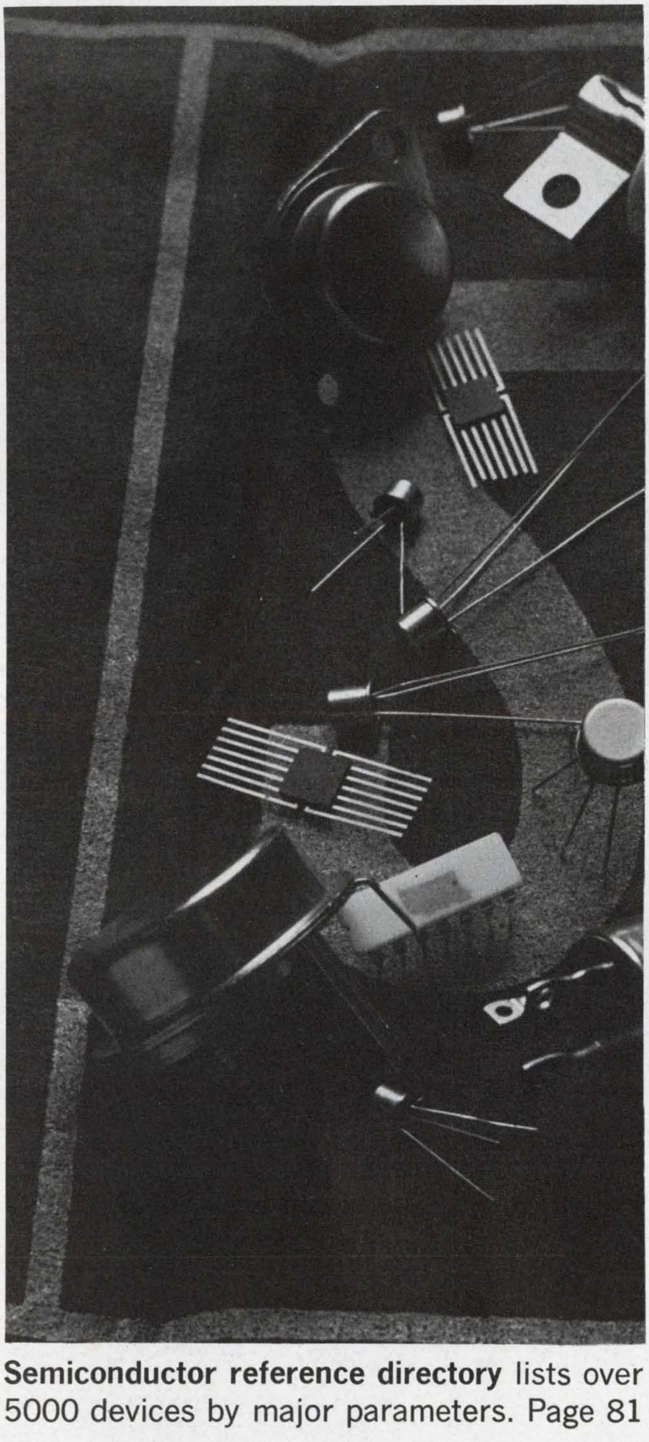

ELECTRONIC PACKAGING COMPONENTS
AND HARDWARE

SCANBE

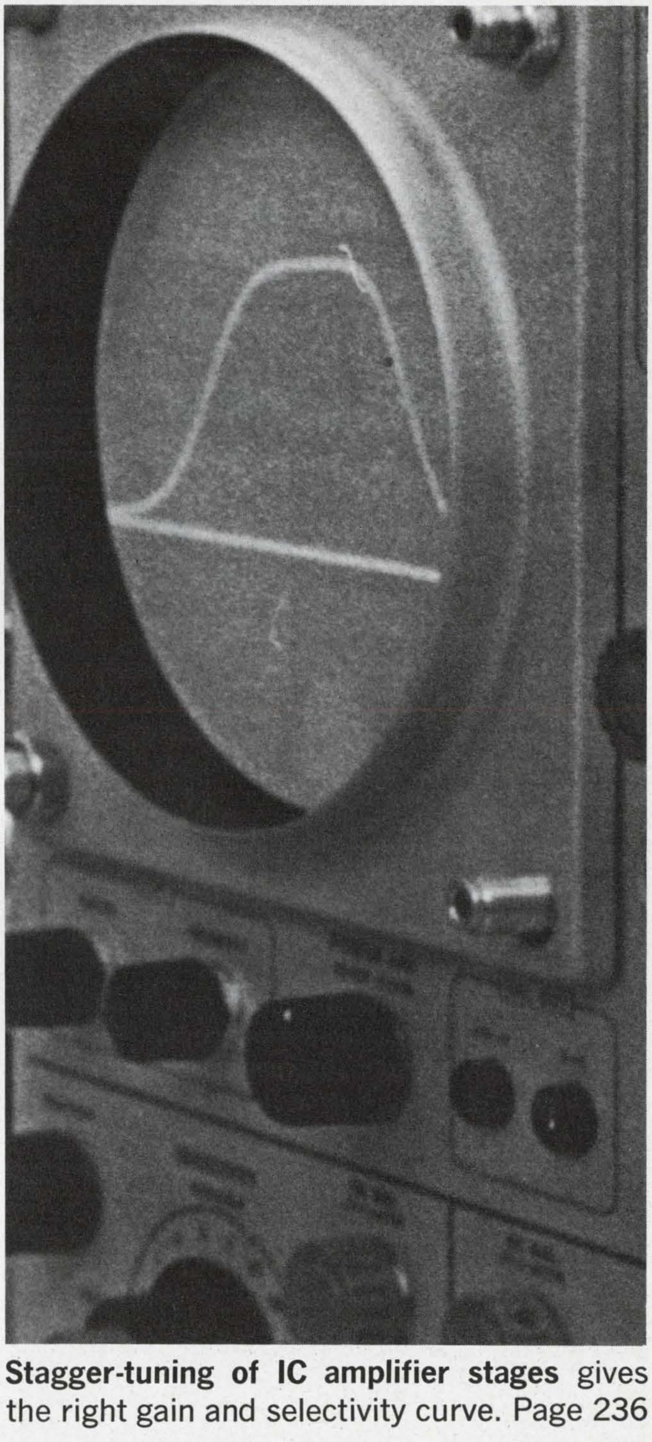
SCANBE MANUFACTURING CORP.
1161 Monterey Pass Road • Monterey Park, California 91754 • Tel. (213) 264-2300 TWX (213) 266-8853

ON READER-SERVICE CARD CIRCLE 54

Technology



Semiconductor reference directory lists over 5000 devices by major parameters. Page 81



Stagger-tuning of IC amplifier stages gives the right gain and selectivity curve. Page 236

Also in this Section:

While other major semiconductor manufacturers are eagerly trying...

One company has already mastered the practical production of Large Scale Integration...

Only General Instrument's exclusive MTOS (Metal-Thick-Oxide-Silicon) process provides Large Scale Integration without the need for high-cost discretionary wiring.

Before MTOS, there existed no practical Large Scale Integration of any real significance. LSI, much discussed, widely experimented with, and heralded throughout the industry as the microcircuitry of the future, was just that... the microcircuitry of the future. While MOS represented an important step on the road to LSI, what was required to make LSI a present-day reality was a major technical breakthrough. General Instrument's exclusive MTOS process provided that breakthrough. For the first time, yield, cost, reliability and performance parameters are being effected that make LSI a dramatic and meaningful reality ... *today*.

The MTOS process—second generation MOS

In the MTOS process a thick oxide is grown over the entire silicon chip except for the gate regions. The thin oxide over the gate regions is retained to keep the threshold voltages low. The thick-oxide layer produced by the MTOS process is ten times as thick over the P-regions as any other known process employed in the manufacture of MOS devices. This strengthened thick-oxide layer over the P-regions, and the sequence of steps used in the MTOS process, which limits the etching time before metallization, eliminate the problems caused by pinholes that could occur at crossover points, a major cause of failure in integrated circuits. Further, the thick oxide over the P-regions also minimizes the possibility of electrical short-circuits caused by the breakdown of the oxide resulting either from a flaw in the oxide layer or an accidental overvoltage.

Speed and MTOS

Because crossovers occur over the thick oxide, stray capacitance is reduced, thereby increasing frequency and switching speeds by a factor approaching 10 for the more complex circuits. The MTOS process, in providing higher yields, permits the production of larger, more complex chips. This increased complexity makes possible the utilization of highly sophisticated circuitry to further improve speed capabilities. One example of such a circuit now in use is a multi-phase dynamic system which not only enhances operating speeds, but reduces still further the low power dissipation inherent in MTOS circuits. MTOS arrays are now being delivered with rated operating frequencies of 5MHz. (Pilot production devices are operating at still higher frequencies.)

LSI means Large Scale Benefits, too...

The unprecedented packaging density and high yields made possible with the MTOS process provide cost and reliability advantages never before attainable in integrated circuits. In addition to the resulting lower initial costs per function, costs are further reduced by the elimination of most external wiring, printed circuit boards and assembly labor. Moreover, by minimizing the need for external interconnections, a higher order of reliability, improved performance and product yield are obtained, making available the most complex functions so far achievable on a single monolithic chip.

What MTOS can do for you

- It can lower the cost of your equipment
- It can shrink the size of your equipment
- It can upgrade the reliability of your equipment
- It can improve the performance of your equipment
- It can put you ahead of your less innovative competitors...and at least abreast of your more aware ones!

General Instrument's exclusive MTOS has made Large Scale Integration a practical reality. There is no longer any need to await the possible future developments of LSI...It is ready now for utilization in your equipment designs — whether you want to choose from the only broad line available, or in order to meet your special requirements—at General Instrument.

Write for full information and the "MTOS Circuit Digest."

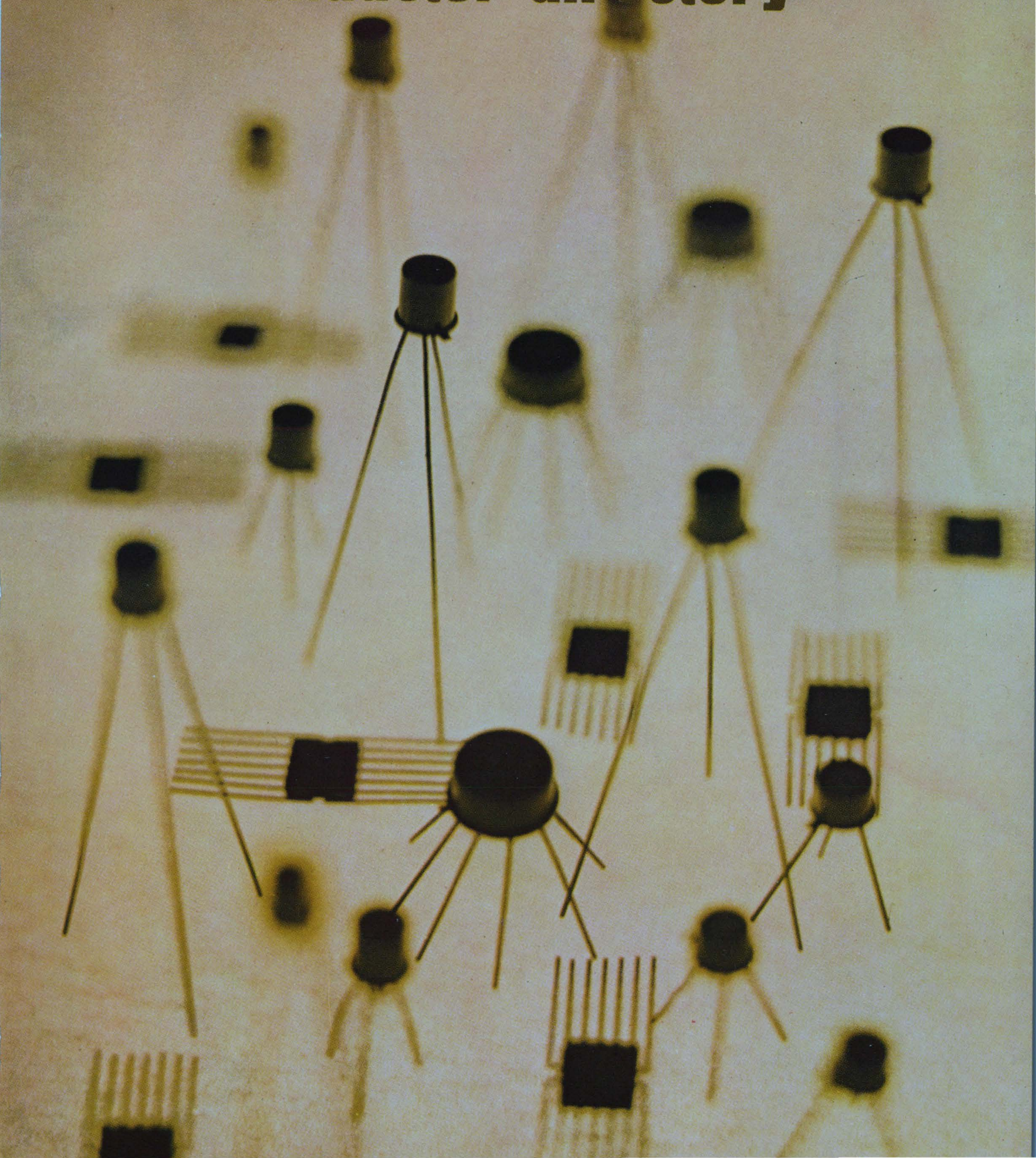
GENERAL
INSTRUMENT

GENERAL INSTRUMENT CORPORATION • 600 WEST JOHN STREET, HICKSVILLE, L. I., NEW YORK

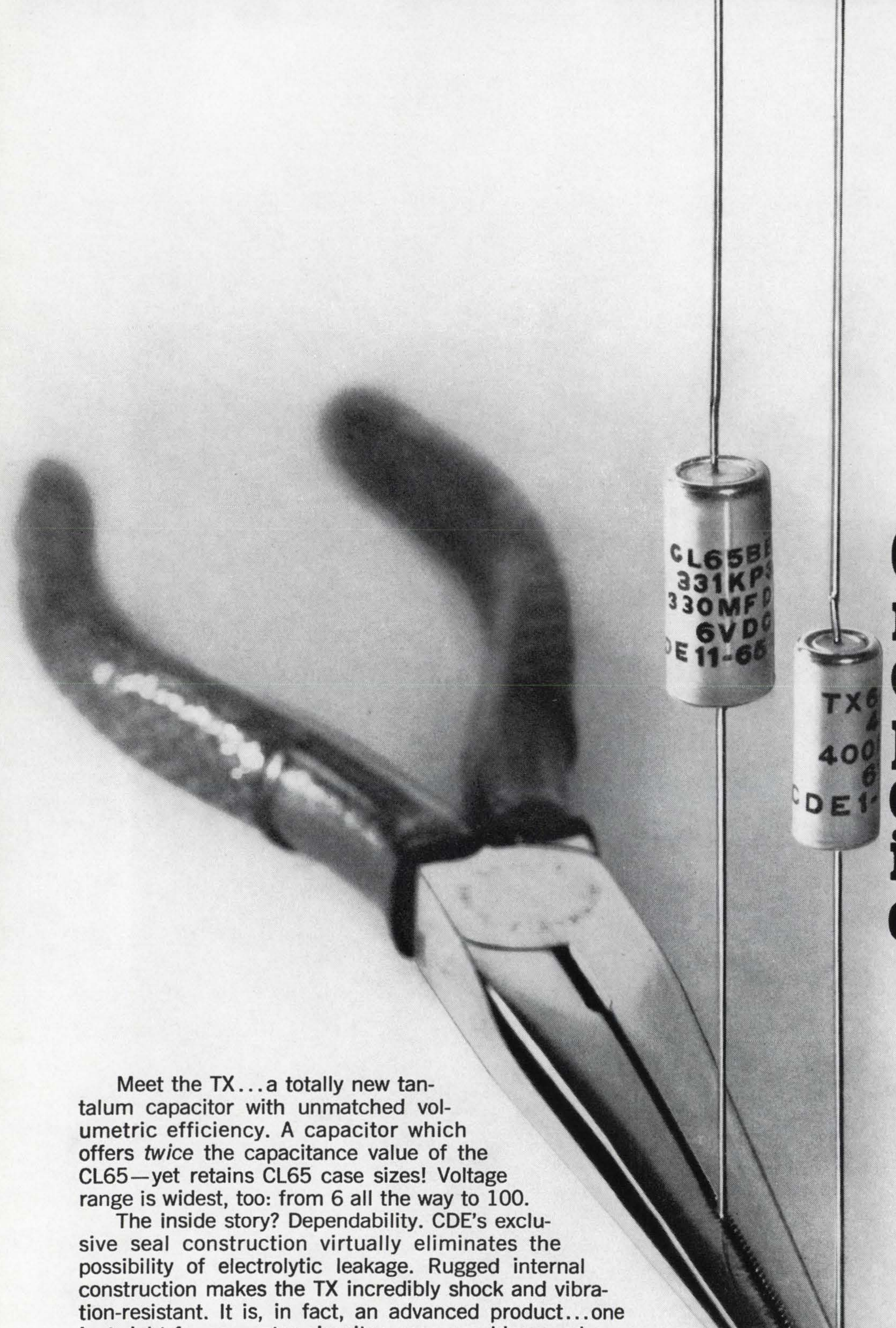
ON READER-SERVICE CARD CIRCLE 55

Electronic Design

semiconductor directory



Looks are deceiving...



CDE's new TX capacitor packs T3 capacitance in a T2 case!

Meet the TX... a totally new tantalum capacitor with unmatched volumetric efficiency. A capacitor which offers *twice* the capacitance value of the CL65—yet retains CL65 case sizes! Voltage range is widest, too: from 6 all the way to 100.

The inside story? Dependability. CDE's exclusive seal construction virtually eliminates the possibility of electrolytic leakage. Rugged internal construction makes the TX incredibly shock and vibration-resistant. It is, in fact, an advanced product... one just right for computer circuitry, copy machines and many other applications.

CDE's new TX capacitor: just another example of doing the job just a little better.

CDE CORNELL-DUBILIER

Addenda to ELECTRONIC DESIGN 1967 Semiconductor Directory (ED 9, April 26, 1967)

The following integrated circuits manufactured by Sprague Electric Co. were omitted from our 1967 Semiconductor Directory. Included are their operating temperature ranges and package descriptions. For full specifications, circle **388** on the Reader-Service Card in this issue.

Operating temperature ranges

–55 C to +125 C	Series SE, US
–20 C to +85 C	Series SU
0 C to +70 C	Series NE, ST
+10 C to +55 C	Series LU
+15 C to +70 C	Series SP

Packages (letter following the type number)

A	14-lead plastic dual in-line
B	10-lead flat pack
C	TO-85
D	TO-78
E	TO-91
G	TO-91
J	TO-88
K	TO-100

			Fan-out	Propagation delay (nsec)	Average power (mW)
DTL	NE106A, NE106J, SE106J	Dual 5-input gate expander	–	–	–
	SE111J	Dual 4-input high fan-out gate	19	20	34
	NE112A, NE112J, SE112J	Dual 3-input high fan-out gate	19	20	34
	NE116A, NE116J, SE116J	Dual 4-input NAND gate	6	25	15
	NE124A, NE124J, SE124J	RST binary element	7	18 MHz	28
	NE125A, NE125J, SE125J	J-K binary element	8	12 MHz	40
	SE155J	Dual 4-input clock/cap. line driver	19	20	34
	NE156A, NE156J, SE156J	Dual 4-input clock/cap. line driver	19	20	34
	NE161A, NE161J, SE161J	Monostable multivibrator	4	–	51
	NE170A, NE170J, SE170J	Triple 3-input NAND gate	6	25	15
	NE180A, NE180J, SE180J	Quadruple 2-input NAND gate	6	25	15
	SP616A, ST616A	Dual 4-input expandable NAND gate	5	30	34
	SP620A, ST620A	J-K binary element	5	5 MHz	28
	SP629A, ST629A	RST binary element	5	10 MHz	40
	SP631A, ST631A	Quadruple 2-input gate expander	–	–	–
	SP659A, ST659A	Dual 3-input buffer/driver	12	25	34
	SP670A, ST670A	Triple 3-input NAND gate	5	30	15
	SP680A, ST680A	Quadruple 2-input NAND gate	5	30	15
	US-720J	Quadruple 2-input NAND gate	6	25	14
	US-721J	Triple 3-input NAND gate	6	25	14
	US-727J	Triple 2-input NAND gate	6	25	15
	US-729J	RST binary element	7	18 MHz	28
	US-730J	Dual 5-input NAND gate	6	25	15
	US-731J	Quadruple 2-input gate expander	–	–	–
	US-732J	12-input gate expander	–	–	–
mWRTL	US-0908D, US-0908E	adder	–	120	10
	US-0909D, US-0909E	buffer	–	80	10
	US-0910D, US-0910E	dual gate	–	40	4
	US-0911D, US-0911E	gate	–	80	4
	US-0912D, US-0912E	half adder	–	120	8
	US-0913D, US-0913E	register	–	120	15
	US-0921D, US-0921E	gate expander	–	40	0
TTL	NE416A, NE416J, SE416J	Dual 4-input expandable NAND gate	7	32	9
	NE417A, NE417J, SE417J	Dual 3-input expandable NAND gate	7	35	8
	NE424A, NE424J, SE424J	Dual AC binary element	7	9 MHz	14
	NE440A, NE440J, SE440J	Dual exclusive OR gate	7	25	10
	NE455A, NE455J, SE455J	Dual 4-input power/driver	24	29	12
	NE480A, NE480J, SE480J	Quad 2-input NAND gate	7	25	9
	NE806A, NE806J, SE806J	Dual 4-input expander	–	–	–
	NE808A, NE808J, SE808J	Single 8-input NAND gate	10	13	20
	NE816A, NE816J, SE816J	Dual 4-input NAND gate	10	13	20
	NE825A, NE825J, SE825J	Dc clocked J-K binary element	10	20 MHz	70
	NE826A, NE826J, SE826J	Dual J-K binary element	5	30 MHz	35
	NE840A, NE840J, SE840J	Dual 4-input exclusive OR gate	10	13	35
	NE855A, NE855J, SE855J	Dual 4-input power gate	30	13	25
	NE870A, NE870J, SE870J	Triple 3-input NAND gate	10	13	20
	NE880A, NE880J, SE880J	Quad 2-input NAND gate	10	13	20
	SE8416J	Dual 4-input expandable NAND gate	7	35	4.5

Operating temperature ranges

−55 C to +125 C	Series SE, US
−20 C to +85 C	Series SU
0 C to +70 C	Series NE, ST
+10 C to +55 C	Series LU
+15 C to +70 C	Series SP

Packages (letter following the type number)

A 14-lead plastic dual in-line
B 10-lead flat pack
C TO-85
D TO-78
E TO-91
G TO-91
J TO-88
K TO-100

			Fan-out	Propagation delay (nsec)	Average power (mW)
TTL	SE8417J	Dual 3-input expandable NAND gate	7	50	4.5
	SE8424J	Dual AC binary element	7	9 MHz	9.0
	SE8440J	Dual exclusive OR gate	7	25	4.5
	SE8455J	Dual 4-input buffer/driver	20	28	7.0
	SE8480J	Quad 4-input NAND gate	7	25	3.5
	SE8806J	Dual 4-input expander	–	–	–
	SE8808J	Single 8-input NAND gate	10	12	20
	SE8816J	Dual 4-input NAND gate	10	12	20
	SE8825J	Dc clocked J-K binary element	10	20 MHz	70
	SE8826J	Dual J-K binary element	10	30 MHz	35
	SE8840J	Dual 4-input exclusive OR gate	10	12	25
	SE8855J	Dual 4-input power gate	26	12	25
	SE8870J	Triple 3-input NAND gate	10	12	20
	SE8880J	Quad 2-input NAND gate	10	12	20
	SP416A, ST416A	Dual 4-input expandable NAND gate	7	40	12
	SP417A, ST417A	Dual 3-input expandable NAND gate	7	40	12
	SP424A, ST424A	Dual AC binary element	7	9 MHz	22
	SP440A, ST440A	Dual exclusive OR gate	7	45	18
	SP455A, ST455A	Dual 4-input power/driver	24	45	16
	SP480A, ST480A	Quad 2-input NAND gate	7	40	9.0
	SP806A, ST806A	Dual 4-input expander	–	–	–
	SP808A, ST808A	Single 8-input	8	20	25
	SP816A, ST816A	Dual 4-input NAND gate	8	20	25
	SP825A, ST825A	Dc clocked J-K binary element	8	20 MHz	135
	SP826A, ST826A	Dual J-K binary element	4	30 MHz	60
	SP840A, ST840A	Dual 4-input exclusive OR gate	8	20	30
	SP855A, ST855A	Dual 4-input power gate	24	20	45
	SP870A, ST870A	Triple 3-input NAND gate	8	20	25
	SP880A, ST880A	Quad 2-input NAND gate	8	20	25
RCTL	US-0100B	R-S flip-flop/counter/shift reg.	4	–	2
	US-0101B	R-S flip-flop/counter/shift reg.	20	–	3
	US-0102B	6-input NOR/NAND gate	5	–	2
	US-0103B	6-input NOR/NAND gate	25	–	2
	US-0104B	Dual 3-input NOR/NAND gate	5	–	2
	US-0104B	Exclusive OR circuit	5	–	3
	US-0106B	Dual 2-input NOR/NAND gate and inv.	25	–	2
	US-0107B	Clock driver circuit	20	–	3
	US-0108B	Single shot multivibrator	5	–	4
	US-0109B	Pulse exclusive OR gate	5	–	6
	US-0110C	R-S flip-flop with dual resets	4	–	2
	US-0111C	R-S flip-flop with dual resets	20	–	3
	US-0112C	Triple 2-input NOR/NAND gate	5	–	2
	US-0113C	Triple 2-input NOR/NAND gate	5	–	2
	US-0114B	4x1x1 input NOR/NAND gate	5	–	2
	US-0115B	4x1x1 input NOR/NAND gate	25	–	2
Linear Circuits	NE501, SE501	RF/video/pulse amplifier	–	4-40 MHz	25
	NE505, SE505	Small signal diff. amplifier	–	1 MHz	100
	NE506, SE506	Operational amplifier	–	500 kHz	180
	NE518, SE518	Voltage comparator	–	5 MHz	170
Utilogic	LU300K, SU300K	Dual 3-input gate expander	–	–	–
	LU305K, SU305K	6-input AND gate	10	25	5
	LU306K, SU306K	Dual 3-input AND gate	10	25	5
	LU314K, SU314K	7-input NOR gate	17	30	18
	LU315K, SU315K	Dual 3-input NOR gate	17	30	18
	LU316K, SU316K	Dual 2-input NOR gate	17	30	18
	LU320K, SU320K	J-K binary element	17	4 MHz	90
	LU331K, SU331K	Dual 2-input OR gate	17	30	36
	LU332K, SU332K	Dual 3-input OR gate	17	30	36

The following companies should be added to the diode chart:

Company	Products
Parametric Industries, Inc. 63 Swanson Street Winchester, Mass. 01890 Tel.: (617) 729-7333	Varactors PIN diodes
Monsanto Electronics 800 N. Lindbergh Blvd. St. Louis, Mo. 63166 Tel.: (314) 694-2136	Lasers Visible and invisible light emitting diodes and arrays
Victory Engineering P.O. Box 187 Springfield, N.J. Tel.: (201) 379-5900	Varistors

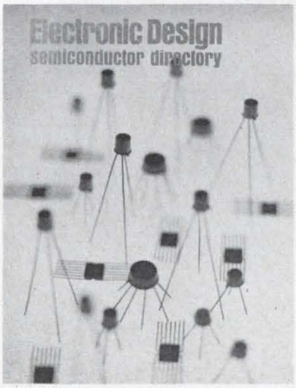
1967

Semiconductor Directory Reference Issue

Roger Kenneth Field **Peter N. Budzilovich**
Technical Editors

ELECTRONIC DESIGN's Fifteenth Annual Semiconductor Data Charts once again are tailored to the specific needs of the design engineer.

Unlike other existing lists, which group devices by manufacturer or numerical sequence (and are fine for salesmen but of limited use to engineers), the devices in ELECTRONIC DESIGN's directory are listed both by application categories and numerically with cross-indexes. Within each application category (see table of contents below) the devices are arranged in order of the corresponding key parameter.



The cover, photographed by Barry Ashley, shows a group of devices that were put at the disposal of Electronic Design by Fairchild Semiconductors.

Update Your Semiconductor File

...in two easy steps (at no charge)

Step 1

Discard obsolete data sheets and catalogs.

Step 2

Circle appropriate numbers on the Reader-Service card and receive the latest data sheets, application notes and catalogs from semiconductor manufacturers. Full test details, recommended applications, price lists and other specific data will be sent to you.

Result

. . . a completely updated semiconductor file.

1967 Semiconductor Directory

How to use the charts

There are two ways to locate the devices—by the application on hand or by the device number (only JEDEC numbers for bipolars are listed).

If you are looking for a device to do some specific job, follow these steps:

1. **Locate the proper chart as defined in the table of contents, page 83.**
2. **Locate the device in accordance with the required value of the key parameter (shaded column in all charts).**

If you know the device number, go through these steps:

1. **Locate the device in the proper Cross Index.**
2. **The Cross Index will tell you exactly where the device is listed in the data charts.**

The manufacturer whose data is used for each device is listed under "Mfr." in coded form. Manufacturers full names and addresses appear in the manufacturers list, page 86.

Other suppliers of the same device are found under "Remarks". There is no implication that the company listed under "Mfr." is a prime supplier or a cheaper source. The final choice of supplier is obviously up to the designer.

Values of only major device parameters are listed in the charts. Detailed specifications in all cases may be obtained by circling appropriate numbers as called out on the Reader-Service card (which is valid for one year). Circle as many numbers as you please.

Key to Symbols

f_{ae} = small signal short-circuit forward current transfer ratio cutoff frequency (common-emitter)
f_{ab} = small-signal short-circuit forward current transfer ratio cutoff frequency (common-base)
f_T = gain-bandwidth product
P_c = collector power dissipation (average)
T_j = junction temperature °C
mW/°C = derating factor
V_{CEO} = max collector voltage, collector to emitter base open
V_{CBO} = max collector voltage, collector to base, emitter open
I_c = max collector current
I_p = max collector current (peak)
h_{fe} = small-signal short-circuit forward current transfer ratio (common-emitter)
h_{FE} = dc short-circuit forward current transfer ratio (common-emitter)
I_{CO} = collector cutoff current (dc) emitter open
C_{oe} = output capacitance (common-emitter)
C_{ob} = output capacitance (common base)
t_r = rise time
t_s = storage time
$V_{CE(sat)}$ = collector-to-emitter saturation voltage
g_m = transconductance
V_p = pinch-off voltage
I_{DSS} = zero-bias drain current
BV_{DGO} = drain-gate breakdown voltage with gate-source open-circuited
BV_{DGS} = breakdown voltage from drain to gate with drain shorted to source
C_{is} = common source short-circuit input capacitance
N.F. = noise figure
η = intrinsic standoff ratio
I_{EO} = max emitter reverse current
I_p = max peak point emitter current
$V_{E(sat)}$ = max emitter saturation voltage
V_{EB2} = min emitter reverse voltage
V_{OB1} = min base one peak pulse voltage

Construction

AE = Annular epitaxial
AJ = Alloy junction
AD = Alloy diffused
DD = Double diffused
DG = Grown diffused
DJ = Diffused junction
DM = Diffused mesa
DDM = Double diffused mesa
DP = Diffused planar
DR = Drift
ED = Electro-chemical diffused-collector
EM = Epitaxial mesa
EP = Epitaxial
FA = Fused alloy
FJ = Fused junction
GD = Grown diffused
GJ = Grown junction
GR = Rate grown
MB = Meltback
MD = Micro-alloy diffused base
MS = Mesa
PE = Planar epitaxial
PL = Planar
SBT = Surface barrier
SP = Surface precision alloy
TDP = Triple-diffused planar
PADT = Past alloy diffused technique

Materials

ge = germanium
si = silicon

FET Symbols

n = n-type channel
p = p-type channel
F = junction FET
M = MOS FET

Microelectronic package types

A = TO-5 type packages.
B = TO-47
C = ¼ in. sq. flat-pack (TO-86, TO-91)
D = ¼ x ⅛ in. flat-pack (TO-84, TO-85, TO-89, TO-90)
E = ⅜ in. sq. flat-pack
F = ¼ x ⅜ in. flat-pack (TO-87, TO-88, TO-95)
G = Special packages
DIP = Dual in-line package (14 lead)

List of Semiconductor Manufacturers

and their literature offerings

Bring your semiconductor data file up to date. Use the Reader-Service card to obtain data sheets, catalogs, application notes and other useful information. Letter codes in the first column are used to identify transistor and microelectronics manufacturers in the data charts. Consult dot charts for Diodes and Rectifiers (p. 186) to learn who makes what.

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Airtron Div., Litton Industries 200 East Hanover Avenue Morris Plains, N.J. 07950 (201) 539-5500 TWX: 201-538-6744	Data sheets. Article reprints.		250	
	Alpha Industries 381 Elliot St. Newton Upper Falls, Mass. 02164	Data sheets. Short form catalog.		251	
	Alpha Microelectronics Co., Inc. 10501 Rhode Island Avenue Beltsville, Maryland 20705 (301) 474-1222	Application notes.			252
AL	**Amelco Semiconductor** 1300 Terra Bella Avenue Mountain View, California 94042 (415) 986-9241 TWX: 415-969-9112	Short form catalog. Application notes. Data sheets. Complete catalog. Article reprints. Customer applications service.	253		254
	American Electronic Laboratories, Inc. P.O. Box 552 Lansdale, Pa. (215) 822-2929 TWX: 510-661-4976	Data sheets. Catalogs. Article reprints. Customer applications service.		255	
	American Semiconductor 4 N. Hickory Ave. Arlington Heights, Ill. 60004	Data sheets. Catalogs.		256	
AMP	**Amperex Electronics Corp.** Providence Pike Slatersville, Rhode Island 02876 (401) 762-9000 TWX: 710-387-1591	Data sheets. Complete catalog. Customer applications service. Design aids. Short form catalog. Article reprints.	257	258	259
	Atlantic Instrument & Elect. Inc. 50 Hunt Street Newton, Massachusetts 02158 (617) 926-2400		260		
	Atlantic Semiconductor Inc. 905 Mattison Ave. Asbury Park, New Jersey 07712 (201) 775-1827	Data sheets.		261	
	Bell, F. W., Inc. 1356 Norton Avenue Columbus, Ohio 43212 (614) 294-4906 TWX: 810-482-1716	Data sheets.		262	
BE	**Bendix Semiconductor Div.** South Street Holmdel, New Jersey 07733 (201) 747-5400 TWX: 201-946-9400	Application notes. Short form catalog.	263	263	
	Bradley Semiconductor Corp. 275 Welton St. New Haven, Connecticut 06506 (203) 787-7181 TWX: 203-772-0676	Short form catalog.		264	
	Bunker-Ramo Corporation 8433 Fallbrook Avenue Canoga Park, California 91304 (213) 346-6000 TWX: 213-348-2361				265
BU	**Burroughs Corp.** **Electronic Components Div.** Mt. Bethel Road Plainfield, New Jersey 07061 (201) 757-5000 TWX: 710-981-7907		266	267	
	CTS Corporation 1142 W. Beardsley Avenue Elkhart, Indiana (219) 523-0210 TWX: 810-294-2256				268

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Centralab **Div. Globe-Union Inc.** 5757 N. Green Bay Ave. Milwaukee, Wisconsin 53201 (414) 228-2616 TWX: 910-262-3084	Data sheets.			269
	Columbia Components Corp. 24-30 Brooklyn-Queens Expressway Woodside, New York 11377 (212) 932-0800	Catalog. Application notes on hybrid circuits.			270
	Computer Diode Corp. Pollitt Drive Fairlawn, N.J. 07410 (201) 797-3900 TWX: 201-796-0660	Data sheets.		271	
	Conant Laboratories 6500 O St. Lincoln, Nebraska 68501 (402) 488-0432	Catalogs.		272	
CDC	**Continental Device Corp.** 12515 Chadron Street Hawthorne, California 90252 (213) 772-4551 TWX: 910-325-6217	Data sheets. Catalogs. Article reprints. Short form catalog.	273	274	
CT	**Crystalonics Inc.** 147 Sherman Street Cambridge, Mass. 02140 (617) 491-1670 TWX: 617-499-9156	Application notes. Data sheets. Short form catalog. Complete catalog. Article reprints.	275	276	
DE	**Delco Radio Div.** **General Motors Corp.** 700 East Firmin Street Kokomo, Indiana 46901 (317) 457-8461 TWX: 317-452-5747	Short form catalog.	277	278	
	Delta Semiconductors Inc. 879 W. 16th St. Newport Beach, California 92660 (714) 540-4160 TWX: 714-642-1335	Data sheets. Catalogs.		279	
DIC	**Dickson Electronics Corp.** Gains Guaranty Building 20 West Main Street Scottsdale, Arizona 85252 (602) 947-5751 TWX: 602-949-0146	Data sheets. Application notes.	280	281	
	Diodes Incorporated 9261 Independence Avenue Chatsworth, California 91311 (213) 341-4850 TWX: 213-341-2912			282	
	Eastern Delta Corporation 2909 Broadway Fairlawn, New Jersey 07411 (201) 797-4200	Data sheets.		283	
	Eastron Corporation 25 Locust Street Haverhill, Massachusetts 01830 (617) 373-3824	Data sheets. Application notes.		284	
	Edal Industries 4 Short Beach Road East Haven, Connecticut 06512 (203) 467-2591	Data sheets. Complete catalog. Short form catalog. Application notes.		285	
	Edgerton, Germeshausen & Grier, Inc. 160 Brookline Ave. Boston, Massachusetts 02215 (617) 267-9700 TWX: 617-262-9317	Data sheets. Application notes.		286	
	Electro-Optical Systems, Inc. 300 North Halstead Pasadena, California 91107 (213) 449-1230 TWX: 213-577-0060			287	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Electronic Control Corp. 1010 Pamela Drive P.O. Box J Euless, Texas (817) 283-1596			288	
	Electronic Devices Inc. 21 Gray Oaks Avenue Yonkers, New York 10710 (914) 965-4400 TWX: 914-476-3110	Application notes. Complete catalog.		289	
ETC	**Electronic Transistors Corp.** 153-13 Northern Boulevard Flushing, New York 11354 (212) 539-6700	Data sheets. Catalogs.	290		
	Erie Technological Products, Inc. 644 West 12th St. Erie, Pennsylvania 16512 (814) 456-8592 TWX: 814-453-6816	Complete catalog.		291	
	Espey Mfg. & Electronics Corp. Box 422 Saratoga Spring, N.Y. 12866 (518) 584-4100	Data sheets.		292	
FA	**Fairchild Semiconductor** 545 Whisman Rd. Mountain View, California 94040 (415) 962-5011 TWX: 910-379-6435	Data sheets. Application notes. Short form catalog.	293	294	295
	Gemini Semiconductors, Inc. 482 Ridgedale Ave. Hanover, N.J. 07936 (203) 887-8181	Catalogs with application notes.		296	
GE	**General Electric Co.** **Semiconductor Products Dept.** Bldg. 7, Electronics Park Syracuse, N.Y. (315) 456-2798 TWX: 710-541-0498	Data sheets. Catalogs. Application notes. Article reprints.	297	298	299
GI	**General Instrument Corp.** 100 Andrews Rd. Hicksville, N.Y. 11802 (516) 681-4042	Application notes. Data sheets. Complete catalog. Short form catalog. Technical bulletin.	311	312	313
	General Semiconductors, Inc. 230 West 5th Street Tempe, Arizona 85280 (682) 966-7263 TWX: 910-950-1942	Data sheets. Catalogs. Data manuals. Customer applications service.		314	
	Green Rectifier Corp. 1-10 30 Street Fairlawn, N.J. 07411 (201) 797-8100			315	
	HP Associates 2900 Park Boulevard Palo Alto, Calif. 94304 (415) 321-8510	Data sheets. Application notes. Catalogs.		316	
	Halex, Inc. 139 Maryland Street El Segundo, Calif. (213) 772-2545 TWX: 213-322-1608	Data sheets.			317
	Heliotek Div. **Textron Electronics Inc.** 12500 Gladstone Ave. Sylmar, Calif. 91734 (213) 365-6301 TWX: 213-764-5923			318	
HOF	**Hoffman Electronics Corp.** **Semiconductor Division** 4501 North Arden Drive El Monte, Calif. 91734 (213) 686-0123 TWX: 910-587-3429	Data sheets. Catalogs. Application notes. Article reprints.		319	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
HU	**Hughes Aircraft Co.** **Microelectronics Division** 500 Superior Ave. Newport Beach, Calif. 92663 (714) 548-0671 TWX: 714-548-0671	Data sheets. Application notes.	320	321	322
	Hunt Electronics Co. 2617 Andjon Dallas, Texas 75220 (214) 352-8421			323	
ITT	**ITT Semiconductors** 3301 Electronics Way West Palm Beach, Fla. 33402 (305) 842-2411 TWX: 510-952-6667	Catalogs.	324	324	324
IND	**Industro Transistor Corp.** 35-10 36th Avenue Long Island City, N.Y. (212) 392-8000		325		
	Instrument Systems Corp. 770 Park Avenue Huntington, N.Y. (516) 423-6200 TWX: 516-421-4042	Data sheets.		326	
IN	**Intellux, Inc.** 26 Coromar Dr. Goleta, Calif. 93017 (805) 968-3541 TWX: 805-449-7223	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service. Design aids.			327
	International Diode Corp. 90 Forrest St. Jersey City, N.J. 07304 (201) 432-7151	Data sheets. Short form catalog.		328	
IEC	**International Electronics Corp.** 316 South Service Rd. Melville, L.I., N.Y. 11749 (516) 694-7700 TWX: 212-479-9410	Data sheets. Application notes. Complete catalog.	329	329	
	International Rectifier Corp. 233 Kansas Street El Segundo, Calif. 90245 (213) 678-6281 TWX: 213-322-2623	Data sheets. Complete catalogs. Application notes.		330	
	IRC, Inc. **Semiconductor Div.** 71 Linden Street West Lynn, Mass. 01905 (617) 598-4800 TWX: 617-599-4391	Data sheets. Complete catalog. Short form catalog.		331	
KMC	**KMC Semiconductor Corp.** Parker Road Long Valley, N.J. 07853 (201) 876-3811	Data sheets. Complete catalogs. Application notes. Article reprints. Short form catalog.	332	332	
KSC	**KSC Semiconductor Corp.** 437 Cherry St. West Newton, Mass. (617) 969-8451	Data sheets. Complete catalog. Short form catalog.	333		
	Kemtron Electron Products 14 Price Place Newburyport, Massachusetts 01950 (617) 462-4464			334	
	Korad Corporation 2520 Colorado Avenue Santa Monica, Calif. 90404 (213) 393-6737 TWX: 213-879-0556			335	
LAN	**Lansdale Transistor & Electronics Inc.** 1111 North Broad Street Lansdale, Pa. 19446 (215) 885-9004 TWX: 510-661-7532		336		

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Ledex, Inc. 123 Webster Street Dayton, Ohio (513) 224-9891 TWX: 513-944-0286	Catalogs.		337	
	M. S. Transistor **Sub. of Silicon Transistor Corp.** 80-02 51st Ave. Elmhurst, N.Y. 11373 (212) 478-3134	Short form catalogs.	338		
	MSI Electronics Corporation 116-06 Myrtle Avenue Richmond Hill, N.Y. (212) 441-6420			339	
	Mallory Semiconductor Co. 424 South Madison Street DuQuoin, Ill. 62832 (618) 542-2154 TWX: 618-542-4120			340	
MEP	**Mepco, Inc.** 35 Abbett Morristown, New Jersey 07960 (201) 539-2000 TWX: 710-986-7437	Data sheets.			341
	MicroSemiconductor Corp. 11250 Playa Court Culver City, Calif. 90230 (213) 391-8271	Data sheets. Catalogs. Application notes. Article reprints. Short form catalog.		342	343
	Micro State Electronics Corp. **Subsidiary of Raytheon Co.** 152 Floral Avenue Murray Hill, N.J. 07971 (201) 464-3000 TWX: 710-984-7966	Data sheets. Catalogs. Application notes. Article reprints. Short form catalog.		344	
	Microwave Associates South Street Northwest Industrial Park Burlington, Mass. 01803 (617) 272-3000 TWX: 272-1492	Data sheets. Application notes. Complete catalogs.		345	
MO	**Motorola Semiconductor Products, Inc.** P.O. Box 955 Phoenix, Ariz. 85001 (602) 273-6900 TWX: 602-255-0590	Data sheets. Catalogs. Short form catalogs. Application notes.	346	347	348
	National Electronics Inc. 628 North Geneva, Ill. 60134 (312) 232-4300 TWX: 910-237-1685	Data sheets.		349	
NA	**National Semiconductor Corp.** Commerce Rd. Danbury, Conn. 06810 (203) 744-0060 TWX: 203-456-1142	Data sheets. Short form catalog.	350		351
NOR	**Norden Div., United Aircraft Corp.** Commerce Road Norwalk, Conn. 06856 (203) 838-4471 TWX: 710-468-0888	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.			352
NUC	**Nucleonic Products Co., Inc.** 3133 East 12th Street Los Angeles, Calif. 90023 (213) 968-3464 TWX: 910-321-3077	Data sheets.	353	354	
	Ohmite Manufacturing Co. 3601 Howard Street Skokie, Ill. 60076 (312) 675-2600 TWX: 312-677-6704			355	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
PR	**Philbrick Researches, Inc.** Allied Drive at Route 128 Dedham, Mass. 02026 (617) 329-1600 TWX: 617-326-5754				356
PH	**Philco-Ford Corporation** **Microelectronic Div.** 2920-San Ysidro Way Santa Clara, Calif. 95051 (408) 245-2966	Data sheets. Short form catalog.	357	358	359
	Power Components, Inc. P.O. Box 421 Scottsdale, Pa. 15683 (412) 887-6600 TWX: 412-887-5152	Catalogs. Application notes.		360	
RAD	**Radiation Inc.** P.O. Box 37 Melbourne, Florida 32901 (305) 723-1511 TWX: 305-723-7865	Data sheets.		361	361
RCA	**Radio Corp. of America** **Electronic Components & Devices** 415 S. Fifth Street Harrison, N.J. 07029 (201) 485-3900 TWX: 201-621-7846	Catalogs.	362	362	362
RA	**Raytheon Co.** **Semiconductor Operation** 350 Ellis St. Mountain View, Calif. 94041 (415) 968-9211 TWX: 910-379-6445	Data sheets. Catalogs.	363	364	365
	Rectico Inc. 20 Village Park Road Cedar Grove, N.J. 07009 (201) 239-6464			366	
	Sanford Miller Corp. 89 Throop Avenue Brooklyn 6, N.Y. (212) 387-0600	Complete catalog.		367	
	Sarkes Tarzian, Inc. 415 N. College Avenue Bloomington, Indiana 47401 (812) 332-1435 TWX: 810-351-1384	Data sheets. Catalogs. Application notes. Data manuals. Short form catalog.		368	
	Schauer Mfg. Corp. 4500 Alpine Avenue Cincinnati, Ohio 45242 (513) 791-3030			369	
	Semcor Div., Components Inc. 3540 W. Osborn Road Phoenix, Arizona 85019 (602) 272-1341 TWX: 602-255-0479			370	
	Semicon Inc. Sweetwater Avenue Bedford, Mass. 01730 (617) 275-8542 TWX: 617-862-3302			371	
	Semiconductor Devices Inc. 875 W. 15th St. Newport Beach, Calif. 92663 (714) 642-5100			372	
	Semiconductor Specialists Inc. 5700 W. North Avenue Chicago, Ill. 60639 (312) 622-8860 TWX: 910-221-1333			373	
	Semi-Elements Inc. Saxonburg Boulevard Saxonburg, Pa. 16056 (412) 352-1548	Catalogs. Data sheets.		374	
	Semtech Corp. 652 Mitchell Rd. Newbury Park, Calif. 91320 (213) 628-5392 TWX: 805-499-7137	Data sheets. Catalogs. Short form catalog.		375	
SA	**Siemens America Inc.** 230 Ferris Ave. White Plains, N.Y. 10603 (914) 948-3434 TWX: 914-997-0725	Data sheets. Complete catalog. Short form catalog.	376	377	378
SIG	**Signetics Corp.** 811 E. Arques Ave. Sunnyvale, Calif. 94086 (408) 739-7700 TWX: 910-339-9220	Data sheets. Application notes. Article reprints.			379
STC	**Silicon Transistor Corp.** E. Gate Blvd. Garden City, N.Y. (516) 742-4100 TWX: 510-222-8258	Data sheets. Catalogs. Application notes. Customer applications service.	380	380	
SI	**Siliconix Inc.** 1140 W. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-1000 TWX: 408-737-9948	Application notes. Data sheets. Article reprints.	381		382
	Slater Electric, Inc. 45 Sea Cliff Ave. Glen Cove, N.Y. (516) 671-7000 TWX: 516-671-3815	Data sheets. Catalogs. Application notes.		383	
	Solar Systems Inc. 8241 N. Kimball Ave. Skokie, Ill. 60076 (312) 676-2040 TWX: 910-233-3642			384	
SSP	**Solid State Products Inc.** One Pingree St. Salem, Mass. 01970 (617) 745-2900 TWX: 710-347-0226	Data sheets. Catalogs. Application notes. Customer applications service.	385	385	
SOL	**Solitron Devices Inc.** 1177 Blue Heron Blvd. Riviera Beach, Fla. 33404 (301) 848-4311 TWX: 510-952-6676	Data sheets. Catalogs. Short form catalogs. Application notes.	386		
SSD	**Sperry Semiconductor** 380 Main Ave. Norwalk, Conn. 06852 (203) 847-3851 TWX: 710-468-0591	Data sheets. Application notes. Short form catalog.	387		387
SPR	**Sprague Electric Co.** 491 Marshall St. North Adams, Mass. 01247 (413) 664-4411 TWX: 413-663-3581	Data sheets. Application notes. Short form catalog.	388		388
SW	**Stewart-Warner Microcircuits Inc.** 730 W. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-9200				389
SY	**Sylvania Electric Prods.** 100 Sylvan Road Woburn, Mass. 01801 (617) 933-3500	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	390	391	392
	Syntron Co. 283 Lexington Ave. Homer City, Pa. 15748 (412) 479-9477			393	
TRWS	**TRW Semiconductors Inc.** 14520 Aviation Blvd. Lawndale, Calif. 90260 (213) 679-4561 TWX: 910-325-6206	Data sheets. Article reprints. Short form catalog.	394	395	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
TI	**Texas Instruments Inc.** **Semiconductor Components Div.** P.O. Box 5012 Dallas, Texas 75222 (214) 238-2011 TWX: 214-231-1492	Data sheets. Catalogs. Application notes. Customer applications service.	396	397	398
TR	**Transitron Electronic Corp.** 168 Albion St. Wakefield, Mass. 01881 (617) 245-4500 TWX: 617-245-7823		399	399	399
TRI	**Trio Laboratories** 80 DuPont St. Plainview, N.Y. 11803 (516) 681-0400 TWX: 516-433-9573	Data sheets. Application notes.		400	401
UC	**Union Carbide Electronics** 365 Middlefield Rd. Mountain View, Calif. 94040 (415) 961-3300		402		403
	Unitrode Corp. 580 Pleasant St. Watertown, Mass. 02172 (617) 926-0404 TWX: 710-327-1297	Data sheets. Catalogs. Data manuals. Customer applications service. Design aids.		404	
	Vactec Inc. 2423 Northline Industrial Blvd. Maryland Heights, Mo. 63045 (314) 432-4200			405	
	Varian/Bomac Div. Salem Road Beverly, Mass. 01915 (617) 922-6000 TWX: 617-922-1978			406	
VAR	**Varo Inc., Special Products Div.** 2201 Walnut St. Garland, Texas 75040 (214) 276-6141 TWX: 214-276-8577			407	408
VEC	**Vector Solid State Labs.** Southampton, Pa. 18966 (215) 357-7600		409		
	Wagner Electric Corp. 1 Summer Ave. Newark, N.J. 07104 (201) 484-8500 TWX: 710-995-4607	Data sheets. Catalogs.		410	
	Western Semiconductors Inc. 2200 Fairview St. Santa Ana, Calif. 92704 (714) 546-5717 TWX: 714-546-2245	Data sheets. Catalogs. Customer applications service.		411	
	Western Transistor Corp. 11581 Federal Drive El Monte, Calif.		412		
WH	**Westinghouse Electric Corp.** **Molecular Electronics Division** Box 7377 Elkridge, Maryland 21227 (301) 796-3666 TWX: 301-761-4340	Data sheets. Short form catalog. Complete catalog. Application notes. Article reprints.			413
WH	**Westinghouse Electric Corp.** **Semiconductor Div.** Youngwood, Pa. 15697 (412) 925-7272 TWX: 412-679-2783	Data sheets. Catalogs. Application notes. Article reprints. Design aids. Short form catalog.	414	415	

Design Aid

Working Tool

Valuable

Time Saver

Unique

Professional

Useful

Easy to Use

Unparalleled

Glorious

Dynamic

Informative

Dear Reader,

If you find our Fifth Annual Semiconductor Reference Issue any one or more of these adjectives, the tremendous amount of work it represents will have been well worthwhile. We would appreciate any comments and suggestions you may have. Please drop us a line.

Electronic Design #20, to be published September 27, will also contain our Test Instrument Issue. It, too, will contain a wealth of information which we hope you find useful.

The Editors of Electronic Design

Type faces supplied by City Typographic Service, New York City.

RCA...where the

From RCA "overlay"... the industry's best performing plastic RF-power transistor— 15 watts min. at 400 MHz

Now . . . get in on the action with the rf-power advantages of RCA "overlay" in plastic!!

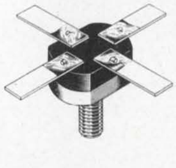
RCA's new 2N5017 stud-mounted plastic transistor provides 15 watts at 400 MHz . . . 22 watts typ. at 225 MHz . . . operates from 28-v supply! And this circuit capability is delivered in a unique package that sets new standards for performance, ruggedness, and versatility at VHF and UHF frequencies.

Performance—the industry's lowest emitter and base inductances (0.1 nH and 0.2 nH respectively) result in optimum gain and power capability right up to 700 MHz . . . efficient for broadband and narrowband transmitters.

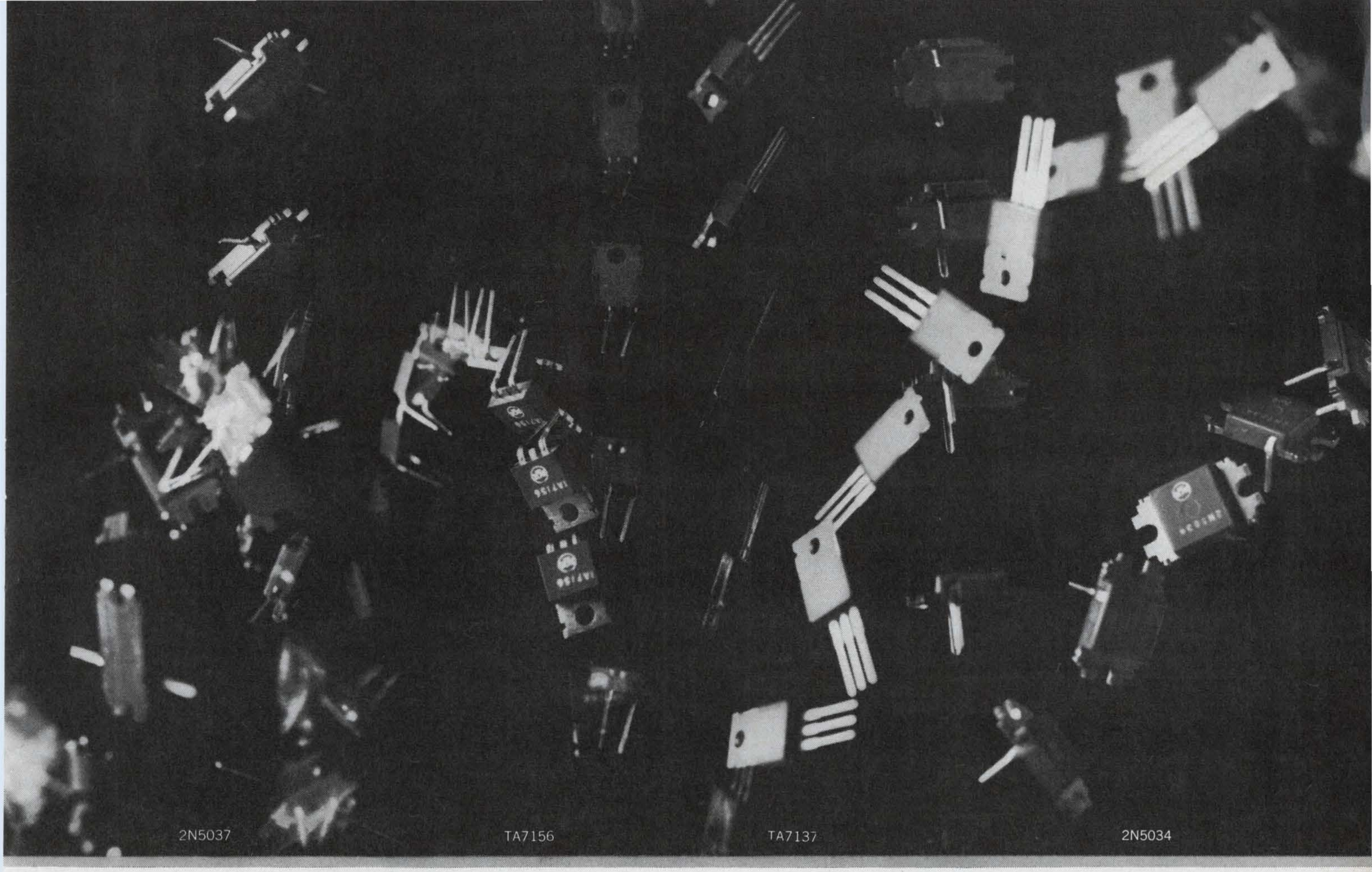
Ruggedness—unexcelled mechanical strength with short "anchor" pins eliminating problems due to lead breakage or vibration.

Versatility—"terminal block" structure permits choice of stripline, printed circuit (both flush and bottom-mounted), or lumped circuit mounting.

Call your RCA representative today for more information on the 2N5017 for military, microwave, and industrial communications usage. If your applications still call for hermetically sealed packages, ask him about the RCA 2N5016—it offers similar electrical performance but in the popular TO-60 case. For technical data, write RCA Commercial Engineering, Section IG4-4A Harrison, N. J. 07029.



Strip-line leads can be easily soldered to terminal block with pins providing additional mechanical strength.



action is plastic

From RCA
Hometaxial-Base...
the industry's most powerful plastic power transistors—dissipation up to 83 watts

Tomorrow's action needs are here today... as RCA, leader in silicon power, now introduces its famous Hometaxial-Base technology in plastic!

Eight transistors in all, RCA's new power program is the first to combine the low cost of plastic with brute power-handling ability —83 watts or 36 watts—each is an industry-high for plastic! And this power comes in your choice of package... a straight-lead design for PC-board mounting or a bent-lead design compatible with standard TO-3 or TO-66 mounting techniques.

TYPE	PACKAGE	V_{CER} (sus)	I_C	h_{FE}	θ_{J-C}	P_T @ 25°C
2N5036 2N5037	TO-3 equivalent P.C. type	60 V @ $R_{BE} = 100$ ohms	8A	20-70 @ 3A	1.5 °C/W	83 W
2N5034 2N5035	TO-3 equivalent P.C. type	45 V @ $R_{BE} = 100$ ohms	6A	20-70 @ 2.5A	1.5 °C/W	83 W
TA7155 TA2911	TO-66 equivalent P.C. type	60 V @ $R_{BE} = 100$ ohms	4A	25-100 @ 0.5A	3.5 °C/W	36 W
TA7156 TA7137	TO-66 equivalent P.C. type	50 V @ $R_{BE} = -500$ ohms	4A	20-120 @ 0.1A	3.5 °C/W	36 W

Performance is tops—RCA mounts the silicon chip directly onto a solid copper base for better current handling, thermal resistance, and dissipation capabilities. You get unsurpassed freedom from second breakdown... the inherent advantage of RCA Hometaxial-Base technology.

Put the cost and performance benefits of RCA plastic transistors in your circuits... they'll do the big job for audio amplifiers and a broad range of industrial applications. Call your RCA representative for more information or write Commercial Engineering, Section IG4-4B Harrison, N. J. 07029.

Also available through your RCA distributor.

RCA Electronic Components and Devices

The Most Trusted Name in Electronics

ON READER-SERVICE CARD CIRCLE 60

Audio and General Purpose

under one watt

Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	MAX. RATINGS					CHARACTERISTICS		Package Outline (TO-)	Remarks
					P_c (mW)	T_j (^oC)	mW/^oC	V_{CEO} *V_{CBO} (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ *f_T (MHz)		
A 1	2N1439	NA	pnp,A,si	5-12	400	200	2.25	50	100	.025	–	5	CT, SSD
	2N1223	SSD	AJ	6	250	175	1.67	40	100	0.1	–	5	CT,SPR
	2N927	NA	pnp,A,si	8-22	150	200	.85	60	100	.025	–	18	SPR,SSD
	2N935	SSD	AJ	*9	385	160	2.85	40	50	0.1	0.2	18	CT,SPR
	2N938	SSD	AJ	9	250	175	1.67	35	50	.025	–	18	CT,SPR
A 2	2N1024	SSD	AJ	9	250	175	1.67	15	100	.025	1	5	AMP,CT,SPR
	2N1025	SSD	AJ	9	250	175	1.67	35	100	.025	–	5	AMP,CT,SPR
	2N1028	SSD	AJ	9	250	175	1.67	10	100	.025	–	5	CT,SPR
	2N1154	TI	npn,si	9	750	150	6	*50	60	5	–	–	TR,NA,ETC
	2N1155	TI	npn,si	9	750	150	6	*80	50	5	–	–	TR,NA,ETC
	2N1156	TI	npn,si	9	750	150	6	*120	40	5	–	–	TR,NA,ETC
	2N1220	SSD	AJ	*9	250	175	1.67	25	100	0.1	–	5	CT,SPR
	2N1222	SSD	AJ	9	250	175	1.67	25	100	0.1	–	5	CT,SPR
	2N1586	TI	npn,si	9	125	87.5	2	10	25	1	–	–	TR,ETC
	2N1587	TI	npn,si	9	125	87.5	2	20	25	1	–	–	TR,ETC
A 3	2N1588	TI	npn,si	9	125	87.5	2	40	25	1	–	–	TR,ETC
	2N332A	GE	npn,DG,si	9-20	500	175	3.33	45	25	.5	–	5	TR,TI, NA
	2N1440	NA	pnp,A,si	9-22	400	200	2.25	50	100	.025	–	5	AMP,CT , SSD
	2N2673	GE	pnp,DG,si	9-22	250	175	1.66	*60	25	.1	–	46	
	2N1394	GI	pnp,ge	10	50	–	0.8	*10	–	15	–	–	
	2N1408	GI	pnp,AJ,ge	*10	150	100	2	*50	–	7.0	1	5	MO,TI
	2N1643	CT	pnp,si	*10	250	160	1.9	25	50	.001	–	5	SSD
	2N1672A	GI	npn,AJ,ge	*10	120	85	2	*55	–	25	2	5	
	2N925	NA	pnp,A,si	10-24	150	200	.85	40	100	.025	–	18	SPR, SSD
	2N470	TR	npn,PL,si	10-25	200	175	1.2	15	25	.5	8	5	
A 4	2N471	TR	npn,PL,si	10-25	200	175	1.2	30	25	.5	8	5	
	2N472	TR	npn,Pl,si	10-25	200	175	1.2	45	25	.5	8	5	
	2N472A	TR	npn,PL,si	10-25	200	175	1.2	45	25	.5	8	5	
	2N1082	TR	npn,PL,si	*10-50	200	175	1.5	*25	50	.5	17.2	5	
	2N102	SY	npn,AL,ge	*10.5	1000	75	–	*30	1500	500	–	13	
	2N117	TI	npn,si	12	150	175	1	*45	25	2	–	–	TR
	2N332	TI	npn,si	12	150	175	1	*45	25	2	–	5	GE, TR, TI, NA
	2N1474	SSD	AJ	12	250	175	1.67	60	100	.050	–	5	CT, AMP,SPR
	2N1476	SSD	AJ	12	250	175	1.67	100	100	0.2	–	5	CT, SPR
	2N756	NA	npn,DM,si	12-22	500	200	2.5	45	100	0.2	–	18	TR
A 5	2N756A	NA	npn,DM,si	12-22	500	200	2.5	60	100	0.1	–	18	TR
	2N923	NA	pnp,A,si	12-30	150	200	.85	25	100	.025	–	18	SPR,SSD
	2N1149	TI	npn,si	12.3	150	175	1	*45	25	2	–	–	TR
	2N726	TI	npn,si	15	300	175	2	20	50	1	–	18	IEC
	2N1248	TR	npn,PLE,si	*15	30	150	.24	6	5	.01	–	5	GE
	2N1311	GI	npn,AJ,ge	*15	120	85	2	*75	–	7.0	1.5	5	TI
	2N1655	RA	pnp,si	*15	250	160	1.85	125	50	1.0	.050	5	CT, SPR
	2N2177	SSD	AJ	*15	100	175	.67	6	50	.005	–	5	CT, SPR
	2N2178	SSD	AJ	*15	10	175	.67	6	50	.005	–	18	CT, SPR
	2N2370	NA	pnp,A,si	*15	200	200	1.0	15	100	.005	–	5	Low Level, Low Noise, AMP, CT, SPR
A 6	2N2372	NA	pnp,A,si	*15	150	200	1	15	100	.005	–	18	Low Level, Low Noise, CT, SPR
	2N2391	TI	pnp,si	15	300	175	2	20	50	10	–	50	
	2N529	GI	–	15-20	100	85	2	*15	–	5.0	2.5	5	
	2N243	TI	npn,si	16	750	150	6	*60	60	1	–	–	TR, NA
	2N936	SSD	AJ	*18	385	160	2.85	35	50	0.1	–	18	CT, SPR
	2N939	SSD	AJ	18	250	175	1.67	35	50	.025	–	18	CT, SPR
	2N1026	SSD	AJ	18	250	175	1.67	35	100	.025	–	5	CT, SPR
	2N1027	SSD	AJ	18	250	175	1.67	15	100	.025	–	5	CT, SPR
	2N1219	SSD	AJ	*18	250	175	1.67	25	100	0.1	–	5	SPR
	2N1221	SSD	AJ	18	250	175	1.67	25	100	0.1	–	5	CT, SPR
A 7	2N1474A	SSD	AJ	18	250	175	1.67	60	100	.050	–	5	CT, SPR
	2N1441	NA	pnp,A,si	18-36	400	200	2.25	35	100	.025	–	5	AMP, CT, SSD
	2N757	NA	npn,DM,si	18-40	500	200	2.5	45	100	0.2	–	18	TR, GI
	2N333A	GE	npn,DG,si	18-44	500	175	3.33	45	25	.5	–	5	TR, TI, NA
	2N2674	GE	npn,DG,si	18-44	250	175	1.66	*60	25	.1	–	46	
	2N928	NA	pnp,A,si	18-55	150	200	.85	60	100	.025	–	18	SPR, SSD
	2N334A	GE	npn,DG,si	18-90	500	175	3.33	45	25	.5	12	5	TR
	2N758	NA	npn,DM,si	18-90	500	200	2.5	45	100	0.2	–	18	TR, GI
	2N758A	NA	npn,DM,si	18-90	500	200	2.5	60	100	0.1	–	18	GI, SSD
	2N734	TI	npn,si	20	500	175	3.33	60	50	1	–	18	TRWS, TR, NA
A 8	2N738	TI	npn,si	20	500	175	3.33	80	50	1	–	18	TR
	2N1273	TI	pnp,ge	20	150	85	2.5	*15	150	14	–	5	
	2N1274	TI	pnp,ge	20	150	85	2.5	*25	150	14	–	5	
	2N1310	GI	npn,AJ,ge	*20	120	85	2	*90	–	7	1	5	TI, IEC
	2N1312	GI	npn,AJ,ge	*20	120	85	2	*50	–	7	2	5	TI
	2N1372	TI	pnp,ge	*20	250	100	3.3	*25	200	–	–	5	
	2N1373	TI	pnp,ge	*20	250	100	3.3	*45	200	–	–	5	
	2N1380	TI	pnp,ge	20	250	100	3.3	*12	200	14	–	5	
	2N1381	TI	pnp,ge	20	250	100	3.3	*25	200	14	–	5	

Audio *(continued)*

					MAX. RATINGS					CHARACTERISTICS			
Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ *f_T (MHz)	Package Outline (TO-)	Remarks
A 9	2N1383	TI	pnp,ge	20	200	85	3.3	*25	200	14	–	5	
	2N1445	TI	npn,si	*20	800	200	4.57	*120	750	10	–	5	
	2N1564	TI	npn,si	20	600	175	4	60	50	1	–	5	TRWS, TR, NA
	2N1572	TI	npn,si	20	600	175	4	80	50	1	–	5	TR
	2N1672	GI	npn,AJ,ge	*20	120	85	2	*40	–	25	2	5	TI
A 10	2N2371	NA	pnp,A,si	*20	200	200	1.0	15	100	.005	–	5	Low Level, Low Noise, AMP, CT, SPR
	2N2373	NA	pnp,A,si	*20	150	200	1	15	100	.005	–	18	Low Level, Low Noise, CT, SPR
	2N3579	SSD	pnp,EP	*20	400	200	2.28	60	30	0.05	80	46	
	2N4292	NA	npn,EP,si	*20	200	150	1.60	*30	–	0.5	*600	–	
	2N4293	NA	npn,EP,si	*20	200	150	1.6	*30	–	0.5	*600	–	
	2N3877	GE	npn,PL,si	*20 min.	200	100	2.67	70	50	0.5	135	98	
	2N3877A	GE	npn,PEP,si	*20 min	200	100	2.67	85	50	0.5	135	98	
	2N530	GI	–	20-25	100	85	2	*15	–	5	3	5	
	2N2042	MO	pnp,AJ,ge	*20-50	200	100	*2.67	105	200	10	–	5	TI
A 11	2N2042A	MO	pnp,AJ,ge	*20-50	200	100	*2.67	105	200	10	–	5	TI
	2N926	NA	pnp,A,si	20-55	150	200	.85	40	100	.025	–	18	SPR, SSD
	2N339A	TR	npn,PL,si	*20-80	250	175	3	60	150	1	10	11	
	2N340A	TR	npn,PL,si	*20-80	250	175	3	85	150	1	10	11	
	2N341A	TR	npn,PL,si	*20-80	250	175	3	125	150	1	10	11	
	2N3793	NA	npn,DD,EP,si	*20-105	250	150	2.0	*40	500	0.5	*1.0	–	
	2N118	TI	npn,si	24	150	175	1	*45	25	2	–	–	TR
	2N333	TI	npn,si	24	150	175	1	*45	25	2	–	5	GE, TR, NA
	2N1150	TI	npn,si	24	150	175	1	*45	25	2	–	–	TR
	2N924	NA	pnp,A,si	24-60	150	200	.85	25	10	.025	–	18	SSD
A 12	2N330A	RA	pnp,si	25	380	160	2-9	30	50	0.1	0.05	5	SSD, AMP, CT
	2N563	GI	pnp,AJ,ge	25	150	85	2.5	*30	300	5	0.8	–	TI, SSD
	2N564	GI	pnp,AJ,ge	25	120	85	2	*30	300	5	0.8	5	IND, TI
	2N1589	TI	npn,si	25	125	87.5	2	10	25	1	–	–	TR
	2N1590	TI	npn,si	25	125	87.5	2	20	25	1	–	–	TR
	2N1591	TI	npn,si	25	125	87.5	2	40	25	1	–	–	TR
	2N1623	RA	pnp,si	*25	250	160	1.85	20	50	1.0	0.05	5	CT, SPR
	2N2304	RA	npn,PL,si	*25	600	300	3-4	30	250	.010	10	5	STC
	2N2617	AMP	pnp,si	*25	350	150	2	*25	50	.001	3	–	
	2N2831	SY	npn,PE,si	*25	360	175	–	*40	200	.30	250	18	TRWS
A 13	2N531	GI	–	25-30	100	85	2	*15	–	5.0	3.5	5	
	2N4298	RCA	npn,TDP,si	*25-75	20,000	175	133	350	1000	100	*60	66	
	2N658	TI	pnp,AJ,ge	*25-80	250	100	6.66	12	1000	6	–	5	
	2N306	SY	npn,AL,ge	*25-125	180	85	–	*20	–	20	.600	22	
	2N2860	SY	npn,PE,si	*25-125	200	175	–	*30	–	1	*1000	18	
	2N279	AMP	pnp,AJ,si	30	125	75	2.5	30	10	110	0.15	1	Low Noise
	2N662	TI	pnp,AJ,ge	*30	250	100	6.66	12	100	6	–	5	
	2N727	TI	npn,si	30	300	175	2	20	50	1	–	18	
	2N1477	SSD	AJ	30	250	175	1.67	100	100	0.2	–	5	CT, SPR
	2N1654	RA	pnp,si	*30	250	160	1.85	80	50	1	.50	5	CT, SPR
A 14	2N1656	RA	pnp,si	*30	250	160	1.85	125	50	1	.050	5	CT, SPR
	2N2173	TI	pnp,ge	*30	240	100	3.2	15	750	10	–	5	
	2N2173	MO	pnp,ge	*30	240	100	3.2	15	750	10	–	5	
	2N2392	TI	pnp,si	30	300	175	2	20	50	10	–	50	
	2N2599A	SSD	pnp,EP	*30	400	200	2.28	100	30	0.025	60	46	
	2N532	GI	–	30-35	100	85	2	*15	–	5	4.0	5	
	2N1101	SY	npn,AL,ge	*30-60	180	85	–	*20	100	50	.10	22	
	2N1102	SY	npn,AL,ge	*30-60	180	85	–	*40	100	50	0.10	22	
	2N1442	NA	pnp,A,si	30-65	400	200	2.25	30	100	.025	–	5	CT, SSD
	2N650	MO	pnp,AJ,ge	30-70	200	100	2.67	*45	500	10	–	5	TI
A 15	2N650A	MO	pnp,AJ,ge	30-70	200	100	2.67	*45	500	10	–	5	TI
	2N653	MO	pnp,AJ,ge	30-70	200	100	2.67	*30	250	15	1	5	TI
	2N1186	MO	pnp,AJ,ge	30-70	200	100	2.67	*60	500	10	–	5	TI
	2N1191	MO	pnp,AJ,ge	30-70	200	100	2.67	*40	200	15	–	5	TI,IEC
	2N2711	GE	npn,PL,si	30-90	200	100	2.67	18	100	.5	–	98	NUC,CDC, IEC
	2N2713	GE	npn,PEP,si	*30-90	200	100	2.67	18	200	0.5	–	98	Full line spread CDC,IEC
	2N1051	GE	npn,DD,si	30-100	500	150	4	40	100	.1	4	5	NA
	2N1707	MO	pnp,AJ,ge	30-150	200	100	2.66	*30	400	15	†4	5	† fab, TI
	2N244	TI	npn,si	32	750	150	6	*60	60	1	–	–	TR, NA
	2N405	RCA	pnp,AJ,ge	35	150	71	–	*20	35	14	0.65	40	
A 16	2N406	RCA	pnp,AJ,ge	35	150	71	–	*20	35	14	0.65	1	LAN
	2N780	TI	npn,si	*35	300	175	2	45	50	0.01	–	18	AL
	2N1010	LAN	npn,AJ,ge	35	20	55	–	*10	2	10	2	1	
	2N2389	TI	npn,si	35	450	200	2.57	*75	500	0.01	–	50	
	2N533	GI	–	35-40	100	85	2.0	*15	–	5	4.5	5	
	2N4284	NA	pnp,EP,si	*35-150	250	150	2.0	*25	100	0.10	*7.0	–	
	2N4285	NA	pnp,EP,si	*35-150	250	150	2.0	*35	100	0.01	*7.0	–	
	2N2926	GE	npn,PL,si	†35-470	200	100	2.67	18	100	0.5	–	98	NUC, † Full line spread, GME, CDC, IEC
	2N937	SSD	AJ	*36	385	160	2.85	30	50	0.1	–	18	CT, SPR

Audio *(continued)*

					MAX. RATINGS					CHARACTERISTICS			
Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ *f_T (MHz)	Package Outline (TO-)	Remarks
A 17	2N940	SSD	AJ	36	250	175	1.67	35	50	.025	–	18	CT, SPR
	2N1469	SSD	AJ	36	250	175	1.67	35	100	.025	–	5	CT, SPR
	2N1475	SSD	AJ	36	250	175	1.67	60	100	.050	–	5	CT, SPR
	2N759	NA	npn,DM,si	36-90	500	200	2.5	45	100	0.2	–	18	TR, GI, TI, SSD
	2N759A	NA	npn,DM,si	36-90	500	200	2.5	60	100	0.1	–	8	SPR, GI, TI, SSD
A 18	2N335A	GE	npn,DG,si	37-90	500	175	3.33	45	25	.5	–	5	TR, TI, NA
	2N2675	GE	npn,DG,si	37-90	250	175	1.66	*60	25	.1	–	46	
	2N334	TI	npn,si	39	150	175	1	*45	25	2	–	5	GE, TR, NA
	2N1151	TI	npn,si	39	150	175	1	*45	25	2	–	–	TR
	2N735	TI	npn,si	40	500	175	3.33	60	50	1	–	18	TRWS, TR, INA, SSD
	2N739	TI	npn,si	40	500	175	3.33	80	50	1	–	18	TR, SSD
	2N934	RCA	pnp,MS,ge	*40	150	–	–	13	–	–	–	18	
	2N1370	TI	pnp,ge	40	150	85	2.5	25	150	14	–	5	
	2N1371	TI	pnp,ge	40	150	85	2.5	45	150	14	–	5	
	2N1374	TI	pnp,si	40	250	100	3.3	*25	200	7	–	5	
A 19	2N1375	TI	pnp,ge	40	250	100	3.3	*45	200	7	–	5	
	2N1382	TI	pnp,ge	40	200	85	3.3	*25	200	14	–	5	
	2N1413	GE	pnp,AJ,ge	*40	200	85	3.33	*35	200	12	–	5	TI, MO
	2N1565	TI	npn,si	40	600	175	4	60	50	1	–	5	TRWS, TR, NA
	2N1573	TI	npn,si	40	600	175	4	80	50	1	–	5	TR
	2N1622	GI	npn,AJ,ge	*40	120	85	2	*90	–	7.0	1	5	TI
	2N2868	GE	npn,PE,si	40	2800	200	16	40	1000	.010	130	5	IEC
	2N2909	GE	pnp,PE,si	40	2800	200	16	40	1000	.010	130	46	
	2N3064	CT	pnp,si	40	400	200	2.3	*110	100	.01	–	46	NA
	2N3065	CT	pnp,si	40	400	200	2.3	110	100	.01	–	46	NA
A 20	2N3580	SSD	pnp,EP	*40	400	200	2.28	60	30	0.05	80	46	
	2N480A	TR	npn,PL,si	40-100	200	175	1.2	45	25	.5	20	5	GE
	2N2043	MO	pnp,AJ,ge	*40-100	200	100	2.67	105	200	10	0.75	5	TI
	2N2043A	MO	pnp,AJ,ge	*40-100	200	100	2.67	105	200	10	0.75	5	TI
	2N659	TI	pnp,AJ,ge	*40-110	250	100	6.66	12	1000	6	–	5	
	2N2244	NA	npn,DM,si	40-120	500	200	2.5	20	100	.01	–	18	Low Level
	2N2247	NA	npn,DM,si	40-120	500	200	2.5	45	100	.01	–	18	Low Level
	2N2250	NA	npn,DM,si	40-120	500	200	2.5	20	100	.01	–	18	Low Noise, CDC
	2N2253	NA	npn,DM,si	40-120	500	200	7.5	45	100	.01	–	18	Low Noise, CDC, AMP
	2N4026	FA	pnp,PE,si	*40-120	2000	200	11.4	60	1000	0.05	*100	18	
A 21	2N4027	FA	pnp,PE,si	*40-120	2000	200	11.4	60	1000	0.05	100	18	
	2N4030	FA	pnp,PE,si	40-120	800	200	22.8	60	–	.2	100	5	
	2N4031	FA	pnp,PE,si	40-120	800	200	22.8	80	–	.2	150	5	
	2N4855	TI	pnp/npn,EP,si	*40-120	600	175	4	40	600	0.01	*200	5	Complementary (pnp/npn)
	2N1192	MO	pnp,AJ,ge	40-135	200	100	2.67	*40	200	15	–	5	TI
	2N3691	FA	npn,PL,si	*40-160	625	150	2	*35	50	.05	*200	–	R097A package, CDC, IEC
	2N3826	IEC	npn,PE,si	40-160	300	150	0.33	45	100	0.10	360	18	
	2N43A	GE	pnp,AJ,ge	42	240	85	4	*45	300	16	1.30	–	RO32
	2N215	RCA	pnp,AJ,ge	44	150	70	–	*30	50	10	0.7	1	
	2N3709	TI	npn,PE,si	*45-165	250	125	2.5	30	30	0.1	–	†	†Plastic, CDC
A 22	2N4060	TI	pnp,EP,si	*45-165	250	125	2.5	30	30	0.1	–	92	
	2N3708	TI	npn,PE,si	*45-660	250	125	2.5	30	30	0.1	–	†	†Plastic, CDC
	2N4059	TI	pnp,EP,si	*45-660	250	125	2.5	30	30	0.1	–	92	
	2N280	AMP	pnp,AJ,ge	47	125	75	2.5	30	10	150	0.1	–	Special Case
	2N119	TI	npn,si	49	150	175	1.19	*45	25	1	–	–	TR
	2N335	TI	npn,si	49	150	175	1	*45	25	2	–	5	GE, TR, NA
	2N1152	TI	npn,si	49	150	175	1	*45	25	2	–	–	TR
	2N917	FA	npn,DP,si	50	300	200	1.71	15	–	0.0005	*800	18	TI, RCA, AL, TRWS, NA, IEC
	2N918	FA	npn,PE,si	*50	300	200	1.71	15	50	0.002	*900	18	MO, TI, RCA, AL, TRWS, VEC, NA, IEC
A 23	2N1443	NA	pnp,A,si	50	400	200	2.25	15	100	.025	–	5	CT, SSD
	2N2432A	TI	npn,EP,si	*50	300	175	2	45	100	0.01	*20	18	Chopper
	2N2616	FA	npn,PE,si	*50	800	200	4.56	15	50	0.002	*900	18	AL, IEC
	2N2729	FA	npn,PE,si	*50	800	200	4.56	15	50	0.002	900	18	AL, IEC
	2N2946A	TI	pnp,EP,si	*50	400	200	2.3	*40	100	0.0005	*5	46	Chopper
	2N3581	SSD	pnp,EP	*50	400	200	2.28	40	30	0.02	30	46	
	2N4138	TI	npn,EP,si	*50	300	175	2	30	100	0.01	*20	46	Chopper
	2N214	SY	npn,AL,ge	*50-100	180	85	–	*40	100	50	.01	22	
	2N1059	SY	npn,AL,ge	*50-100	180	85	–	*20	100	20	.10	22	
	2N4248	FA	pnp,PE,si	*50-110	500	125	5.0	40	50	0.01	*40	18	
A 24	2N651	MO	pnp,AJ,ge	50-120	200	100	2.67	*45	500	10	–	5	TI
	2N651A	MO	pnp,AJ,ge	50-120	200	100	2.67	*45	500	10	–	5	TI
	2N1187	MO	pnp,AJ,ge	50-120	200	100	2.67	*60	500	10	2	5	TI
	2N654	MO	pnp,AJ,ge	50-125	200	100	2.67	*30	250	15	–	5	TI
	2N2706	MO	pnp,AJ,ge	50-150	200	100	2.66	*25	400	10	†3	5	†fab
	2N4296	RCA	npn,TDP,si	50-150	20,000	175	133	250	1000	100	*60	66	
	2N4299	RCA	npn,TDP,si	*50-150	20,000	175	133	350	1000	100	*60	66	
	2N4290	NA	pnp,DD,EP,si	*50-300	250	150	2.0	*30	200	0.5	*100	–	
	2N4354	FA	pnp,PE,si	*50-500	800	125	8.0	60	1000	0.05	*100	5	
	2N4355	FA	pnp,PE,si	*50-500	800	125	8.0	60	1000	0.05	*100	5	

Audio *(continued)*

Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	MAX. RATINGS					CHARACTERISTICS		Package Outline (TO-)	Remarks
					P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ *f_T (MHz)		
A 25	2N566	GI	pnp,AJ,ge	55	120	85	2.0	*30	300	5	1	5	IND, TI
	2N2717	GE	npn,PL,si	55	200	100	2.67	–	100	0.5	–	18	
	2N3394	GE	npn,PL,si	*55-110	200	100	2.67	25	100	0.1	–	98	Epoxy case, CDC, IEC
	2N169	GE	npn,GR,ge	*60	65	85	1.1	15	20	–	8		
	2N449	GE	npn,GR,ge	*60	65	85	1.1	15	20	–	8	–	
A 26	2N736A	TI	npn,si	60	500	175	3.33	60	100	0.5	–	18	TR, NA
	2N929	TI	npn,si	60	300	175	2	45	30	0.01	–	18	FA, GI, TR, AL, SPR, UC, MO, NA, SSD, IEC
	2N957	FA	npn,DD,si	*60	800	150	6.5	20	–	1.0	250	18	TRWS, AMP, IEC
	2N1097	GE	pnp,AJ,ge	*60	175	–	2.9	*16	200	16	–	5	TI
	2N1098	GE	pnp,AJ,ge	*60	175	–	2.9	*16	200	16	–	5	TI
	2N1121	GE	npn,GR,ge	*60	65	85	1.1	15	20	–	8	–	
	2N1376	TI	pnp,ge	60	250	100	3.3	*25	200	7	–	5	
	2N1377	TI	pnp,ge	60	250	100	3.3	*45	200	7	–	5	MO
	2N1414	GE	pnp,AJ,ge	*60	200	85	3.33	*35	200	12	–	5	TI
A 27	2N1566A	TI	npn,si	60	600	175	4	60	100	0.1	–	5	
	2N2387	TI	npn,si	60	300	175	2	45	30	0.01	–	50	
	2N2600A	SSD	pnp,EP	*60	400	200	2.28	100	30	0.025	80	46	
	2N3858	GE	npn,PEP,si	*60-120	200	100	2.67	30	100	0.5	–	98	
	2N3858A	GE	npn,PEP,si	*60-120	200	100	2.67	60	100	0.1	–	98	
	2N660	TI	pnp,AJ,ge	*60-150	250	100	6.66	12	1000	6	–	5	
	2N3721	GE	npn,PL,si	60-660	200	100	2.67	18	100	0.5	–	98	
	2N2430	AMP	npn,ge	*63	360	90	3.3	*32	30	–	–	1	NUC
	2N175	RCA	pnp,AJ,ge	65	20	71	–	*10	2	12	.85	40	
	2N220	RCA	pnp,AJ,ge	65	20	71	–	*10	2	12	0.85	1	
A 28	2N407	RCA	pnp,AJ,ge	*65	150	71	–	*20	70	14	–	40	
	2N408	RCA	pnp,AJ,ge	*65	150	71	–	*20	70	14	–	1	LAN
	2N649	RCA	pnp,AJ,ge	*65	100	71	–	25	50	14	–	1	LAN
	2N1924	GE	pnp,ge	*65	225	85	3.7	*60	500	10	–	5	TI, MO
	2N3062	CT	pnp,si	65	400	200	2.3	*90	100	.01	–	46	NA
	2N3063	CT	pnp,si	65	400	200	2.3	*90	100	.01	–	46	NA
	2N270	RCA	pnp,AJ,ge	*70	250	50	–	*25	75	10	1	7	
	2N281	AMP	pnp,AJ,ge	70	165	75	.3	*32	50	4.5	0.9	1	
	2N282	AMP	pnp,AJ,ge	70	165	75	.3	*32	50	4.5	0.9	1	Matched Pair 2N281's
	2N647	RCA	pnp,AJ,ge	*70	100	71	–	25	50	14	–	1	LAN
A 29	2N1592	TI	npn,si	70	125	87.5	2	10	25	1	–	–	TR
	2N1593	TI	npn,si	70	125	87.5	2	20	25	1	–	–	TR
	2N1594	TI	npn,si	70	125	87.5	2	40	25	1	–	–	TR
	2N2945A	TI	pnp,EP,si	*70	400	200	2.3	*25	100	0.002	*10	46	Chopper
	2N3128	NA	npn,PL,si	70	150	150	1.2	20	100	.002	–	–	
	2N1175A	MO	pnp,AJ,ge	*70-140	200	100	3.33	*35	200	12	–	5	TI
	2N1705	MO	pnp,AJ,ge	70-150	200	100	2.66	*18	400	10	†3	5	†fab, TI
	2N213	SY	npn,AL,ge	70-250	180	85	–	*40	100	50	0.1	22	
	2N1251	SY	npn,AL,ge	*70-250	180	85	–	*20	100	20	7.5	22	
	2N109	RCA	pnp,AJ,ge	*75	150	71	–	*25	70	7	1	40	LAN
A 30	2N217	RCA	pnp,AJ,ge	*75	150	71	–	*25	70	7	1	1	LAN
	2N412	RCA	pnp,AJ,ge	75	80	71	–	13	15	10	10	1	LAN
	2N1378	TI	pnp,ge	75	250	100	3.3	*12	200	7	–	5	
	2N1379	TI	pnp,ge	75	250	100	3.3	*25	200	7	–	5	
	2N1431	SY	npn,AL,ge	*75-150	180	85	–	*25	100	20	.01	22	
	2N1189	MO	pnp,AJ,ge	*75-175	200	100	2.67	*45	500	10	–	5	TI
	2N2712	GE	npn,PL,si	*75-225	200	100	2.67	18	100	0.5	–	98	NUC, IEC
	2N2714	GE	npn,PEP,si	*75-225	200	100	2.67	18	200	0.5	–	98	IEC
	2N3402	GE	npn,PE,si	*75-225	560	150	4.47	25	500	0.1	–	98	Epoxy case, heat clip
	2N3404	GE	npn,PE,si	*75-225	560	150	4.47	50	500	0.1	–	98	Epoxy case, heat clip
A 31	2N3414	GE	npn,PE,si	*75-225	360	150	2.67	25	500	0.1	–	98	Epoxy case, CDC, IEC
	2N3416	GE	npn,PE,si	*75-225	360	150	2.67	50	500	0.1	–	98	Epoxy case, CDC, IEC
	2N4297	RCA	npn,TDP,si	75-300	20,000	175	133	250	1000	100	*60	66	
	2N336A	GE	npn,DG,si	76-333	500	175	3.33	45	25	.5	–	5	TR, TI, NA
	2N760	NA	npn,DM,si	76-333	500	200	2.5	45	100	0.2	–	18	TR, GI, AL, TI, SSD
	2N760A	NA	npn,DM,si	76-333	500	200	2.5	60	100	0.1	–	18	TR, GI, AL, TI, SSD
	2N2676	GE	npn,DG,si	76-333	250	175	1.66	*60	25	.1	–	46	
	2N661	TI	pnp,AJ,ge	*80	250	100	6.66	12	100	6	–	5	
	2N736	TI	npn,si	80	500	175	3.33	60	50	1	–	18	TRWS, TR, NA, SSD
	2N740	TI	npn,si	80	500	175	3.33	80	50	1	–	18	TR, AL, SSD
A 32	2N1415	GE	pnp,AJ,ge	*80	200	85	3.33	*35	200	12	–	5	TI, MO
	2N1566	TI	npn,si	80	600	175	4	60	50	1	–	5	TRWS, TR, NA
	2N1574	TI	npn,si	80	600	175	4	80	50	1	–	5	TR
	2N3462	AMP	npn,si	*80	600	200	1.7	35	50	0.07	–	18	Low Noise
	2N3463	AMP	npn,si	*80	300	200	1.7	50	50	0.002	–	18	Low Noise
	2N3930	FA	pnp,PE,si	*80	1400	200	8.0	180	50	0.01	*40-160	18	
	2N3931	FA	pnp,PE,si	*80	1400	200	8.0	180	50	0.01	*40-160	18	
	2N4357	FA	pnp,PE,si	*80	1400	200	8.0	240	50	0.02	*40-160	18	
	2N4358	FA	pnp,PE,si	*80	1400	200	8.0	240	50	0.02	*40-60	18	
	2N543A	TR	npn,PL,si	80-200	200	175	1.2	50	25	.5	10	5	GE

Audio *(continued)*

					MAX. RATINGS					CHARACTERISTICS			
Cross Index Key	Type No.	Mfr.	Type	h_{fe} $*h_{FE}$	P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ $*f_T$ (MHz)	Package Outline (TO-)	Remarks
A 33	2N2245	NA	npn,DM,si	80-250	500	200	2.5	20	100	.01	–	18	Low Level
	2N2248	NA	npn,DM,si	80-250	500	200	2.5	45	100	.01	–	18	Low Level
	2N2251	NA	npn,DM,si	80-250	500	200	2.5	20	100	.01	–	18	Low Noise, CDC
	2N2254	NA	npn,DM,si	80-250	500	200	2.5	45	100	.01	–	18	Low Noise
	2N2715	GE	npn,PL,si	82	200	100	2.67	*18-18	100	0.5	–	18	GME, CDC
A 34	2N3060	CT	pnp,si	85	400	200	2.3	*70	100	.005	–	46	NA
	2N1144	GE	pnp,AJ,ge	*90	175	85	2.9	*16	200	16	–	–	
	2N1145	GE	pnp,AJ,ge	*90	175	85	2.9	*16	200	16	–	–	
	2N1925	GE	pnp,ge	*90	225	85	3.7	*60	500	10	–	5	TI, MO
	2N2431	AMP	pnp,ge	*90	1000	75	3.3	*32	1000	10	1.7	1	NUC
	2N3058	CT	pnp,si	90	400	200	2.3	6	100	.0001	–	46	
	2N2923	GE	npn,PL,si	90-180	200	100	2.67	25	100	0.5	–	98	IEC, GME, CDC, IEC
	2N3393	GE	npn,PL,si	*90-180	200	100	2.67	25	100	0.1	–	98	Epoxy case, GME, CDC, IEC
	2N3710	TI	npn,PE,si	*90-330	250	125	2.5	30	30	0.1	–	†	†Plastic, CDC
	2N4061	TI	pnp,EP,si	*90-330	250	125	2.5	30	30	0.1	–	92	
A 35	2N120	TI	npn,si	99	150	175	1	*45	25	2	–	–	TR
	2N336	TI	npn,si	99	150	175	1	*45	25	2	–	5	GE, TR, NA
	2N1153	TI	npn,si	99	150	175	1	*45	25	2	–	–	TR
	2N567	GI	pnp,AJ,ge	100	150	85	2.5	*30	300	5.0	1.5	–	
	2N568	GI	pnp,AJ,ge	100	120	85	2.0	*30	300	5.0	1.5	5	IND
	2N2944A	TI	pnp,EP,si	*100	400	200	2.3	*15	100	0.0001	*15	46	Chopper
	2N3130	NA	npn,PL,si	100	150	150	1.2	60	100	.002	–	–	
	2N3582	SSD	pnp,EP	*100	400	200	2.28	40	30	0.02	30	46	
	2N508A	MO	pnp,AJ,ge	*100-200	200	100	3.33	*30	200	7	–	5	TI, GE
	2N3794	NA	npn,DD,EP,si	*100-200	250	150	2.0	*40	500	0.5	*1.0	–	
A 36	2N3859	GE	npn,PEP,si	*100-200	200	100	2.67	30	100	0.5	–	98	CDC
	2N3859A	GE	npn,PEP,si	100-200	200	100	2.67	60	100	0.1	–	98	CDC
	2N652	MO	pnp,AJ,ge	100-225	200	100	2.67	*45	500	10	–	5	TI
	2N652A	MO	pnp,AJ,ge	100-225	200	100	2.67	*45	500	10	–	5	TI
	2N1188	MO	pnp,AJ,ge	100-225	200	100	2.67	*60	500	10	–	5	TI
	2N213A	SY	npn,AL,ge	100-250	180	85	–	*40	100	50	0.1	22	
	2N655	MO	pnp,AJ,ge	100-250	200	100	2.67	*30	250	15	–	5	TI
	2N1193	MO	pnp,AJ,ge	100-250	200	100	2.67	*40	200	15	–	5	TI
	2N4249	FA	pnp,PE,si	*100-250	500	125	5.0	60	50	0.01	*40	18	
	2N4250	FA	pnp,PE,si	*100-250	500	125	5.0	60	50	0.01	*40	18	
A 37	2N3838	TI	pnp/npn,EP,si	*100-300	350	175	2.34	40	600	0.01	*200	89	
	2N4028	FA	pnp,PE,si	*100-300	2000	200	11.4	60	1000	0.05	*150	18	
	2N4029	FA	pnp,PE,si	*100-300	2000	200	11.4	60	1000	0.05	*150	18	
	2N4032	FA	pnp,PE,si	100-300	800	200	22.8	60	–	.2	100	–	
	2N4033	FA	pnp,PE,si	100-300	800	200	22.8	80	–	.2	150	–	
	2N4291	NA	pnp,DD,EP,si	*100-300	250	150	2.0	*40	200	0.2	100	–	
	2N4854	TI	pnp,EP,si	*100-300	600	175	4	40	600	0.01	*200	5	Complementary (pnp/npn)
	2N3692	FA	npn,PL,si	*100-400	625	150	2	*35	50	.05	*200	–	RO97A package, CDC, IEC
	2N3707	TI	npn,PE,si	*100-400	250	125	2.5	30	30	0.1	–	†	†Plastic, CDC
	2N4058	TI	pnp,EP,si	*100-400	250	125	2.5	30	30	0.1	–	92	
A 38	2N2716	NUC	npn,PL,si	110	200	100	2.67	–	100	0.5	–	18	IEC, GME, CDC
	2N2171	MO	pnp,AJ,ge	120-310	500	100	6.7	*50	400	10	†7.5	5	†fab, TI
	2N1926	GE	pnp,ge	*121	85	3.7	*60	500	10	–	–	5	TI, MO
	2N1190	MO	pnp,AJ,ge	*125-300	200	100	2.67	*45	500	10	–	5	TI
	2N2903	AL	npn,DP,si	*125-625	600	200	3.5	*60	–	.010	–	5	Dual,SSD, MO
	2N2903A	AL	npn,DP,si	*125-625	600	200	3.5	*60	–	.010	–	5	Dual, SSD, MO
	2N2428	AMP	pnp,ge	130	500	75	0.3	32	100	–	1.7	1	
	2N2706	AMP	pnp,AJ,ge	*135	500	90	0.37	*32	200	–	2.5	1	
	2N2707	AMP	ge	*135	500	90	0.37	*32	200	–	2.5	1	Matched npn, pnp pair
	2N569	GI	pnp,AJ,ge	150	150	85	2.5	*30	300	5	2	–	
A 39	2N570	GI	pnp,AJ,ge	150	120	85	2.0	*30	300	5	2	5	IND, TI
	2N930	TI	npn,si	150	300	175	2	45	30	0.01	–	18	FA, GI, TR, NUC, SPR, UC, MO, AL, NA, SSD, IEC
	2N2388	TI	npn,si	150	300	175	2	45	30	0.01	–	50	
	2N2586	TI	npn,si	150	300	175	2	45	30	0.002	–	18	AMP, FA, AL, UC, NA, SSD
	2N3129	NA	npn,PL,si	150	150	150	1.2	45	100	.002	–	–	
	2N3241A	RCA	npn,DPE,si	*150	2000	175	20	25	–	0.1	*175	104	
	2N4074	RCA	npn,DPE,si	*150	2000	175	20	40	300	0.01	*80	104	
	2N2924	GE	npn,PL,si	150-300	200	100	2.67	25	100	0.5	–	98	IEC, GME, CDC, IEC
	2N3392	GE	npn,PL,si	*150-300	200	100	2.67	25	100	0.1	–	98	Epoxy case, GME, CDC
A 40	2N3860	GE	npn,PEP,si	*150-300	200	100	2.67	30	100	0.5	–	98	CDC
	2N4086	GE	npn,PL,si	*150-300	200	100	2.67	12	100	0.1	–	98	
	2N2246	NA	npn,DM,si	150-450	500	200	2.5	20	100	.01	–	18	Low Level
	2N2249	NA	npn,DM,si	150-450	500	200	2.5	45	100	.01	–	18	Low Level
	2N2252	NA	npn,DM,si	150-450	500	200	2.5	20	100	.01	–	18	Low Noise, CDC, AMP
	2N2255	NA	npn,DM,si	150-450	500	200	2.5	45	100	.01	–	18	Low Noise
	2N2453	AL	npn,DP,si	*150-600	600	200	114	*60	9	.005	–	5	Dual, TI, GE, SSD, MO
	2N2453A	AL	npn,DP,si	*150-600	600	200	1.14	*80	9	.005	–	5	Dual, GE, SSD, MO
	2N4286	NA	npn,DD,EP,si	*150-600	250	150	2.0	*30	100	0.05	*40	–	
	2N4287	NA	npn,DD,EP,si	*150-600	250	150	2.0	*45	100	0.01	*40	–	

Audio *(continued)*

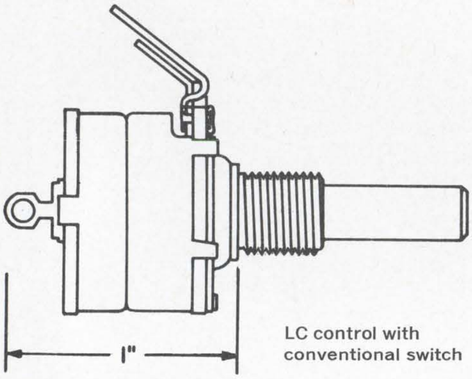
Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	MAX. RATINGS					CHARACTERISTICS		Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_c (mA)	I_{co} (μA)	$f_{\alpha e}$ *f_T (MHz)		
A 41	2N4288	NA	pnp,DD,EP,si	150-600	250	150	2.0	*30	100	0.05	*40	–	
	2N4289	NA	pnp,DD,EP,si	150-600	250	150	2.0	*60	100	0.01	*40	–	
	2N3061	CT	pnp,si	155	400	200	2.3	*70	100	.005	–	48	NA
	2N2613	RCA	pnp,AJ,ge	160	120	100	–	*30	50	5	10	1	
	2N3403	GE	npn,PE,si	*180-540	560	150	4.47	25	500	0.1	–	98	Epoxy case, heat clip
A 42	2N3405	GE	npn,PE,si	*180-540	560	150	4.47	50	500	0.1	–	98	Epoxy case, heat clip
	2N3415	GE	npn,PE,si	*180-540	360	150	2.67	25	500	0.1	–	98	Epoxy case
	2N3417	GE	npn,PE,si	*180-540	360	150	2.67	50	500	0.1	–	98	Epoxy case, heat clip
	2N4424	GE	npn,PE,si	*180-540	360	150	2.67	40	500	0.1	–	98	
	2N4425	GE	npn,PE,si	*180-540	560	150	4.47	40	500	0.1	–	98	
	2N3711	TI	npn,PE,si	*180-660	250	125	2.5	30	30	0.1	–	†	†Plastic, CDC
	2N4062	TI	pnp,EP,si	*180-660	250	125	2.5	30	30	0.1	–	92	
	2N1185	MO	pnp,AJ,ge	190-400	200	100	2.67	*45	500	10	–	5	TI
	2N1194	MO	pnp,AJ,ge	190-500	200	100	2.67	*40	200	15	–	5	TI
	2N1086	GE	npn,GR,ge	195	65	85	1.1	9	20	–	8	–	
A 43	2N1086A	GE	npn,GR,ge	195	65	85	1.1	9	20	–	8	–	
	2N1087	GE	npn,GR,ge	195	65	85	1.1	9	20	–	8	–	
	2N571	GI	pnp,AJ,ge	200	150	85	2.5	*30	300	5	3	–	TI
	2N572	GI	pnp,AJ,ge	200	120	85	2.0	*30	300	5	3	5	IND
	2N2614	RCA	pnp,AJ,ge	200	120	100	–	*40	50	5	10	1	
	2N3059	CT	pnp,si	200	400	200	2.3	6	100	.0001	–	46	
	2N3242A	RCA	npn,DPE,si	*200	2000	175	20	40	–	0.01	*175	104	
	2N3427	MO	pnp,AJ,ge	200-500	200	100	2.67	*45	500	3.0	6.0	6	TI
	2N2429	AMP	pnp,ge	220	500	75	3.3	32	100	–	2.3	1	
	2N2925	GE	npn,PL,si	235-470	200	100	2.67	25	100	0.5	–	98	IEC, GME
A 44	2N3900A	GE	npn,PL,si	250-500	200	100	2.67	18	100	0.1	–	98	5 dB(max nf)
	2N3391	GE	npn,PL,si	*250-500	200	100	2.67	25	100	0.1	–	98	Economy–Epoxy,NUC,IEC,GME
	2N3391A	GE	npn,PL,si	*250-500	200	100	2.67	25	100	0.1	–	98	5 dB(max nf), GME, IEC
	2N3900	GE	npn,PL,si	*250-500	200	100	2.67	18	100	0.1	–	98	
	2N2953	RCA	pnp,AJ,ge	350	120	100	–	*30	150	5	10	1	
	2N4017	FA	pnp,DPE,si	*350	600	200	3.4	*80	200	10	5.5	–	RO52A package, Dual pnp
	2N3428	MO	pnp,AJ,ge	350-800	200	100	2.67	*45	500	3.0	8.0	5	TI
	2N3078	AMP	npn,PL,si	360	0.360	200	2.06	*80	50	0.01	–	18	TR
	2N3390	GE	npn,PL,si	*400-800	200	100	2.67	25	100	0.1	–	98	Economy–Epoxy,NUC,IEC,GME, CDC, IEC
	2N4104	TI	npn,PL,si	*400-800	300	175	2	60	50	0.01	*90	18	
A 45	2N4018	FA	pnp,DPE,si	*500	600	200	3.4	*60	200	10	7.0	–	RO52A package, Dual pnp
	2N4019	FA	pnp,DPE,si	*500	600	200	3.4	*45	200	10	7.0	–	RO52A package, Dual pnp
	2N3077	AMP	npn,PL,si	600	360	200	2.06	*80	50	0.01	–	18	TR
	2N3395	GE	npn,PL,si	800	200	125	0.375	25	100	0.1	–	†	Economy–Epoxy,GME,IEC,CDC, IEC
	2N3396	GE	npn,PL,si	800	200	125	9.375	25	100	0.1	– .	†	Economy–Epoxy, GME, IEC, CDC
	2N3397	GE	npn,PL,si	800	200	125	0.375	25	100	0.1	–	†	Economy–Epoxy, GME, IEC, CDC
	2N3398	GE	npn,PL,si	1250	200	125	0.375	25	100	0.1	–	†	Economy–Epoxy, GME, IEC, CDC
A 46	2N2785	GE	npn,PL,si	2000	1800	200	10	40	500	10	–	5	SPR, MO
	2N997	TI	npn,si	*7000	500	175	3.33	40	300	0.01	–	18	(Darlington), FA,SPR,GE
	2N35	–	pnp,AS,ge	–	50	–	–	*25	–	–	–	–	SY, GI
	2N331	MO	pnp,AJ,ge	–	200	71	–	*30	–	16	–	5	GI, IND, IEC
	2N1392	GI	pnp,ge	–	50	–	0.8	*20	–	8.0	–	–	
	2N1393	GI	pnp,ge	–	50	–	0.8	*20	–	8.0	–	–	
	2N4020	FA	pnp,DPE,si	–	600	200	2.3	*45	200	10	160	–	RO52A package, Dual pnp
	2N4021	FA	pnp,DPE,si	–	600	200	2.3	*45	200	10	160	–	RO52A package, Dual pnp
	2N4022	FA	pnp,DPE,si	–	600	200	2.3	15	200	10	160	–	RO52A package, Dual pnp
	2N4023	FA	pnp,DPE,si	–	600	200	2.3	45	200	10	160	–	RO52A package, Dual pnp
A 47	2N4024	FA	pnp,DPE,si	–	600	200	2.3	45	200	10	160	–	RO52A package, Dual pnp
	2N4025	FA	pnp,DPE,si	–	600	200	2.3	45	200	10	160	–	RO52A package, Dual pnp
	3N74	TI	npn,PL,si	–	300	175	2	*50	20	0.01	*30	72	Double emitter chopper
	3N75	TI	npn,PL,si	–	300	0.75	2	*50	20	0.01	*30	72	Double emitter chopper
	3N76	TI	npn,PL,si	–	300	175	2	*50	20	0.01	*30	72	Double emitter chopper
	3N77	TI	npn,PL,si	–	300	175	2	*40	20	0.01	*30	72	Double emitter chopper
	3N78	TI	npn,PL,si	–	300	175	2	*40	20	0.01	*30	72	Double emitter chopper
	3N79	TI	npn,PL,si	–	300	175	2	*40	20	0.02	*30	72	Double emitter chopper
	3N108	TI	pnp,EP,si	–	300	200	1.71	*50	20	0.25	*12	72	Double emitter chopper
	3N109	TI	pnp,EP,si	–	300	200	1.71	*50	20	0.25	*12	72	Double emitter chopper
A 48	3N110	TI	pnp,EP,si	–	300	200	1.71	*50	20	0.5	*12	72	Double emitter chopper
	3N111	TI	pnp,EP,si	–	300	200	1.71	*50	20	0.5	*12	72	Double emitter chopper

DESIGNER'S

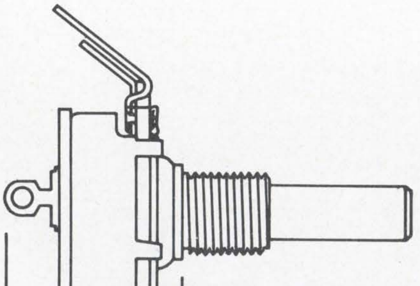
P. R. MALLORY & CO. INC., INDIANAPOLIS, INDIANA 46206

New space-saving switch now available on Mallory carbon controls

A new kind of rotary switch, with flat configuration, can now be supplied on Mallory carbon controls for applications where back of panel space is limited. From front face of the mounting bushing to tip of the terminals, the total back-of-panel depth of a Mallory LC single control with the new switch measures only 0.798″—compared with 1.00″ for the usual single LC control-switch combination.



LC control with conventional switch

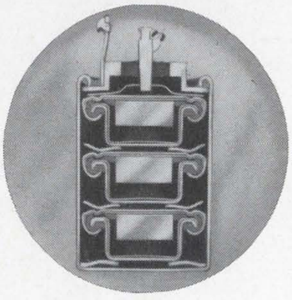


LC control with FAC switch

The new switch is rated 3 amperes at 125 VAC, and is presently available in the SPST design. It has UL approval. Price is slightly lower than that of the standard Mallory "O" ring switch. The FAC switch can be supplied on all standard Mallory LC series controls.

CIRCLE 106 ON READER SERVICE CARD

Reliability Report on Mallory Wet Slug Tantalum Capacitors



Cutaway view of 3-cell Type XT capacitor
U.S. Patent 3,275,902

Ever since we started making wet slug tantalum capacitors 17 years ago, we have been accumulating data on their reliability. At latest count, we had over 22 million piece-hours of testing for this product line on which to base evaluation of reliability.

The incidence of catastrophic failure has been exceptionally low. This quality is an inherent property of the wet slug construction, which provides a self-healing capability.

The data shown on the chart represents a summary of test programs to date on several Mallory wet slug types. We will be glad to supply detailed test records on specific capacitor models. And we welcome your personal inspection of our manufacturing, quality control and life test facilities.

CIRCLE 105 ON READER SERVICE CARD

SUMMARY OF RELIABILITY DATA
MALLORY WET SLUG TANTALUM CAPACITORS

Capacitor Type	Test Conditions Temp.	Volts	Total Unit test hrs.	Failures (catast.)	Failure rate: % per 1000 hrs.*	Mean time between failures: hours*
MTPH	85°C	Rated	6,214,300	1	0.032	3×10^6
TLS	85°C	Rated	832,750	0	0.11	0.9×10^6
	125°C	67% Rated	697,650	1	0.29	0.32×10^6
All XT	85°C	Rated	8,291,100	6	0.09	1.1×10^6
Series	175°C	67% Rated	7,361,200	7	0.11	0.9×10^6

*60% confidence level

Matched dual controls for stereo systems

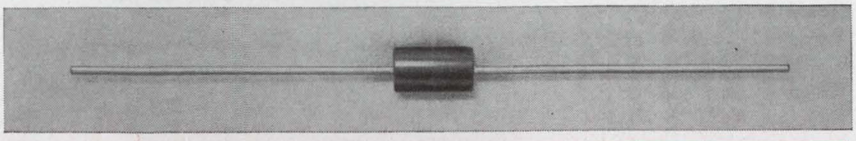
For the leading manufacturers of stereo equipment, we have been producing dual volume controls whose resistance tapers are closely matched throughout the audible range of the control. Single-knob control of both stereo channels simultaneously becomes practical, with perfect tracking of both amplifiers without need for adjustment of a clutch coupling the control sections.

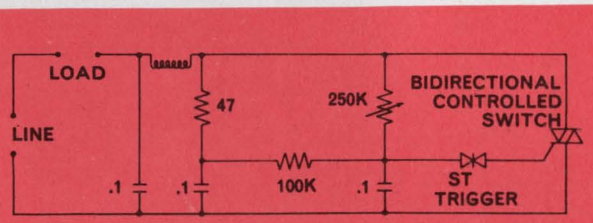
This simplification of stereo adjustment is made possible by the refined production control procedures which Mallory applies to the manufacture of carbon control elements. We were the first to make dual controls which tracked within 2 db, from 0 to —50 db, and are now producing matched controls in a variety of tapers for audio equipment—including the lower resistance values used in solid-state circuitry.

CIRCLE 107 ON READER SERVICE CARD

FILE MALLORY

Dual trigger diode generates voltage peaks for SCR circuits





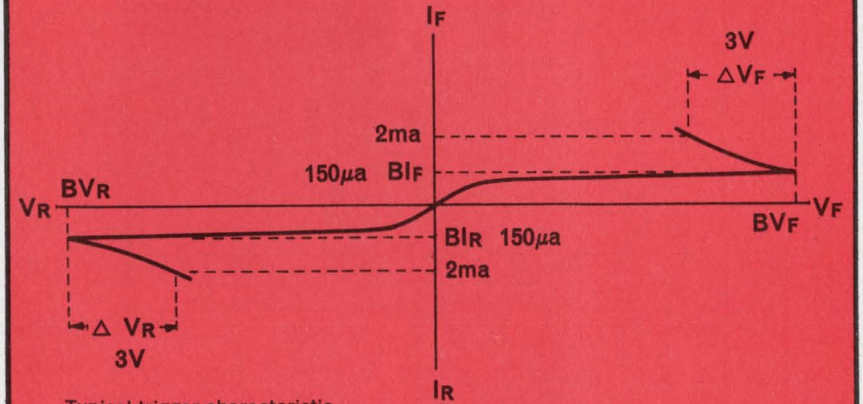
Typical light dimmer circuit using STD trigger

The Mallory STD dual trigger diode is a symmetrical three-layer avalanche diode which has many applications in activating SCR's and bi-switches. It's somewhat like two zener diodes connected back to back. When you apply AC to it, it allows current to pass only during that part of each half cycle when applied voltage exceeds its firing voltage. Thus it produces impulses, whose phase can be readily controlled, to switch the SCR on at different points in the cycle.

The STD has a symmetrical switching mode, as shown by the typical characteristic curve. At voltages beyond the breakover point, its resistance decreases rapidly; this "snap back" characteristic affords improved stability of control in the SCR circuit.

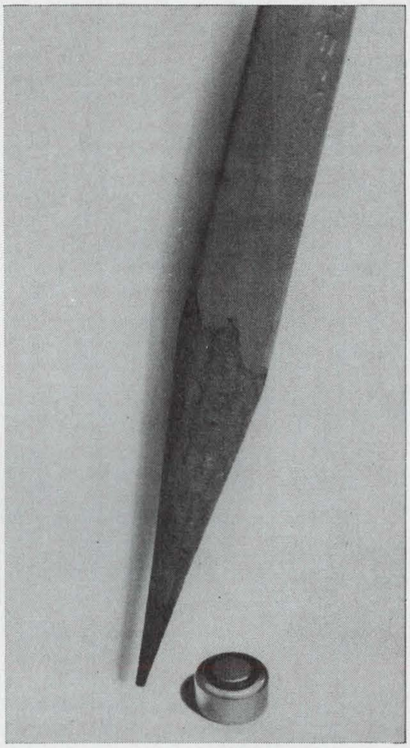
The STD comes in molded case only .375″ long by .200″ in diameter. It is rated 1 watt average at 50°C ambient. It can handle 1.0 ampere peaks of 20 microseconds duration on a 0.5% duty cycle. Standard breakover voltage ratings go from 24 to 120 volts, in standard tolerance of ±10%. Symmetry of breakover voltage is within 5%.

TYPICAL TRIGGER CHARACTERISTIC



Typical trigger characteristic

CIRCLE 108 ON READER SERVICE CARD



Miniature cells for Microcircuits

Circuits have shrunk and now so have batteries—but that doesn't mean that efficiency suffers in the least. The new Mallory mercury batteries in sizes to complement integrated circuits retain their extraordinary high energy density. Performance, if anything, is improved.

Miniature Mallory mercury cells are now available to power everything from hearing aids to ordnance devices. Capacities range from 16 MAH to 160 MAH, sizes from 0.225″ to 0.450″ diameter.

(See Table below.)

	RM-212	RM-312	RM-575	RM-675
CAPACITY MAH	16	36	100	160
RATED DRAIN MA	.75	2	3	5
DIA. (IN.)	.225	.305	.450	.450
HT. (IN.)	.130	.135	.130	.200
WT. (OZ.)	.01	.02	.05	.09

CIRCLE 109 ON READER SERVICE CARD

High-Frequency one MHz and above

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (μA)	C_{oe} *C_{ob} (pF)	Package Outline (TO-)	Remarks
HF 1	2N2709	RA	pnp,si	0.05	250	160	1.85	35	50	*10	1	*110	5	
	2N444	GI	npn,AJ,ge	1	100	85	1.67	*15	–	10	6	*16	5	TI, ETC
	2N444A	GI	npn,AJ,ge	1	150	100	2	*35	–	15	4	*14	5	TI, ETC
	2N3296	MO	npn,E,si	*1	6W	175	40	*60	700	*5-50	0.1	*20	–	Special ceramic stud-mount
	2N3297	MO	npn,E,si	*1	25W	175	167	*60	1.5A	*2.5-35	1.0	*60	3	
HF 2	2N94	SY	npn,AL,ge	2	150	100	–	*20	100	*10-80	30	9	22	ETC
	2N233	SY	npn,AL,ge	2	150	85	–	*10	100	10	–	7	22	ETC
	2N233A	SY	npn,AL,ge	2	150	85	–	*10	100	*10	–	7	22	ETC
	2N445	GI	npn,AJ,ge	2	100	85	1.67	*15	–	20	6	*16	5	TI, ETC
	2N445A	GI	npn,AJ,ge	2	150	100	2.0	*25	–	35	4	*14	5	TI
	2N515	SY	npn,AL,ge	2	150	85	–	*18	100	*10-50	50	8	22	
	2N516	SY	npn,AL,ge	2	150	85	–	*18	100	*15-75	50	8	22	
	2N3295	MO	npn,E,si	2	2W	175	13.3	*60	250	*20-60	0.1	*8	5	
	2N1391	GI	npn,AJ,ge	3	150	100	2	*25	–	*40-160	4	*20	5	TI
	2N2946	CT	pnp,PE,si	*3	400	200	2.4	*40	100	*30-150	0.0005	*10	46	SPR, NA, SSD
HF 3	2N212	SY	npn,AL,ge	4	150	85	–	*18	100	*10-30	30	7	22	
	2N517	SY	npn,AL,ge	4	150	85	–	*18	100	*20-100	50	8	22	
	2N1058	SY	npn,AL,ge	4	50	75	–	*18	50	*10-23	50	7	22	
	2N139	RCA	pnp,AJ,ge	4.7	80	70	–	*16	15	48	6	–	40	
	2N218	RCA	pnp,AJ,ge	4.7	80	70	–	*16	15	48	6	–	1	
	2N94A	SY	npn,AJ,ge	5	150	100	–	*20	100	*7-21	30	9	22	
	2N211	SY	npn,AL,ge	5	150	85	–	*18	100	*20-100	30	7	22	
	2N446	GI	npn,AJ,ge	5	100	85	1.67	*15	–	30	6.0	*16	5	TI
	2N446A	GI	npn,AJ,ge	5	150	100	2	*25	–	60	4.0	*14	5	TI
	2N1090	RCA	npn,AJ,ge	5	120	85	–	*25	400	*30	8	*25	5	GI, TI
HF 4	2N2945	SPR	pnp,PE,si	*5	400	200	2.4	*25	100	*40-250	0.0002	*10	46	NA, SSD
	2N2276	SPR	pnp,AT,si	*6	150	140	1.3	*15	50	*15	0.003	*6.0	*18	Matched Pair 2N2277
	2N2277	SPR	pnp,SP,si	*6	150	140	1.3	*15	50	*15	0.003	*6.0	18	Matched Pair 2N2276
	3N90	SPR	pnp,PE,si	*6	300	200	1.7	30	20	–	0.01	8	18	Duet, Voff < 50 μ V, CT, NA
	3N91	SPR	pnp,PE,si	*6	300	200	1.7	30	20	–	0.01	8	18	Duet, Voff < 100 μ V, CT, NA
	3N92	SPR	pnp,PE,si	6	300	200	1.7	30	20	–	0.01	8	18	Duet, Voff < 200 μ V, CT, NA
	3N93	SPR	pnp,PE,si	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff < 50 μ V, CT, NA
	3N94	SPR	pnp,PE,SI	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff < 100 μ V, CT, NA
	3N95	SPR	pnp,PE,si	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff < 200 μ V, CT, NA
	3N112	SPR	pnp,PE,si	*6	200	200	1.1	*50	20	1.5	.010	*10	90	Dual, CT
HF 5	3N113	SPR	pnp,PE,si	*6	200	200	1.1	*50	20	1.5	.010	*10	90	Dual, CT
	2N409	RCA	pnp,AJ,ge	6.7	80	71	–	*13	15	48	10	–	40	
	2N410	RCA	pnp,AJ,ge	6.7	80	71	–	*13	15	48	10	–	2	LAN
	2N2378	SPR	pnp,SAT,si	*7.2	150	140	1.3	*10	50	*25	0.001	*6	18	
	2N3318	SPR	pnp,SPAT,si	*7.6	150	140	1.3	15	50	–	0.001	*9	18	Chopper, CT
	2N471A	TR	npn,PL,si	8	200	175	1.2	30	25	10-25	.5	*8	5	
	2N472A	TR	npn,PL,si	8	200	175	1.2	45	25	10-25	.5	*8	5	
	2N473	TR	npn,PL,si	8	200	175	1.2	15	25	20-50	.5	*8	5	
	2N474	TR	npn,PL,si	8	200	175	1.2	30	25	20-50	.5	*8	5	
	2N474A	TR	npn,PL,si	8	200	175	1.2	30	25	20-50	.5	*8	5	
HF 6	2N475	TR	npn,PL,si	8	200	175	1.2	45	25	20-50	.5	*8	5	
	2N475A	TR	npn,PL,si	8	200	175	1.2	45	25	20-50	.5	*8	5	
	2N495	SPR	pnp,SPAT,si	*8	150	140	1.3	25	50	15-30	0.1	*12	1	
	2N581	GI	pnp,AJ,ge	8	150	85	–	*18	100	30	3	–	5	TI, LAN, IND
	2N1054	TR	npn,PL,si	8	600	175	23	*125	750	*20	5	*120	5	SSP
	2N1118	*SPR	pnp,SAT,si	8	150	140	1.3	25	50	35	0.001	*6	5	*PH orig Reg, CT
	2N1118A	*SPR	pnp,SAT,si	8	150	140	1.3	25	50	25	0.001	*6	5	*PH orig Reg, CT
	2N2377	SPR	pnp,SAT,si	*8	150	140	1.3	*25	50	30	0.002	*6	18	
	2N78A	IEC	npn,PE,si	9.00	360	150	0.91	0.3	50	30-300	0.1	3.0	18	
	2N167A	IEC	npn,PE,si	9.00	360	150	0.91	0.3	50	30-300	0.1	3.0	18	
HF 7	2N447	GI	npn,AJ,ge	9	100	85	1.67	*15	–	50	6	*16	5	TI
	2N447A	GI	npn,AJ,ge	9	15	100	2	*25	–	85	4	*14	5	TI
	2N447B	GI	npn,AJ,ge	9	150	100	2	*25	–	150	4	*14	5	TI
	2N1173	IEC	npn,PE,si	9.00	360	150	0.91	0.3	50	30-300	0.1	3.0	18	
	2N140	RCA	pnp,AJ,ge	10	80	70	–	*16	15	75	6	–	40	
	2N219	RCA	pnp,AJ,ge	10	80	70	–	*16	15	75	6	–	1	
	2N411	RCA	pnp,AJ,ge	10	80	71	–	*13	15	75	10	–	40	
	2N541	TR	npn,PL,si	10	200	175	1.2	15	25	80-200	.5	*20	5	GE, NA
	2N542	TR	npn,PL,si	10	200	175	1.2	30	25	80-200	.5	*20	5	GE, NA
	2N542A	TR	npn,PL,si	10	200	175	1.2	30	25	80-200	.5	*8	5	GE
HF 8	2N543	TR	npn,PL,si	10	200	175	1.2	50	25	80-200	.5	*20	5	GE, NA
	2N602	GI	pnp,DR,ge	*10	120	85	2.0	*30	–	*20-80	8	*7	5	
	2N1206	TR	npn,PL,si	10	3000	175	25	60	150	*20-80	1	50	5	
	2N1207	TR	npn,PL,si	10	3000	175	25	125	150	*20-80	1	*50	5	
	2N1907	TI	pnp,ge	*10	6000	100	2000	*100	20	*20	500	–	3	
	2N1908	TI	pnp,ge	*10	60,000	100	2000	*130	20	*20	500	–	3	
	2N1974	FA	npn,DP,si	*10	3W	200	17.2	60	–	70	0.005	*13	5	TRWS, CDC, TR, AMP
	2N2944	CT	pnp,PE,si	*10	400	200	2.4	*15	100	*80-450	0.0001	*10	46	SPR, NA, SSD
	2N3317	SPR	pnp,SPAT,si	*10	150	140	1.3	30	50	–	0.001	*9	18	Chopper, CT
	2N3319	SPR	pnp,SP,si	*10	150	140	1.3	30	50	–	0.001	*9	18	Chopper, CT

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 9	2N476	TR	npn,PL,si	12	200	175	1.2	15	25	30-60	.5	*10	5	
	2N477	TR	npn,PL,si	12	200	175	1.2	30	25	30-60	.5	*10	5	
	3N114	SPR	pnp,PE,si	*12	300	200	1.7	*30	20	3	.010	*10	8	Dual, CT, NA
	3N115	SPR	pnp,PE,si	*12	300	200	1.7	*30	20	3	.010	*10	18	Dual, CT, NA
	3N116	SPR	pnp,PE,si	*12	300	200	1.7	*30	20	3	.010	*10	18	Dual, CT, NA
HF 10	3N117	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	18	Dual, CT,NA
	3N118	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	13	Dual, CT, NA
	3N119	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	18	Dual, CT, NA
	2N582		pnp,AJ,ge	18	150	85	–	*25	100	60	2	–	5	GI, TI, RCA, LAN, IND
	2N1429		pnp,SAT,si	18	100	140	0.86	6	50	45	0.001	*7	5	SPR, CT
	2N478	TR	npn,PL,si	20	200	175	1.2	15	25	40-100	.5	*8	5	GE
	2N479	TR	npn,PL,si	20	200	175	1.2	30	25	40-100	.5	*8	5	GE
	2N479A	TR	npn,PL,si	20	200	175	1.2	30	25	40-100	.5	*8	5	GE
	2N480	TR	npn,PL,si	20	200	175	1.2	45	25	40-100	.5	*8	5	GE, CDC, NA
	2N496	*SPR	pnp,SPAT,si	*20	150	140	1.3	10	50	*25	0.1	*12	1	* PH orig. Reg.
HF 11	2N1065	GI	pnp,DR,ge	*20	120	85	2.0	*40	–	*20-80	8	*7	5	
	2N2432	TI	npn,PE,si	*20	300	175	2	30	100	50	0.01	*12	18	NA
	2N4138	TI	npn,PE,si	*20	300	175	2	30	100	50	0.01	*12	46	
	2N1411	SPR	pnp,MA,ge	*25	25	85	–	*5	50	*75	0.3	*3	24	PH, GI
	2N274	RCA	pnp,DR,ge	30	120	100	1.6	–	–10	60	4	*2	44	Vcev = –40
	2N344	*SPR	pnp,SBT,ge	30	20	55	1.33	*5	5	22	0.7	*3	24	*PH orig Reg
	2N345	*SPR	pnp,SBT,ge	30	20	55	1.33	*5	5	35	0.7	*3	24	*PH orig Reg
	2N603	GI	pnp,DR,ge	*30	120	85	2	*30	–	*30-100	8	*5	5	TI
	2N754	TR	npn,PLE,si	30	300	175	3	*60	50	*15	1	*10	18	
	2N755	TR	npn,PLE,si	30	300	175	3	*100	50	*15	1	*10	18	
HF 12	2N840	TR	npn,PLE,si	30	300	175	3	45	50	*30-100	1	*15	18	CDC
	2N842	TR	npn,PLE,si	30	300	175	2	45	50	*20-55	1	10	18	
	2N1224	RCA	pnp,DR,ge	30	120	85	–	*40	–	60	12	–	33	AMP
	2N1226	RCA	pnp,DR,ge	30	120	85	–	*60	–	60	12	–	33	AMP
	2N1395	RCA	pnp,DR,ge	30	120	100	–	*40	10	90	4	*2	33	SY, AMP
	2N1983	FA	npn,DD,si	*30	2000	150	16	25	–	100	1	*35	5	TRWS, CDC, AL
	2N1984	FA	npn,DD,si	*30	2000	150	16	25	–	80	1	*35	5	TRWS, CDC, AL
	2N1985	FA	npn,DP,si	*30	2000	150	0.016	25	–	60	1	*35	5	TRWS, CDC, AL
	2N2225	KSC	pnp,ge	30	200	100	–	*15	400	*60	25	*14	5	
	2N3742	MO	npn,AE,si	*30	5000	200	28.6	300	50	*20-200	0.2	*6	5	
HF 13	2N3743	MO	pnp,AE,si	*30	5000	200	28.6	300	50	*25-250	0.3	*15	5	
	2N1524	RCA	pnp,DR,ge	33	80	71	–	*24	10	60	16	–	1	
	2N1526	RCA	pnp,DR,ge	33	80	71	–	*24	10	130	16	–	1	
	2N1417	TR	npn,si	*34	150	150	1.25	15	–	60	0.05	*1.5	5	GE
	2N1418	TR	npn,si	*34	150	150	1.25	30	–	60	0.05	*1.5	5	GE
	2N794	RCA	pnp,ge	*35	150	85	–	*13	100	*50	13	*12	18	SPR
	2N795	RCA	pnp,ge	*35	150	85	–	*13	100	*75	13	12	18	SPR, TI
	2N393	* SPR	pnp,MA,ge	40	25	100	0.63	*6	50	155	1.5	*3.5	24	*PH orig Reg, GI
	2N841	TR	npn,PE,si	40	300	175	3	45	50	*60-400	1	*15	18	TRWS, CDC
	2N843	TR	npn,PE,si	40	300	175	2	45	50	*45-150	1	*10	18	
HF 14	2N1122	*SPR	pnp,MA,ge	*40	25	85	0.63	*12	50	35	5	6	24	*PH orig Reg
	2N1122A	*SPR	pnp,MA,ge	*40	25	85	0.63	*15	50	35	5	6	24	*PH orig Reg
	2N1300	SPR	pnp,ge	*40	150	85	–	*13	100	30	3	–	5	
	2N1409	RA	npn,si	*40	550	150	4.5	*30	500	*30	10	35	5	GI
	2N1410	RA	npn,si	*40	550	150	4.5	*30	500	*30	10	35	5	GI
	2N1638	RCA	pnp,DR,ge	40	80	85	–	*34	10	–	–	–	1	LAN
	2N3565	FA	npn,PL,si	*40	500	125	5.0	25	–	*150-600	0.05	*40	–	CDC, IEC, PH
	2N3566	FA	npn,PL,si	*40	800	125	8.0	30	–	*400	0.05	25	–	CDC, IEC, PH
	2N3712	TI	npn,PL,si	*40	800	175	5.33	150	200	*30-150	0.1	9	5	Metal header, MO
	2N128	*SPR	pnp,SBT,ge	45	25	85	0.82	*10	5	40	0.6	*2.5	24	*PH orig Reg
HF 15	2N1631	RCA	pnp,DR,ge	45	80	85	–	*34	10	80	16	–	40	
	2N1632	RCA	pnp,DR,ge	45	80	85	–	*34	10	80	16	–	1	
	2N1637	RCA	pnp,DR,ge	45	80	85	–	*34	10	48	–	–	1	
	2N1639	RCA	pnp,DR,ge	45	80	85	–	*34	10	–	–	–	1	
	2N2509	AL	DP	45	1.2W	200	6.9	80	–	40	.005	*6	18	GI, TR, AMP, UC, NA
	2N2510	AL	DP	45	1.2W	200	6.9	65	–	150	.005	*6	18	GI, TR, AMP, UC, NA
	2N2511	AL	DP	45	1.2W	200	6.9	50	–	240	.005	*6	18	GI, TR, AMP, UC, NA
	2N2605A	SSD	pnp,PL	*45	400	200	2.28	45	30	150	0.002	*6	46	
	2N504	*SPR	pnp,MD,ge	50	30	85	0.75	*35	50	16	10	*2.5	1	*PH orig Reg, GI
	2N604	GI	pnp,DR,ge	*50	120	85	2	*30	–	*40-140	8	*5	5	TI
HF 16	2N605	GI	pnp,DR,ge	*50	120	85	2	*15	–	40	10	*7	5	
	2N606	GI	pnp,DR,ge	*50	120	85	2	*15	–	60	10	*7	5	
	2N607	GI	pnp,DR,ge	*50	120	85	2	*15	–	80	10	*7	5	
	2N796	SPR	pnp,ge	*50	150	85	–	*13	100	*85	13	*12	18	TI
	2N844	TR	npn,PLE,si	50	300	175	3	*60	50	*40-120	1	*10	18	
	2N845	TR	npn,PLE,si	50	300	175	3	*100	50	*40-120	1	10	18	
	2N1409	TRWS	npn,PL,si	*50	600	175	4	*30	500	*15-45	10	35	5	GI
	2N1410	TRWS	npn,PL,si	*50	600	175	4	*45	500	*30-90	10	24	5	GI
	2N1427	*SPR	pnp,MA,ge	*50	25	85	–	*6	50	120	0.5	*3.5	24	*PH orig Reg, GI
	2N1683	SPR	pnp,ge	*50	150	85	–	12	100	*50	3	*12	5	

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (μA)	C_{oe} *C_{ob} (pF)	Package Outline (TO-)	Remarks
HF 17	2N1752	*SPR	pnp,MD,ge	50	60	100	0.8	*12	50	250	0.8	*1.0	9	*PH orig Reg
	2N1785	*SPR	pnp,MD,ge	50	45	85	0.75	*10	50	150	2	*1.5	9	*PH orig Reg
	2N1786	*SPR	pnp,MD,ge	50	45	85	0.75	*10	50	250	2	*1.7	9	*PH orig Reg
	2N1787	*SPR	pnp,MD,ge	50	45	85	0.75	*15	50	120	1.5	*1.5	9	*PH orig Reg
	2N1864	*SPR	pnp,MD,ge	50	60	100	0.8	*20	50	60	1.5	*1.6	9	*PH orig Reg
HF 18	2N1893	FA	npn,si	50	3	200	0.017	80	0.5	*40-120	0.01	*15	5	RCA, TR, NA, TRWS, TI, CDC. MO
	2N1978	FA	npn,DP,si	*50	3000	200	172	*60	–	*30	1	*70	–	
	2N1986	FA	npn,DD,si	*50	2000	150	16	25	–	150	1	*25	5	TRWS, CDC, GI, AL, AMP
	2N1987	FA	npn,DD,si	*50	2000	150	16	25	–	50	1	*25	5	TRWS, CDC, GI, AL, AMP
	2N1988	FA	npn,DD,si	*50	2000	150	16	45	–	*75	1	*17	5	TRWS, CDC, GI, AL
	2N1989	FA	npn,DD,si	*50	2W	150	16	45	–	*40	1	*17	5	TRWS, CDC, GI, AL
	2N2427	TR	npn,PE,si	50	500	175	2.86	40	50	40	.5	*8	18	
	2N1900	TRWS	npn,PL,si	*>50	125000	150	1000	*140	10000	5.0	10000	*1000	38	Single Ended
	2N1903	TRWS	npn,PL,si	*>50	125000	150	1000	*140	10000	5.0	10000	*1000	39	Double Ended
	2N2223	MO	npn,AE,si	*50	3000	200	17.2	60	500	*25-150	.01	*15	77	Diff. Amp. TI, AL, GE
HF 19	2N2223A	MO	npn,AE,si	*50	3000	200	17.2	60	500	*25-150	.01	*15	77	Diff. Amp. TI, AL, GE
	2N346	*SPR	pnp,SBT,ge	60	20	55	1.33	*5	5	35	0.7	*3	24	*PH orig Reg
	2N370	RCA	pnp,DR,ge	60	80	71	–	*24	10	100	10	–	7	
	2N698	FA	npn,DP,si	*60	3.0W	200	17.2	60	–	*40	0.0005	*13	5	TRWS, TR, STC, AMP, CDC
	2N717	FA	npn,DD,si	*60	1.5W	175	10	*60	–	*40	0.01	*17	18	TRWS, CDC, TR, GI, AMP, NA, TI, IEC
	2N719	FA	npn,DD,si	*60	1.5W	175	10	*120	–	*40	0.01	*12	18	TRWS, CDC, TR, GI, AMP, TI
	2N719A	FA	npn,DP,si	*60	1.8W	200	10.3	*120	–	*40	0.005	*12	18	TRWS, CDC, AMP, AL, GI, TR, TI
	2N720A	FA	npn,DP,si	*60	1.8W	200	10.3	*120	–	*80	0.005	*12	18	TRWS, CDC, GI, AMP, AL TR, RCA, TI
HF 20	2N912	FA	npn,DP,si	*60	1800	200	10.3	60	–	45	0.005	*13	18	TRWS, CDC, AMP, AL, TI
	2N1301	SPR	pnp,ge	*60	150	85	–	*13	100	30	3	–	5	
	2N1972	FA	npn,DD,si	*60	2.0	175	10	*60	–	*250	0.1	*25	5	TR, AMP, TRWS, CDC
	2N1975	FA	npn,DP,si	*60	3W	200	17.2	60	–	45	0.005	*13	5	TRWS, CDC, AL, TR, AMP
	2N2060	MO	npn,AE,si	*60	3000	200	17.2	60	500	*40-120	.002	*15	77	Diff. Amp. TI, AL, GE
	2N2060A	MO	npn,AE,si	*60	3000	200	17.2	60	500	*40-120	.002	*15	77	Diff. Amp. AL
	2N2484	IEC	npn,PE,si	60	360	150	0.49	50	25	100	25	3.0	18	
	2N2595	SSD	pnp,PL	*60	400	200	2.3	60	50	*15	.025	*6	46	
	2N2598	SSD	pnp,PL	*60	400	200	2.3	80	50	*15	.025	*6	46	
	2N2601	SSD	pnp,PL	*60	400	200	2.3	60	50	*12.5	.025	*6	46	AL
HF 21	2N2980	FA	npn,DP,si	*60	750	200	4.3	60	500	*100	0.0001	*8	18	GI
	2N2981	FA	npn,DP,si	*60	750	200	4.3	60	500	*100	0.0001	*8	18	GI, IEC
	2N3567	FA	npn,PE,si	*60	800	125	8.0	40	–	*80	0.05	*20	–	TEC, CDC, PH, IEC
	2N3568	FA	npn,PE,si	*60	800	125	8.0	60	–	*80	0.05	*20	–	CDC, IEC
	2N3569	FA	npn,PE,si	*60	800	125	8.0	40	–	*150	0/05	*18	–	IEC, CDC, PH
	2N2483	FA	npn,DP,si	*69	1.2W	200	6.9	60	50	*280	0.0001	*3.5	18	AMP, GI, TR, AL, UC, NA, SSD
	2N911	FA	npn,DP,si	*70	1800	200	10.3	60	–	70	0.005	*13	18	TRWS, CDC, AMP, AL, TI
	2N1335	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*8	5	
	2N1336	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*10	5	
	2N1337	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*8	5	
HF 22	2N1338	TRWS	npn,PL,si	*70	800	175	5.3	*80	300	*10-150	1	*10	5	
	2N1339	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*8	5	
	2N1340	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*8	5	
	2N1341	TRWS	npn,PL,si	*70	800	175	5.3	*120	300	*10-150	1	*8	5	
	2N1342	TRWS	npn,PL,si	*70	800	175	5.3	*150	300	*12	10	*8	5	
	2N1505	TRWS	npn,PL,si	*>70	3W	175	20	*50	500	1.0	50	*10	5	NUC, NA
	2N2092	AMP	pnp,PADT,ge	*70	83	85	0.6	*25	10	150	–	–	7	
	2N2093	AMP	pnp,PADT,ge	*70	83	85	1.7	*25	10	150	–	–	7	
	2N2914	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*450	0.001	*5	5	SPR, GI, AL, UC, MO, TI, AMP. GE, SSD, NA
HF 23	2N2915	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*240	0.001	*5	5	GI, AL, UC, MO, SPR, TI, AMP. GE, SSD, NA
	2N2916	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*450	0.001	*5	5	SPR, GI, AL, UC, MO, TI, AMP. GE, SSD, NA
	2N2917	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*240	0.001	*5	5	SPR, GI, UC, AL, MO, TI, AMP. GE, NA, SSD
	2N2918	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*450	0.001	*5	5	SPR, GI, UC, AL, MO,. TI, AMP. NA, GE, SSD
	2N2919	FA	npn,DP,si	*70	1.5W	200	3.42	60	30	*240	0.001	*5	5	SPR, GI, AL, UC, MO, TI, AMP. GE, SSD, NA
HF 24	2N2920	FA	npn,DP,si	*70	1.5W	200	3.42	60	30	*450	0.001	*5	5	SPR, GI, AL, UC, MO, TI, AMP GE, SSD, NA
	2N2972	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	*5	18	GI, AL, UC, MO, SPR, NA. SSD
	2N2973	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR, NA, SSD
	2N2974	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	*5	–	GI, AL, UC, MO, SPR, VEC, NA. SSD
	2N2975	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	5	18	GI, AL, UC, MO, SPR, VEC. NA. SSD
	2N2976	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	5	18	GI, AL, UC, MO, SPR, NA,SSD
	2N2976	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	5	18	GI, AL, UC, MO, SPR, NA, SSD

4 NEW MINIATURE HIGH POWER DIODES

Which of these new Unitrode developments is going to help you build a smaller, lighter, more reliable circuit this year?

RADIATION-RESISTANT HIGH CURRENT RECTIFIERS


Actual Size

- **2 Amp Continuous Rating**
- **25 Amp Surge Rating**
- **PIV's to 250 Volts**

These high current, controlled avalanche diodes are capable of withstanding substantial dosages of various types of radiation with negligible change in specified parameters. They may be operated at their full 2 Amp rating after withstanding a cumulative neutron dose in excess of 10^{16} N.V.T. Both gamma and electron radiation have negligible effect.

CIRCLE 131 ON INQUIRY CARD

HIGH POWER THYRISTOR DIODES


Actual Size

- **1.5 Amp Continuous Rating**
- **Firing Voltages to 300 Volts**
- **High Surge Ratings**

Four-layer diodes have been available for some years, but this is the first miniature high power and high voltage controlled avalanche version to be offered. Firing voltages are available from 40 to 300 volts. Continuous current is 1.5 amp and short duration surges as high as 500 amps can be withstood, with an 8.3 msec surge rating of 15 amps.

CIRCLE 132 ON INQUIRY CARD

ULTRA-FAST RECOVERY RECTIFIER


Actual Size

- **Typical Recovery under 50 Nanoseconds**
- **25 Amp Surge Rating**
- **PIV's to 250 Volts**

These ultra-fast recovery, controlled avalanche rectifiers can operate at frequencies of 100 KC square wave, or 350 KC sine wave. These 2 amp rated devices have typical recovery times of 50 nanoseconds; they can withstand surges up to 25 amps, and have leakages under 1 microamp at 25°C.

CIRCLE 133 ON INQUIRY CARD

9 AMP FAST-RECOVERY RECTIFIER (Stud Mount)


Actual Size

- **Controlled Avalanche**
- **150 Amp Surge Rating**
- **40 KC Square Wave Operation**

Recovery times as low as 250 nanoseconds permit full power operation at frequencies as high as 40 KC square wave, or even higher frequencies sine wave. These miniature stud mount rectifiers provide a 9 amp continuous and 150 amp surge rating in a package that, at less than 1.5 grams, is only one-fifth the weight and one-quarter the volume of conventional types.

THE SAME PACKAGE IS ALSO AVAILABLE IN REGULAR RECOVERY WITH A 12 AMP RATING

CIRCLE 134 ON INQUIRY CARD

THE UNIQUE UNITRODE CONSTRUCTION

The silicon wafer is metallurgically bonded between two terminal pins of the same thermal coefficient as the silicon. A sleeve of hard glass is then fused to the pins and all the exposed silicon surface, resulting in a voidless, monolithic, whiskerless structure.

NEW 32 PAGE DIODE CATALOG

SEND FOR YOURS TODAY!

- Technical Specifications
- Mounting Data
- Applications Information
- Physical Drawings
- Derating Information
- Multiple Surge Ratings

UNITRODE®

580 PLEASANT STREET, WATERTOWN, MASS. 02172
TELEPHONE (617) 926-0404 TWX (710) 327-1296

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 25	2N2977	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR, NA, SSD
	2N2978	FA	npn,DP,si	*70	750	200	1.71	60	30	*240	0.001	5	18	GI, AL, UC, MO, SPR, VEC, NA. SSD
	2N2979	FA	npn,DP,si	*70	750	200	1.71	60	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR, VEC, NA, SSD
HF 26	2N2982	FA	npn,DP,si	*70	750	200	4.3	60	500	*100	0.0001	*8	18	GI
	2N3056	RA	npn,PL,EP	*70	400	300	2.3	60	1000	*40	.010	*12	46	
	2N3019	RA	npn,PL,EP	*70	800	300	4.6	80	1000	*100	.010	*12	5	MO, TRWS, NA
	2N3020	RA	npn,PL,EP	*70	800	300	4.6	80	1000	*40	.010	*12	5	MO, TRWS
	2N3057	RA	npn,PL,EP	*70	400	300	2.3	60	1000	*100	.010	*12	46	
	2N3075	AMP	pnp,PADT,GE	70	140	90	3.1	30	20	27	10	3	12	
	2N990	AMP	pnp,PADT,ge	75	67	75	1.33	*32	10	150	–	–	18	4 Lead
	2N993	AMP	pnp,PADT,ge	*75	67	75	1.7	*32	10	150	–	–	18	4 Lead
	2N2089	AMP	pnp,PADT,ge	75	100	85	0.6	*32	10	150	–	–	7	
	2N2590	SSD	pnp,PL	*75	400	200	2.3	60	50	*20	.025	*6	46	
HF 27	2N2671	AMP	pnp,AD,ge	75	100	75	0.6	*32	10	150	8	2.5	12	
	2N2672	AMP	pnp,AD,ge	75	100	85	0.6	*32	10	150	8	2.5	39	Veb=1 Volt
	2N696	FA	npn,DD,si	*80	2.0W	175	13.3	*60	–	*40	0.01	*20	5	TRWS, TR, GI, AMP, CDC, NA, TI, ITT,IEC
	2N699	FA	npn,DD,si	*80	2.0W	175	13.3	*120	–	*80	0.01	12	5	TRWS, SY, TR, GI, AMP, CDC, NA, RCA, TI
	2N718	FA	npn,DD,si	*80	1.5W	175	10	*60	–	*75	0.01	*17	18	TRWS, CDC, SY, TR, GI, AMP, AL, NA, MO, ITT, IEC
	2N718A	FA	npn,DP,si	*80	1.8W	200	10.3	*75	–	*80	0.003	*18	18	CDC, MO, TR, GI, AMP, AL, NA, RCA, TRWS, TI
HF 28	2N720	FA	pnp,DD,si	*80	1.5W	175	10	*120	–	*80	0.01	12	18	TRWS, CDC, TR, GI, AMP, AL, TI
	2N870	FA	npn,DP,si	*80	1.8W	200	10.3	60	–	*75	0.004	*13	18	TRWS, CDC, GI, AMP, AL, IEC
	2N910	FA	npn,DP,si	*80	1800	200	10.3	60	–	140	0.005	*13	18	TRWS, CDC, AMP, AL, TI, NA
	2N1252	FA	npn,DD,si	*80	2.0W	175	13.3	*30	–	*35	0.1	*30	5	AL, NA, GI
	2N1613	FA	npn,DP,si	*80	3W	200	17.2	*75	–	*80	0.003	*18	5	TRWS, CDC, MO, TR, GI, AMP, AL, RCA, IEC, TI
	2N1748	*SPR	pnp,MD,ge	*80	60	100	0.8	*25	50	45	1.5	*1.3	9	*PH orig Reg
	2N1749	*SPR	pnp,MD,ge	*80	75	100	1.0	*40	10	45	1.5	*1.3	9	*PH orig Reg
	2N1973	FA	npn,DP,si	*80	3W	200	4.56	60	–	140	0.005	*13	5	TRWS, CDC, AL, TR
HF 29	2N2451	SPR	pnp,MAT,ge	*80	25	85	4.54	*6	50	40	5	6	24	
	2N2645	IEC	npn,PE,si	80	500	150	0.35	75	–	100	0.01	25	18	
	2N2720	SSD	npn,PL	*80	600	200	3.4	60	50	*35	.010	–	5	Differential amp, AL, SPR, MO
	2N2721	SSD	npn,PL	*80	600	200	3.4	60	50	*35	.010	*6	5	Differential amp, AL, SPR, MO
	2N501	*SPR	pnp,MD,ge	*90	60	100	0.8	*15	50	*35	1	*1.5	1	*PH orig Reg, GI
	2N2188	TI	pnp,AD,ge	*90	125	85	2.1	*40	30	90	1.0	*1.6	58	
	2N2190	TI	pnp,AD,ge	90	125	85	2.1	*60	30	90	1.0	*1.6	58	
	2N2596	SSD	pnp,PL	*90	400	200	2.3	60	50	*30	.025	*6	46	
	2N2599	SSD	pnp,PL	*90	400	200	2.3	80	50	*30	.025	*6	46	
	2N2602	SSD	pnp,PL	*90	400	200	2.3	60	50	*25	.025	*6	46	AL
HF 30	2N4104	TI	npn,PL,si	*90	300	175	2	60	50	*400	0.01	4.5	18	
	2N384	RCA	pnp,DR,ge	100	120	100	–	40	–	60	12	–	44	
	2N466	IEC	pnp,PE,si	100	360	150	0.3	0.3	50	30-300	0.1	36	18	
	2N697	FA	npn,DD,si	*100	2.0W	175	13.3	*60	–	*75	0.01	*20	–	TRWS, MO, TR, GI, AMP, CDC, NA, RCA, ITT, IEC
	2N728	TR	npn,PE,si	100	300	175	4	15	100	*20-200	5	*12	18	
	2N729	TR	npn,PE,si	100	300	175	4	30	100	*20-200	5	12	18	
	2N871	FA	npn,DP,si	*100	1.8W	200	10.3	60	10A	*30	0.004	*13	18	TRWS, CDC, GI, AL, IEC, TI
	2N956	FA	npn,DP,si	*100	1.8W	200	10.3	*75	–	*130	0.003	*18	18	TRWS, CDC, MO, GI, AMP
	2N979	SPR	pnp,MD,ge	*100	60	100	0.8	*20	100	*70	1	*1.5	18	
HF 31	2N980	SPR	pnp,MD,ge	*100	60	100	0.8	*20	100	*70	1	*1.5	18	
	2N987	AMP	pnp,PADT,ge	100	86	90	1.33	*40	10	100	–	–	18	4 Lead
	2N1180	RCA	pnp,DR,ge	100	80	71	–	*30	10	100	12	–	45	
	2N1225	RCA	pnp,DR,ge	100	120	85	–	*40	–	60	12	–	33	AMP
	2N1396	RCA	pnp,DR,ge	100	120	100	–	*40	10	90	4	*2	33	SY, AMP
	2N1420	FA	npn,DD,si	*100	2W	175	13.3	*60	–	*200	0.01	17	5	TRWS, CDC, MO, TR, GI, AMP, NA, TI, IEC, CDC
	2N1499A	*SPR	pnp,MD,ge	*100	60	100	0.8	*20	100	*70	1	*1.5	9	*PH orig Reg, GI
	2N1711	FA	npn,DP,si	*100	2W	200	17.2	*75	–	*130	.003	*18	5	TRWS, CDC, MO, TR, GI, AL, NA, RCA, AMP, TI, NA, RCA, IEC
HF 32	2N1726	*SPR	pnp,MD,ge	100	60	100	0.8	*20	50	60	1.5	*1.5	9	*PH orig Reg
	2N1727	*SPR	pnp,MD,ge	100	60	100	0.8	*20	50	*60	1.5	*1.5	9	*PH orig Reg
	2N1728	*SPR	pnp,MD,ge	100	60	100	0.8	*20	50	*60	1.5	*1.5	9	*PH orig Reg
	2N1746	*SPR	pnp,MD,ge	100	60	100	0.8	*20	50	70	1	*1.2	9	*PH orig Reg
	2N1747	*SPR	pnp,MD,ge	100	60	100	0.8	*20	50	70	1	–	9	*PH orgi Reg
	2N1748A	*SPR	pnp,MD,ge	*100	60	100	0.8	*25	50	70	1.5	*1.3	9	*PH orig Reg
	2N1788	*SPR	pnp,MD,ge	100	60	100	0.8	*35	50	150	1.5	*1.5	9	*PH orig Reg
	2N1789	*SPR	pnp,MD,ge	100	60	100	0.8	*35	50	200	1.5	*1.5	9	*PH orig Reg
	2N1790	*SPR	pnp,MD,ge	100	60	100	0.8	*35	50	120	1.5	*1.5	9	*PH orig Reg
	2N1893A	TRWS	npn,PL,si	*>100	3W	200	17.14	*140	500	*40-120	.01	50	5	GI, TR

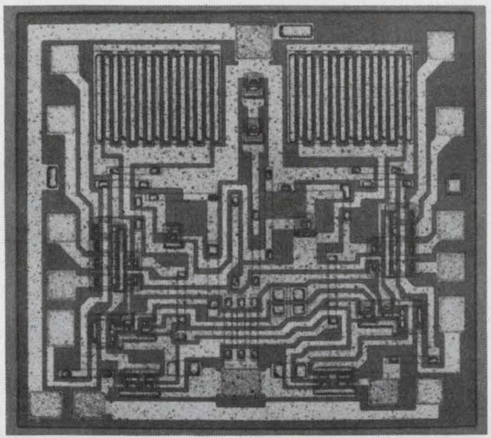
High-Frequency *(continued)*

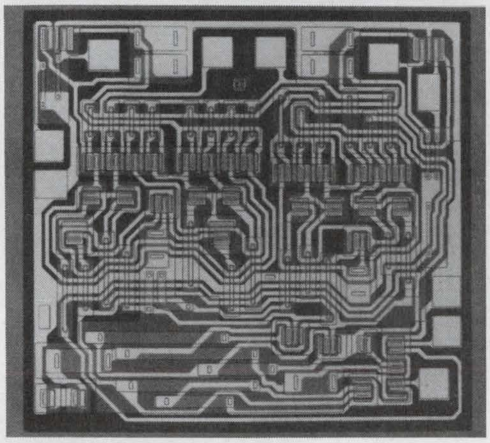
					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 33	2N1958	SY	npn,PE,si	*100	600	175	–	*60	500	*20-60	0.5	18	5	GI
	2N1958A	SY	npn,PE,si	*100	600	175	–	*120	500	*20-60	300	18	5	GI
	2N1959	SY	npn,PE,si	*100	600	175	–	*60	500	*40-120	0.5	18	5	SY, GI, NA
	2N1959A	SY	npn,PE,si	*100	600	175	–	*120	500	*40-120	0.5	18	5	GI, NA
	2N1964	SY	npn,EP,PL,si	*100	400	175	–	*60	500	*20-60	0.5	18	46	NA
HF 34	2N1965	SY	npn,EP,PL,si	*100	400	175	–	*60	500	40-120	0.5	18	46	NA
	2N2084	AMP	pnp,PADT,ge	100	125	90	1.93	*40	10	100	–	–	33	
	2N2330	MO	npn,PE,si	*100	3W	175	5.33	*30	–	*50	0.001	*10	5	
	2N2331	MO	npn,PE,si	*100	1.8W	175	3.33	*30	–	*50	0.001	*10	5	
	2N2405	RCA	npn,si	*100	5W	200	28.6	*120	1000	*60-200	0.01	*15	5	GI, MO, TRWS
	2N2591	SSD	pnp,PL	*100	400	200	2.3	60	50	*35	.025	*6	46	
	2N2695	IEC	npn,PE,si	100	360	†150	0.49	0.25	500	30	0.025	20	18	
	2N2696	IEC	npn,PE,si	100	360	150	0.49	20	500	30	0.5	12	18	
	2N2722	SSD	npn,PL	*100	600	200	3.4	45	50	*60	.001	*6	5	Differential amp, MO, AL, SPR
	2N2895	RCA	npn,si	*100	1800	200	10.3	65	1000	*40-120	.002	*15	18	CDC
HF 35	2N2896	RCA	npn,si	*100	1800	200	10.3	90	1000	*60-200	.01	*75	18	CDC
	2N2897	RCA	npn,si	*100	1.8W	200	10.3	45	1A	*50-200	.05	*15	18	CDC
	2N2900	CDC	npn,si	*100	1800	200	10.3	45	1000	*50-200	.05	*15	46	
	2N2947	MO	pnp,EP,si	*100	25W	175	167	*60	1.5	2.5-35	1	*60	3	
	2N2948	MO	npn,EP,si	*100	25W	175	167	*40	1.5	2.5-100	1	*60	3	
	2N2949	MO	npn,EP,si	*100	6W	175	40	*60	.7	5-100	.1	*20	–	
	2N2950	MO	npn,EP,si	*100	6W	175	40	*60	.7	5-100	.1	*20	–	
	2N3702	TI	pnp,PL,si	*100	300	125	3	25	200	*60-300	0.1	*12	–	Plas IEC, PH
	2N3703	TI	pnp,PL,si	*100	300	125	3	25	200	*50-150	0.1	*12	–	Plas IEC, PH
	2N3704	TI	npn,EP,si	*100	300	150	3	20	800	*90-330	0.1	12	–	Plas IEC, CDC, PH
HF 36	2N3705	TI	npn,EP,si	*100	300	150	3	30	800	*45-165	0.1	12	–	Plas IEC, CDC, PH
	2N3706	TI	npn,EP,si	*100	300	150	3	20	800	*30-660	0.1	12	–	Plas IEC, CDC, PH
	2N3798	MO	pnp,AE,si	*100	1200	200	6.9	60	50	*150-450	.01	*4	18	TI
	2N3799	MO	pnp,AE,si	*100	1200	200	6.9	60	50	*300-900	.01	*4	18	TI
	2N3800	MO	pnp,AE,si	*100	360	200	2.06	60	50	*150-450	.01	*4	71	Dual
	2N3801	MO	pnp,AE,si	*100	360	200	2.06	60	50	*300-900	.01	*4	71	Dual
	2N3802	MO	pnp,AE,si	*100	360	200	2.06	60	50	*150-450	.01	*4	71	Diff. Amp.
	2N3803	MO	pnp,AE,si	*100	360	200	2.06	60	50	*300-900	.01	*4	71	Diff. Amp.
	2N3804	MO	pnp,AE,si	*100	360	200	2.06	60	50	*150-450	.01	*4	71	Diff. Amp.
	2N3805	MO	pnp,AE,si	*100	360	200	2.06	60	50	*300-900	.01	*4	71	Diff. Amp.
HF 37	2N3806	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Dual; Low Profile Can, TI
	2N3807	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Dual; Low Profile Can, TI
	2N3808	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Diff. Amp.: Low Profile Can, TI
	2N3809	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Diff. Amp.; Low Profile Can, TI
	2N3810	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Diff. Amp.; Low Profile Can, TI
	2N3811	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Diff. Amp.; Low Profile Can, TI
	2N1253	FA	npn,DD,si	*110	2.0W	175	13.3	*30	–	*45	0.1	*30	5	AL, NA, IEC
	2N2189	TI	pnp,AD,ge	110	125	85	2.1	*40	30	135	1.0	*1.6	58	
	2N2191	TI	pnp,AD,ge	110	125	85	2.1	*60	30	135	1.0	*1.6	58	
	2N501A	*SPR	pnp,MD,ge	*120	60	100	0.8	*15	50	*100	1	*1.5	1	*PH orig Reg, GI
HF 38	2N1023	RCA	pnp,DR,ge	120	120	100	–	40	–	60	12	–	44	
	2N1066	RCA	pnp,DR,ge	120	120	100	–	*40	–	*60	12	–	33	AMP, KSC
	2N1397	RCA	pnp,DR,ge	120	120	100	–	*40	10	90	4	*2	33	SY, AMP
	2N1500	*SPR	pnp,MD,ge	*120	60	100	0.8	*15	50	*50	1	*1.5	9	*PH orig Reg, GI
	2N2597	SSD	pnp,PL	*120	400	200	2.3	60	50	*60	.025	*6	46	
	2N2600	SSD	pnp,PL	*120	400	200	2.3	80	50	*60	.025	*6	46	
	2N2603	SSD	pnp,PL	*120	400	200	2.3	60	50	*50	.025	*6	46	AL
	2N2798	SPR	pnp,ED,ge	*120	75	100	1	*60	100	*50	–	*2.5	9	
	2N2799	SPR	pnp,ED,ge	*120	75	100	1	*30	100	*50	–	*2.5	9	
	2N2837	MO	pnp,EP,si	*120	1.8W	200	10.3	35	800	*30-90	–	*25	18	NA
HF 39	2N2838	MO	pnp,EP,si	*120	1.8W	200	10.3	35	800	*75-225	–	*25	18	NA
	2N2943	SPR	pnp,ED,ge	*120	150	100	2	*30	100	*50	–	*2.5	9	
	2N1710	TRWS	npn,PL,si	*> 120	1500	175	100	*60	2000	4.0	50	*40	8	NUC
	2N768	*SPR	pnp,MD,ge	*124	35	100	0.467	*12	100	*40	1	*1.6	18	*PH orig Reg
	2N2592	SSD	pnp,PL	*125	400	200	2.3	60	50	*70	.025	*6	46	
	2N2193A	GE	npn,PE,si	*130	2.8W	200	1.6	50	1A	*40-120	.01	*20	5	CDC, GI, FA, NA, MO, AL, TI
	2N2194A	GE	npn,PE,si	*130	2.8W	200	16	40	1A	*20-60	.010	*20	5	CDC, FA, GI, NA, MO, AL, TI
	2N2195A	GE	npn,PE,si	*130	2.8W	200	16	25	1A	20	0.01	*20	5	CDC, FA, GI, MO, AL, TI
	2N2243A	GE	npn,PE,si	*130	2.8W	200	16	80	1A	*40-120	.01	*20	5	GI, CDC, NA
	2N2350A	GE	npn;PE,si	*130	5000	200	28.5	25	1000	*20	.01	*20	46	
HF 40	2N2351A	GE	npn,PE,si	*130	5000	200	28.5	50	1000	*40-120	.01	*20	46	NA
	2N2352A	GE	npn,PE,si	*130	5000	200	28.5	40	1000	*20-60	.01	*20	46	NA
	2N2353A	GE	npn,PE,si	*130	5000	200	28.5	25	1000	*20	.01	*20	46	NA
	2N2364A	GE	npn,PE,si	*130	5000	200	28.5	80	1000	*40-120	.01	*20	46	CDC, NA
	2N3843	GE	npn,PE,si	*135	200	100	2.67	30	100	20-40	0.5	*2.8	98	10.5 d B (max rf nf), CDC
	2N3843A	GE	npn,PEP,si	*135	200	100	2.67	30	100	*20-40	0.5	*2.8	98	8.5 d B (max rf nf)
	2N3844	GE	npn,PE,si	*135	200	100	2.67	30	100	35-70	0.5	*2.8	98	10.5 d B (max rf nf)
	2N3844A	GE	npn,PEP,si	*135	200	100	2.67	30	100	*35-70	0.5	*2.8	98	8.5 d B (max rf nf)
	2N3845	GE	npn,PE,si	*135	200	100	2.67	30	100	60-120	0.5	*2.8	98	10.5 d B (max rf nf)
	2N3845A	GE	npn,PEP,si	*135	200	100	2.67	30	0.5	*60-120	0.5	*2.8	98	8.5 d B (max rf nf)

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 41	2N1177	RCA	pnp,DR,ge	140	80	71	–	*30	10	100	12	–	45	LAN
	2N1178	RCA	pnp,DR,ge	140	80	71	–	*30	10	40	12	–	45	LAN
	2N1179	RCA	pnp,DR,ge	140	80	71	–	*30	10	80	12	–	45	LAN
	2N1506	TRWS	npn,PL	*>140	3W	175	20	*60	500	2	10	*10	5	NUC
	2N1506A	TRWS	npn,PL,si	*>140	3.5W	200	20	*80	500	2	.05	*10	5	NA
HF 42	2N2874	TRWS	npn,PL,si	*140	15000	175	100	*75	2000	2	10	*40	8	
	2N2781	TRWS	npn,PL,si	*>140	15000	175	100	*75	2000	2	500	*40	8	
	2N2782	TRWS	npn,PL,si	*>140	15000	175	100	*100	2000	2	500	*40	8	
	2N2783	TRWS	npn,PL,si	*>140	15000	175	100	*100	2000	2	10	*40	8	
	2N702	TI	npn,si	*150	300	175	2	25	50	*20	0.5	*3	18	TRWS, GI, NA
	2N703	TI	npn,si	*150	300	175	2	25	50	*40	0.5	*3	18	TRWS, FA, SY, GI, NA
	2N758B	SSD	npn,PL	*150	500	200	2.85	60	50	*12.5	.005	*6	18	
	2N995	FA	pnp,PE,si	*150	1.2W	200	6.9	15	–	*70	0.001	*8	18	MO, TR, AL, IEC
	2N1499B	SPR	pnp,ED,ge	*150	75	100	1	*30	100	*70	0.6	*2.5	9	
	2N1709	TRWS	npn,PL,si	*150	15000	175	100	*75	2000	5	10	*40	8	NUC
HF 43	2N2048	*SPR	pnp,MD,ge	*150	150	100	2	*20	100	*125	1	*1.5	9	*PH orig Reg
	2N2048A	*SPR	pnp,MD,ge	*150	150	100	2	*30	100	*50	–	3	9	*PH orig Reg
	2N2400	*SPR	pnp,MD,ge	*150	150	100	2	*12	100	*30	3	4	18	*PH orig Reg
	2N2520	SSD	npn,PL	*150	400	200	2.3	60	50	*12.5	.005	*6	46	
	2N2593	SSD	pnp,PL	*150	400	200	2.3	60	50	*100	.025	*6	46	
	2N2604	SSD	pnp,PL	*150	400	200	2.3	45	50	*60	.010	*6	46	TI, AL, UC, NA
	2N2654	AMP	pnp,AD,ge	150	100	75	0.5	*32	10	50	8	*1.5	12	
	2N2797	SPR	pnp,ED,ge	*150	75	100	1	*40	100	*80	–	*2.5	9	
	2N2927	FA	pnp,PE,si	*150	3000	200	4.56	25	–	*60	0.001	*12	5	
	2N2942	SPR	pnp,ED,ge	*150	150	100	2	*50	100	*80	–	*2.5	9	
HF 44	2N3081	SY	pnp,EP,PL,si	*150	600	175	–	*70	600	*30-90	.01	13	5	
	2N3081/46	SY	npn,PL,EP,si	*150	400	175	–	*70	600	*30-90	.01	13	46	
	2N3081/51	SY	npn,PL,EP,si	*150	300	175	–	*70	600	*30-90	.01	13	51	
	2N3245	MO	pnp,ED,si	*150	5W	200	28.6	50	1A	*30-90	.50	*25	5	TI
	2N3262	RCA	npn,si	*150	8.75W	200	5.71	80	1.5A	3	0.1	*20	39	
	2N3638	FA	pnp,PE,si	*150	700	125	7.0	25	500	*40	0.0001	*12	–	IEC, CDC, PH
	2N3763	MO	pnp,AE,si	*150	4000	200	22.8	60	1500	*20-80	†0.1	*15	5	
	2N3765	MO	pnp,AE,si	*150	2000	200	11.4	60	1500	*20-80	†0.1	*15	46	
	2N3818	MO	npn,EP,si	*150	25000	175	167	*60	2000	*5-50	1	*40	60	
	2N3950	MO	npn,si	*150	70,000	200	900	35	3300	–	*10,000	*120	60	
HF 45	2N4402	MO	pnp,si	*150	310	135	2.81	40	600	*50-150	†0.1	–	92	
	2N4932	RCA	npn,si	*150	70 W	200	400	25	10 A	–	1 mA	*120	60	
	2N4933	RCA	npn,si	*150	70 W	200	400	35	10 A	–	1 mA	*85	60	
	2N1499A	PH	pnp,ge	*160	60	100	0.8	*20	100	*70	0.6	*1.5	9	GI
	2N3962	FA	pnp,DP,si	160	1.2W	200	6.85	60	50	*300	–	*6	18	TI
	2N3963	FA	pnp,DP,si	160	1.2W	200	6.85	80	50	*300	–	*6	18	TI
	2N3964	FA	pnp,DP,si	160	1.2W	200	6.85	45	50	*500	–	*6	18	TI
	2N3965	FA	pnp,DP,si	160	1.2W	200	6.85	60	50	*500	–	*6	18	TI
	2N2525	TRWS	npn,PL,si	*162	16000	200	91.43	80	1000	2.23	–	*25	–	
	2N2913	FA	npn,DP,si	*170	1.5W	200	3.42	45	30	*240	0.001	*5	5	SPR, GI, AL, UC, MO, AMP, GE, NA, SSD
HF 46	2N735A	SSD	npn,PL	*175	500	200	2.85	60	50	*30	.005	*6	18	TR, TI
	2N739A	SSD	npn,PL	*175	500	200	2.85	80	50	*30	.005	*6	18	TR
	2N759B	SSD	npn,PL	*175	500	200	2.85	60	50	*25	.005	*6	18	
	2N2207	AMP	pnp,AD,ge	175	260	75	0.25	*70	50	200	–	–	7	
	2N2459	SSD	npn,PL	*175	400	200	2.3	60	50	*20	.002	*6	46	
	2N2463	SSD	npn,PL	*175	500	200	2.85	60	50	*20	.002	*6	18	
	2N2512		pnp,AD,ge	175	260	75	0.25	*70	50	200	5	–	33	AMP
	2N2515	SSD	npn,PL	*175	400	200	2.3	60	50	*30	.005	*6	46	
	2N2518	SSD	npn,PL	*175	400	200	2.3	80	50	*30	.005	*6	46	
	2N2519	SSD	npn,PL	*175	400	200	2.3	80	50	*60	.005	*6	46	
HF 47	2N2521	SSD	npn,PL	*175	400	200	2.3	60	50	*25	.005	*6	46	
	2N2605	SSD	pnp,PL	*175	400	200	2.3	45	50	*150	.010	*6	46	TI, AL, UC, NA
	2N3244	MO	pnp,ED,si	*175	5W	200	28.6	40	1A	*50-150	.050	*25	5	TI
	2N3253	MO	npn,AE,si	*175	5W	200	28.6	*40	–	*25-75	.5	*12	5	NA, TI, AMP
	2N1493	RCA	npn,si	*180	3W	175	20	*100	50	15-200	10	*5	39	
	2N2494	AMP	pnp,AD,ge	180	100	85	1.67	*35	10	70	2	–	7	
	2N2495	AMP	pnp,AD,ge	180	100	85	1.67	*35	10	70	2	–	33	
	2N2496	AMP	pnp,AD,ge	180	100	85	1.67	*35	10	70	2	–	18	
	2N3074	AMP	pnp,PADT,ge	180	140	90	3.1	25	20	*14	10	3	12	
	2N3762	MO	pnp,AE,si	*180	4000	200	22.8	40	1500	*30-120	†0.1	*15	5	
HF 48	2N3764	MO	pnp,AE,si	*180	2000	200	11.4	40	1500	*30-120	†0.1	*15	46	
	2N588	*SPR	pnp,MD,ge	200	30	85	0.75	*15	50	–	3	–	1	*PH orig Reg, GI
	2N706/51	SY	npn,si	200	300	200	–	15	50	*20-60	.025	5	51	TR
	2N706A/51	SY	npn,si	200	300	200	–	*25	50	*20-60	0.5	5	51	TR
	2N706B/46	SY	npn,PE,si	*200	400	200	–	*25	50	*20-60	0.5	5	46	GI, TR, NA
	2N706B/51	SY	npn,si	200	300	200	–	*25	50	*20-60	0.5	5	51	TR
	2N706C/46	SY	npn,si	200	400	200	–	15	50	*20-60	.025	5	46	GI, TR
	2N706C/51	SY	npn,si	200	300	200	–	15	50	*20-60	.025	5	51	TR
	2N736B	SSD	npn,PL	*200	500	200	2.85	60	50	*60	.005	*6	18	TR
	2N740A	SSD	npn,PL	*200	500	200	2.85	80	50	*60	.005	6	18	TR

85 MHz J-K FLIP-FLOP





8 ns FULL ADDER

...you're in fast company with MECL II Integrated Circuits!

The impressive speed credentials of Motorola's new MECL II* integrated circuit logic are well represented by the ultra-fast 85 MHz (typ) J-K Flip-Flop and the complex 12-gate-array Full Adder (and Subtractor, too) with 8 nanosecond typical propagation delay.

These circuits command the attention of any designer who needs *speed* in his design. And, you can count on the entire line of multifunction MECL II circuits to deliver state-of-the-art performance for fastest overall system operation.

	Min.	Max.	Unit
J-K FLIP-FLOP (MC1013P†, MC1213F†)			
Toggle Frequency (50% duty cycle)	70	—	MHz
AC Fan-out	15	—	—
FULL ADDER (MC1019P, MC1219F)			
FULL SUBTRACTOR (MC1021P, MC1221F)			
Propagation Delay (Carry-in to sum)	—	8	ns
AC Fan-out	15	—	—

†"P" suffix for plastic package (0 to +75°C temp. range)
"F" suffix for flat package (−55°C to +125°C temp. range)

And, if you're already designing with MECL I* circuits, you'll find these new MECL II types fit right in your present designs — with identical logic levels and power supply requirements. (They are compatible with the 1.0 ns MECL III* gates we're presently developing, too.)

If your design doesn't require highest speed, ask your Motorola representative about our other digital integrated logic families . . . MTTL*, MDTL*, MRTL*, MVTL*, MHTL* (high threshold), mWRTL*. We make them all.

See your nearest Motorola distributor for evaluation quantities of new MECL II circuits for prototyping. For complete details, write Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001.

*Trademark of Motorola, Inc.

–where the priceless ingredient is care!

MOTOROLA
Semiconductors

ON READER-SERVICE CARD CIRCLE 62

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $^*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (mA)	h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^†I_{CEX}$ (μA)	C_{oe} $^*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 49	2N752	NA	pnp,DM,si	*200	500	200	2.5	45	100	40-120	0.1	5	18	
	2N760B	SSD	npn,PL	*200	500	200	2.85	60	50	*50	.005	*6	18	TR
	2N783	SY	npn,EP,si	200	300	100	–	*40	200	*20-80	.025	3.5	18	FA, IEC
	2N869	FA	pnp,DP,si	*200	1.2W	200	6.86	18	–	*60	0.005	*60	18	MO, AL, IEC
	2N1962	SY	npn,PE,si	200	400	175	–	*40	200	*20-80	0.25	3.0	46	
HF 50	2N1963	SY	npn,PE,si	*200	400	175	–	*30	200	*25	0.25	3.5	46	
	2N2397	SY	npn,PE,si	*200	300	200	–	*35	200	*25-120	0.1	5	51	
	2N2401	*SPR	pnp,MD,ge	*200	150	100	2.0	*15	100	*50	1.5	4	18	*PH orig Reg
	2N2460	SSD	npn,PL	*200	400	200	2.3	60	50	*35	.002	*6	46	
	2N2464	SSD	npn,PL	*200	500	200	2.85	60	50	*35	.002	*6	18	
	2N2516	SSD	npn,PL	*200	400	200	2.3	69	50	*60	.005	*6	46	
	2N2522	SSD	npn,PL	*200	400	200	2.3	60	50	*50	.005	*6	46	
	2N2618	SY	npn,PE,si	*200	600	175	–	*60	750	*50-200	.25	14	5	TRWS
	2N2618/4	SY	npn,PE,si	*200	400	175	–	*60	750	*50-200	.25	14	5	
	2N2876	RCA	npn,si	*200	17500	200	100	60	2500	50-275	0.1	*20	60	TI, VEC
HF 51	2N2904	MO	pnp,AE,si	*200	3W	200	17.2	40	600	*40-120	.02	*8	5	GI, TR, SPR, AL, TI, GE, NA, IEC
	2N2904A	MO	pnp,AE,si	*200	3W	200	17.2	60	600	*40-120	.01	*8	5	GI, TR, SPR, AL, TI, GE, NA
	2N2905	MO	pnp,AE,si	*200	3W	*100	200	40	600	100-300	.02	*8	5	GI. TR. SPR. AL. TI. GE. NA
	2N2905A	MO	pnp,AE,si	*200	3W	200	17.2	60	600	100-300	.01	*8	5	GI, TR, SPR, AL, TI, GE, NA
	2N2906	MO	pnp,AE,si	*200	1.8W	*100	10.3	40	600	40-120	.02	*8	18	TR, SPR, AL, TI, GE, NA
	2N2906A	MO	pnp,AE,si	*200	1.8W	200	10.3	60	600	*40-120	0.01	*8	18	GI, TR, SPR, AL, TI, GE, NA
	2N2907	MO	pnp,AE,si	*200	1.8W	200	10.3	40	600	*100-300	0.2	*8	18	GI, TR, SPR, AL, TI, GE, NA
	2N2907A	MO	pnp,AE,si	*200	1.8W	200	10.3	60	600	*100-300	.01	*8	18	GI, TR, SPR, AL, TI, GE, NA
	2N2921	IEC	npn,PE,si	200	200	125	0.38	25	100	35	0.5	12	18	
HF 52	2N2922	IEC	npn,PE,si	200	200	125	0.38	25	100	55	0.5	12	18	
	2N2951	MO	npn,EP,si	*200	3W	175	20	*60	250	*20-150	0.1	*8	5	TRWS, SPR
	2N2952	MO	npn,EP,si	*200	1.8W	175	12	*60	250	*20-150	.1	*8	18	TRWS
	2N3133	MO	pnp,AE,si	*200	3W	200	17.3	35	600	*40-120	.05	*10	5	SPR, NA
	2N3134	MO	pnp,AE,si	*200	3W	200	17.3	35	600	*100-300	.05	*10	5	SPR, NA
	2N3135	MO	pnp,AE,si	*200	1.8W	200	10.3	35	600	*40-120	0.05	*10	18	SPR, NA
	2N3136	MO	pnp,AE,si	*200	1.8W	200	10.3	35	600	*100-300	.05	*10	18	SPR, NA
	2N3229	RCA	npn,si	*200	17.5W	200	100	60	2.5A	–	0.1	*20	60	15 W (min) @ 50 MHz
	2N3229	RCA	npn,si	*200	17.5W	200	100	60	2.5A	–	0.1	*20	60	15 W (min) @ 50 MHz
	2N3252	MO	npn,AE,si	*200	5W	200	28.6	*30	–	*30-90	.5	*12	5	NA, TI, AMP
HF 53	2N3298	MO	npn,E,si	*200	1W	175	6.67	*25	100	*60-120	0.5	*6	18	TRWS
	2N3323	MO	pnp,EA,ge	*200	300	100	4	*35	100	*30-200	10	*3	18	TI
	2N3324	MO	pnp,EM,ge	*200	300	100	4	*35	100	*30-200	10	*3	18	TI
	2N3325	MO	pnp,EM,ge	*200	300	100	4	*35	100	*30-200	10	*3	18	TI
	2N3426	FA	npn,PE,si	*200	3W	200	17.2	12	1A	*50	1.5	*6.2	–	
	2N3619	BE	npn,PE,si	*200	7.5W	175	50	*75	2.5A	*40	25	*50	5	
	2N3621	BE	npn,PE,si	200	15W	175	200	*75	5A	*40	25	*50	61	Isolated Collector
	2N3622	BE	npn,PE,si	200	15W	175	200	*75	10A	*40	25	*50	61	
	2N3620	BE	npn,PE,si	200	7.5W	175	50	*75	5A	*40	25	*50	†	†MT-27
	2N3623	BE	npn,PE,si	200	7.5W	175	50	*75	25	*40	1	*50	5	
HF 54	2N3624	BE	npn,PE,si	200	7.5W	175	50	*75	5A	*40	1	*50	†	†MT-27
	2N3625	BE	npn,PE,si	200	15W	175	200	*75	5A	*40	25	*50	61	Isolated Collector
	2N3626	BE	npn,PE,si	200	15W	175	200	*75	10A	*40	1	*50	61	
	2N3627	BE	npn,PE,si	200	7.5W	175	50	*100	2.5A	*40	1	*50	5	
	2N3628	BE	npn,PE,si	200	7.5W	175	50	*100	5A	*40	1	*50	†	†MT-27
	2N3629	BE	npn,PE,si	200	20W	175	200	*100	10A	*40	1	*50	61	Isolated collector
	2N3630	BE	npn,PE,si	200	20W	175	200	*100	10A	*40	1	*50	61	
	2N3691	FA	npn,PL,si	*200	625	150	2	*35	50	*40-160	.05	.5-3.5	–	R097A package, CDC, IEC
	2N3692	FA	npn,PL,si	*200	625	150	2	*35	50	*100-400	.05	.5-35	–	R097A package, CDC, IEC
	2N3693	FA	npn,DP,si	200	500	125	5	45	–	*40	5	–	–	R0110 package, IEC
HF 55	2N3694	FA	npn,DP,si	200	500	125	5	45	–	*100	5	–	–	R0110 package, IEC
	2N3701	FA	npn,DPE,si	200	1.8W	200	10.3	80	1000	*120	10	–	18	
	2N3766	FA	npn,DPE,si	200	1.8W	200	10.3	80	1000	*300	10	–	18	
	2N3825	TI	npn,EP,si	*200	250	125	2.5	15	100	*20	0.1	*3.5	92	
	2N3826	TI	npn,EP,si	*200	200	125	2	45	30	*40	0.1	*3.5	92	
	2N3827	TI	npn,EP,si	*200	200	125	2	45	30	*100	0.1	*3.5	92	
	2N4125	MO	pnp,AE,si	*200	310	135	2.81	30	200	*50-150	.05	*4.5	92	
	2N4400	MO	npn,si	*200	310	135	2.81	40	600	*50-150	†0.1	*6.5	92	
	2N4403	MO	pnp,si	*200	310	135	2.81	40	600	*100-300	†0.1	–	92	
	2N4433	AMP	npn,PL,si	200	165	175	1.1	30	30	*220	1.0	–	72	
HF 56	2N4435	AMP	npn,PL,si	220	145	175	–	20	30	*67	–	1.4	72	
	2N2461	SSD	npn,PL	*225	400	200	2.3	60	50	*70	.002	*6	46	
	2N2465	SSD	npn,PL	*225	500	200	2.85	60	50	*70	.002	*6	18	
	2N996	FA	pnp,PE,si	*230	1.2W	200	6.85	12	–	*75	0.0002	*7.5	18	TR, IEC
	2N499	*SPR	pnp,MD,ge	240	30	85	0.75	*30	50	8.5	1	*1.3	1	*PH orig Reg, GI
	2N499A	*SPR	pnp,MD,ge	240	60	100	0.8	*30	50	50	1	*1.3	1	*PH orig Reg
	2N3588	AMP	pnp,PADT,ge	*240	100	75	2.2	*25	10	*65	8	2	18	4 lead
	2N929A	SSD	npn,PL	*250	500	200	2.85	45	50	*60	.002	*6	18	TR, AL, UC, TI, NA
	2N947	FA	npn,DP,si	*250	1200	200	6.9	*20	100	*40	0.1	*7	18	
	2N957	FA	npn,DD,si	*250	800	150	6.5	20	–	*60	1	*5	18	TRWS, AMP, IEC

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (μA)	C_{oe} *C_{ob} (pF)		
HF 57	2N1491	RCA	npn,si	*250	3000	175	20	*30	50	15-200	10	*5	39	
	2N2217	MO	npn,PE,si	*250	3W	175	20	30	–	*20-60	0.01	8	5	GI, FA, SPR, TR, NA, TRWS, AMP, AL, TI, ITT, IEC
	2N2218	MO	npn,PE,si	*250	3W	175	20	30	–	*40-120	0.01	8	5	GI, FA, SPR, TR, NA, TRWS, AL, AMP, TI, ITT, IEC
HF 58	2N2218A	MO	npn,AE,si	*250	3W	175	20	40	–	40-120	.01	*8	5	SPR, TR, NA, AL, TI, ITT
	2N3292	MO	npn,E,si	*250	300	200	1.71	*25	50	10-200	0.1	*2	18	AL
	2N3293	MO	npn,E,si	*250	300	200	1.7	*20	50	10-200	0.1	*2	18	AL
	2N3294	MO	npn,E,si	*250	300	200	1.71	*20	50	10-200	0.1	*2	18	AL
	2N3326	GI	npn,PE,si	*250	800	175	5.33	45	800	*40-120	0.01	*8	5	
	2N3409	MO	npn,si	250	600	200	3.4	*60	500	*30-120	0.01	*8	5	SPR
	2N3410	MO	npn,PE,si	250	600	200	3.4	*60	500	*30-120	0.01	*8	5	SPR
	2N3411	MO	npn,PE,si	250	600	200	3.4	*60	500	*30-120	0.01	*8	5	SPR
	2N2219	MO	npn,PE,si	*250	3W	175	20	30	–	*100-300	0.01	8	5	GI, FA, SPR, TR, NA, TRWS, AL, AMP, TI, ITT, IEC
HF 59	2N2220	MO	npn,PE,si	*250	1.8W	175	12	30	–	*20-60	0.01	8	18	GI, FA, SPR, TR, NA, TRWS, AMP, AL, TI, ITT, IEC
	2N2221	MO	npn,AE,si	*250	1.8W	175	12	30	–	*40-120	0.01	8	18	GI, FA, SPR, TR, NA, TRWS, AMP, AL, ITT, IEC
	2N2221A	MO	npn,AE,si	*250	1.8W	175	12	40	–	40-120	.01	*8	18	GI, SPR, TR, NA, AL, TI, ITT
	2N2222	MO	npn,AE,si	*250	1.8W	175	12	30	–	*100-300	0.01	8	18	TRWS, GI, FA, SPR, TR, NA, AL, AMP, TI, ITT, IEC
	2N2273	MO	pnp,EM,ge	*250	150	100	2	15	100	*20-75	10	*3.5	18	TI
	2N2402	*SPR	pnp,MD,ge	*250	150	100	2	*18	100	*60	1.5	*4	18	*PH orig Reg
	2N2462	SSD	npn,PL	*250	400	200	2.3	60	50	*100	.002	*6	46	
HF 60	2N2466	SSD	npn,PL	*250	500	200	2.85	60	50	*100	.002	*6	18	
	2N2476	RCA	npn,PE,si	250	2W	200	3.4	*60	–	*20	0.2	10	5	SPR
	2N2477	RCA	npn,PE,si	250	2W	200	3.4	*60	–	*40	0.2	10	5	SPR
	2N2523	SSD	npn,PL	*250	400	200	2.3	45	50	*40	.002	*6	46	
	2N2537	MO	npn,AE,si	*250	3W	200	17.2	30	–	*50-150	.25	*8	5	GI, NA, SPR, TI, GE
	2N2538	MO	npn,AE,si	*250	3W	200	17.2	30	–	*100-300	.25	*8	5	GI, NA, SPR, TI, GE
	2N2539	MO	npn,AE,si	*250	1.8W	200	10.3	30	–	*501.50	.25	*8	18	GI, NA, SPR, TI, GE
	2N2540	MO	npn,AE,si	*250	1.8W	200	10.3	30	–	*100-300	.25	*8	18	GI, NA, SPR, TI, GE
	2N2787	GI	npn,PE,si	*250	3W	300	5.33	*75	800	*20-60	0.01	*8	5	SPR
	2N2788	GI	npn,PE,si	*250	3W	300	5.33	*75	800	*40-120	0.01	*8	5	SPR
HF 61	2N2789	GI	npn,PE,si	*250	3W	300	5.33	*75	800	*100-300	0.01	*8	5	SPR
	2N2790	GI	npn,PE,si	*250	1.8W	300	3.33	*75	800	*20-60	0.01	*8	18	SPR
	2N2791	GI	npn,PE,si	*250	1.8W	300	3.33	*75	800	*40-120	0.01	*8	18	SPR
	2N2792	GI	npn,PE,si	*250	1.8W	300	3.33	*75	800	*100-300	0.01	*8	18	SPR
	2N2958	MO	npn,AE,si	*250	3W	175	20	20	600	*40-120	.025	*8	5	GI, SPR, TRWS
	2N2959	MO	npn,AE,si	*250	3W	175	20	20	600	*100-300	.025	*8	5	GI, SPR, TRWS
	2N3015	FA	npn,PE,si	*250	3W	200	–	*60	–	*10	–	*8	5	SPR, TI
	2N3115	MO	npn,AE,si	*250	1.8W	175	12	20	600	*40-120	.025	*8	18	GI, SPR, TRWS, NA
	2N3116	MO	npn,AE,si	*250	1.8W	175	12	20	600	*100-300	.025	*8	18	GI, SPR, TRWS
	2N3118	RCA	npn,si	*250	4000	200	22.9	60	500	*50-275	.1	*6	5	
HF 62	2N3119	RCA	npn,si	*250	4000	200	22.9	80	500	*50-200	50	*6	5	
	2N3248	MO	pnp,ED,si	*250	1.2W	200	6.9	12	–	*50-150	0.05	*8	18	IEC
	2N3250	MO	pnp,ED,si	*250	1.2W	200	6.9	*40	200	*50-150	.02	*6	18	
	2N3283	MO	pnp,EM,ge	*250	100	100	1.33	*25	50	*10-200	10	*1.5	18	TI
	2N3284	MO	pnp,EM,ge	*250	100	100	1.33	*25	50	10-200	10	*1.5	18	TI
	2N3285	MO	pnp,EM,ge	*250	100	100	1.33	*20	50	5-200	10	*1.5	18	TI
	2N3286	MO	pnp,EA,ge	*250	100	100	1.33	*20	50	5-200	10	*1.5	18	TI
	2N3291	MO	npn,E,si	*250	300	200	1.71	*25	50	10-200	0.1	*2	18	AL
	2N3502	FA	pnp,PE,si	*250	3W	200	17.2	60	600	*70	0.00005	4.5	5	TI, GE, NA
	2N3503	FA	pnp,PE,si	*250	3W	200	17.2	60	600	*70	0.00007	4.5	5	TI, GE, NA
HF 63	2N3504	FA	pnp,PE,si	*250	1.3W	200	2.28	45	600	*70	0.00005	*4.5	18	TI, GE, NA
	2N3505	FA	pnp,PE,si	*250	1.3W	200	2.28	45	600	*70	0.00005	*4.5	18	TI, GE, NA
	2N2656	TRWS	npn,PL,si	*>250	1200	200	6.86	*25	200	160	0.5	*5	18	KSC
	2N3734	MO	npn,AE,si	*250	4000	200	22.8	30	1500	*30-120	†0.2	*9	5	
	2N3735	MO	npn,AE,si	*250	4000	200	22.8	50	1500	*20-80	†0.2	*9	5	
	2N3736	MO	npn,AE,si	*250	2000	200	11.4	30	1500	*30-120	†0.2	*9	46	
	2N3737	MO	npn,AE,si	*250	2000	200	11.4	50	1500	*20-80	†0.2	*9	46	
	2N3903	MO	npn,AE,si	*250	310	135	2.81	40	200	*50-150	†.05	*4	92	CDC
	2N3905	MO	pnp,AE,si	*250	310	135	2.81	40	200	*50-150	†0.05	*4.5	92	
	2N3946	MO	npn,AE,si	*250	1200	200	6.9	40	200	*50-150	†.01	*4	18	
HF 64	2N4123	MO	npn,AE,si	*250	310	135	2.81	30	200	*50-150	.05	*4	92	
	2N4126	MO	pnp,AE,si	*250	310	135	2.81	25	200	*120-360	.05	*4.5	92	
	2N4401	MO	npn,si	*250	310	135	2.81	40	600	*100-300	†0.1	*6.5	92	
	2N930A	SSD	npn,PL	*275	500	200	2.85	45	50	*150	.002	*6	18	AL, TI, NA
	2N1492	RCA	npn,si	*275	3000	175	20	*60	50	15-200	10	*5	39	
	2N2524	SSD	npn,PL	*275	400	200	2.3	45	50	*100	.002	*6	46	NA
	2N784	SY	npn,EP,si	300	300	175	–	*30	200	*25-150	.25	3.5	18	FA, ITT
	2N784/51	SY	npn,EP,si	300	300	175	–	*30	200	*25-150	.025	3.5	51	
	2N784A	SY	npn,EP,si	300	360	200	–	*40	200	*25-150	.025	3.5	18	
	2N835	MO	npn,EP,si	*300	1W	175	6.67	*25	200	201-	0.5	4	18	SY, GE, GI, ITT, SPR, IEC

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	f_{ae} $^*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (mA)	h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^\dagger I_{CEX}$ (μA)	C_{oe} $^*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 65	2N835/46	SY	npn,PE,si	*300	400	200	–	*25	200	*20	0.5	*4	46	GI
	2N835/51	SY	npn,PE,si	*300	300	200	–	*25	200	*20	0.5	*4	51	
	2N914/46	SY	npn,PE,si	*300	400	200	–	*40	–	*30-120	.025	*6	46	GI
	2N914/51	SY	npn,PE,si	*300	300	200	–	*40	–	*30-120	.025	6	51	
	2N915	FA	npn,DP,si	*300	1200	200	6.9	50	–	*100	0.005	*3	18	AMP, NA, AL, IEC
HF 66	2N963	MO	pnp,EM,ge	*300	300	100	4	*12	–	20/–	5	*5	18	SY, TI, RCA
	2N967	MO	pnp,EM,ge	*300	300	100	4	*12	–	40/–	5	*5	18	SY, TI, RCA
	2N988	TRWS	npn,PL,si	*300	1000	175	6.67	*20	220	*20-120	0.5	*4	18	
	2N989	TRWS	npn,PL,si	*300	1000	175	6.67	*20	220	*20-120	0.5	*3.5	18	
	2N1493	RCA	npn,si	*300	3000	175	20	*100	50	15-200	10	*5	39	CT
	2N2219A	MO	npn,PE,si	*300	3W	175	20	40	800	100-300	0.01	*8	5	TR, SPR, TRWS, TI, AL, ITT, NA
	2N2222A	MO	npn,AE,si	*300	1.8W	175	12	40	–	*100-300	.01	*8	18	GI, SPR, TR, NA, TRWS, TI, AL, ITT
	2N2318	GI	npn,si	*300	360	175	2.0	15	–	*40	.50	*5	18	STC
	2N2319	GI	npn,si	*300	300	175	1.7	15	–	*40	.050	*5	46	STC
HF 67	2N2320	GI	npn,si	*300	600	175	3.4	15	–	*40	.050	*5	5	STC
	2N2381	MO	pnp,EM,ge	*300	750	100	10	15	500	*40	1	*3.5	5	TI
	2N2382	MO	pnp,EM,ge	*300	750	100	10	20	500	*40	1	*3.5	5	TI
	2N2489	SPR	pnp,ED,ge	*300	60	100	0.8	*20	100	*20	2.5	3	18	
	2N2795	SPR	pnp,ED,ge	*300	75	100	1	*25	100	*100	†0.35	*2.5	18	
	2N2796	SPR	pnp,ED,ge	*300	75	100	1	*20	100	*60	†0.35	*2.5	18	
	2N2885	TR	npn,PL,si	300	150	175	1	15	50	*30-120	.025	*6	51	
	2N2887	TRWS	npn,PL,si	*300	25000	200	142.8	80	1200	*15-80	–	*30	–	NA
	2N3043	SPR	npn,PE,si	*300	1.4W	200	9.33	45	30	*100-300	0.01	*8	–	Flat Pack, TI, MO
	2N3249	MO	pnp,AE,si	*300	1.2W	200	6.9	12	–	*100-300	–	*8	18	IEC
HF 68	2N3251	MO	pnp,AE,si	*300	1.2W	200	6.9	*50	200	*100-300	–	*6	18	
	2N3281	MO	pnp,EM,ge	*300	100	100	1.33	15	50	*10-100	5	*1.2	18	TI
	2N3282	MO	pnp,EM,ge	*300	100	100	1.33	15	50	*10-100	5	*1.2	18	TI
	2N3289	MO	npn,E,si	*300	300	200	1.71	15	50	*10-200	0.010	*1.5	18	AL
	2N3290	MO	npn,E,si	*300	300	200	1.71	15	50	*10-200	0.010	*1.5	18	AL
	2N3307	MO	pnp,EA,si	*300	300	200	1.71	35	50	*40-250	0.010	*1.3	18	
	2N3308	MO	npn,EA,si	*300	300	200	1.71	25	50	*25-250	0.010	*1.3	18	
	2N3309	MO	npn,E,si	*300	3.5W	175	23.3	*50	500	*5-100	0.5	*10	5	
	2N3854	GE	npn,PE,si	*300	200	100	2.67	18	100	*35-70	0.5	*2.5	98	CDC
	2N3854A	GE	npn,PEP,si	*300	200	100	2.67	30	100	*35-70	0.5	*2.5	98	CDC, IEC
HF 69	2N3904	MO	npn,AE,si	*300	310	135	2.81	40	200	*100-300	*.05	*4	92	CDC
	2N3906	MO	pnp,AE,si	*300	310	135	2.81	40	200	*100-300	*.05	*4.5	92	
	2N3947	MO	npn,AE,si	*300	1200	200	6.9	40	200	*100-300	*.01	*4	18	
	2N4124	MO	npn,AE,si	*300	310	135	2.81	25	200	*120-360	.05	*4	92	
	2N4264	MO	npn,AE,si	*300	310	135	2.81	15	200	*40-160	†0.1	*4	92	
	2N4265	MO	npn,AE,si	*300	310	135	2.81	12	200	*100-400	†0.1	*4	92	
	2N4409	MO	npn,si	*300	310	135	2.81	50	250	*60-400	0.01	–	92	
	2N4410	MO	npn,si	*300	310	135	2.81	80	250	*60-400	0.01	–	92	
	2N4434	AMP	npn,PL,si	300	145	175	–	20	30	*115	–	1.4	72	
	2N503	*SPR	pnp,MD,ge	320	25	85	0.5	*20	50	4.2	3	2	9	*PH orig. Reg.
HF 70	2N779A	*SPR	pnp,MD,ge	*320	60	100	0.8	*15	100	*90	1.0	*1.9	18	*PH orig Reg
	2N846A	*SPR	pnp,MD,ge	*320	60	100	0.8	*15	100	*50	1.0	*1.9	18	*PH orig, Reg
	2N968	MO	pnp,MD,ge	*320	300	100	4	*15	–	*35	3	*4	18	SY, IT
	2N969	MO	pnp,MD,ge	*320	300	100	4	*12	–	*35	3	*4	18	TI
	2N970	MO	pnp,MD,ge	*320	300	100	4	*12	–	*35	3	*4	18	TI
	2N971	MO	pnp,MD,ge	*320	300	100	4	*7	–	*35	10	*4	18	TI
	2N972	MO	pnp,MD,ge	*320	300	100	4	*15	–	*75	3	*4	18	TI
	2N973	MO	pnp,MD,ge	*320	300	100	4	*12	–	*75	3	*4	18	TI
	2N974	MO	pnp,MD,ge	*320	300	100	4	*12	–	*75	3	*4	18	TI
	2N975	MO	pnp,MD,ge	*320	300	100	4	*7	–	*75	10	*4	18	TI
HF 71	2N2256	MO	pnp,ME,si	*320	1000	175	6.67	7	100	*30	3	*4	18	CL
	2N2257	MO	npn,ME,si	*320	1000	175	6.67	7	100	*50	3	*4	18	CL
	2N2258	MO	pnp,ME,ge	*320	300	100	4	7	100	*30	3	*4	18	TI
	2N2259	MO	pnp,ME,ge	*320	300	100	4	7	100	*50	3	*4	18	TI
	2N834/46	SY	npn,EP,si	*350	400	200	–	*40	200	*25	0.5	4	46	GI, NA
	2N834/51	SY	npn,EP,si	*350	300	200	–	*40	200	*25	0.5	4	51	
	2N914	FA	npn,PE,si	*350	1.2W	200	6.9	15	–	*55	0.004	*4.5	18	SY, MO, TR, GI, AMP, SPR, NUC, MO, TI, IEC TI, IEC
	2N984	SPR	pnp,MD,ge	*350	60	100	0.8	*15	100	*70	1	*1.9	18	
HF 72	2N2170	SPR	pnp,MD,ge	*350	60	100	0.8	*15	100	*70	1	*1.9	9	
	2N2501	MO	npn,AE,si	*350	1.2W	200	6.9	20	–	*50-150	–	*4	18	SY, GI, TR, SPR, IEC
	2N2845	FA	npn,PE,si	*350	1.2W	200	6.9	30	–	*60	0.04	*6	18	SPR, NA, GE, IEC
	2N2846	FA	npn,PE,si	*350	3W	200	17.2	30	–	*60	0.04	*6	5	SPR, NA, GE
	2N2847	FA	npn,PE,si	*350	1.2W	200	6.9	20	–	*60	0.04	*6	18	SPR, NA, GE
	2N2848	FA	npn,PE,si	*350	3W	200	17.2	20	–	*60	0.04	*6	5	SPR, NA, RCA, NUC, GE
	2N2894	FA	pnp,PE,si	*350	1.2W	200	6.85	12	–	*75	5	*3.3	18	TI, MO
	2N2955	MO	pnp,EM,ge	*350	300	100	4	*40	.100	*20-60	–	*2.5	18	TI
	2N3009	FA	npn,PE,si	*350	1200	200	6.85	*40	200	*15	–	*5	52	TI, ITT
	2N3287	MO	npn,E,si	*350	300	200	1.71	20	50	*15-150	0.010	*1.1	18	

Solitron's low cost ISOLTAXIAL T.M.

NPN SILICON TRANSISTORS

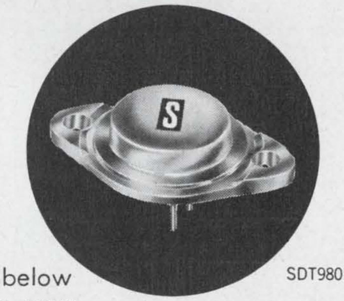
PAT. PENDING

SDT9901-4

GUARANTEE RELIABILITY

with...

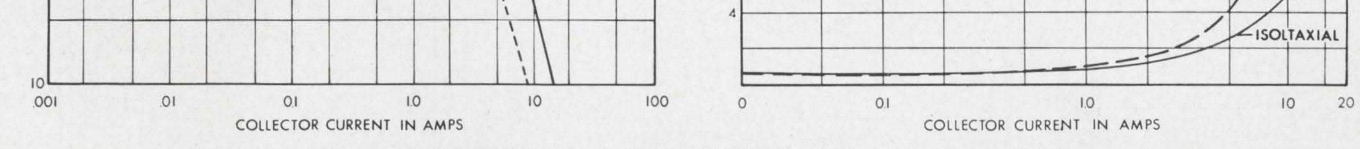
- All aluminum metalization-die and leads
- Molybdenum pedestal mounting for matching thermal coefficients
- Alloy mounting to eliminate thermal fatigue
- Copper base assembly providing low thermal resistance



SDT9801-4

The gain and V_{CE} (sat) comparison curves shown below warrant your inspection. They illustrate Solitron's new ISOLTAXIAL NPN Silicon Power Transistors which have characteristics of low-leakage planar units, combined with resistance to secondary breakdown offered by homogeneous devices. Developed with the high reliability standards associated with Solitron, these ISOLTAXIAL devices may be used in power supplies, audio amplifiers, inverters, converters, relay drivers and series regulators. Available in TO-3 and TO-61 cases, the ISOLTAXIAL transistors are priced lower than epitaxial or triple-diffused planar devices.

COMPARISON OF ISOLTAXIAL DEVICE TO COMPETITIVE 2N3055



CONTACT US TODAY FOR COMPLETE INFORMATION

TRANSISTOR DIVISION **Solitron DEVICES, INC.**

1177 BLUE HERON BLVD. / RIVIERA BEACH, FLORIDA / (305) 848-4311 / TWX: (510) 952-6676

Leader in Germanium and Silicon Power Transistors, Cryogenic Thermometers, High Voltage Rectifiers, Hot Carrier Diodes, Temperature Compensated Zeners, Voltage Variable Capacitors, Random/White Noise Components, Microelectronic Circuits, and Power-Sink Interconnection Systems.

ON READER-SERVICE CARD CIRCLE 63

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 73	2N3288	MO	npn,E,si	*350	300	200	1.71	20	50	*15-150	0.010	*1.5	18	
	2N3829	TI	pnp,EP,si	*350	360	175	2.4	20	200	*30-120	0.3	*6	52	
	2N3855	GE	npn,PE,si	*350	200	100	2.67	18	100	*60-120	0.5	*2.5	98	CDC
	2N3855A	GE	npn,PEP,si	*350	200	100	2.67	30	100	*60-120	0.5	*2.5	98	CDC, IEC
	2N4420	TI	npn,EP,si	*350	250	125	2.5	20	200	*30-120	0.5	+5	92	
HF 74	2N741	MO	pnp,DM,ge	*360	300	100	2	*15	100	*25	0.2	*6	18	SY, TI
	2N741A	MO	pnp,DM,ge	*360	300	100	2	*20	100	*25	0.2	*6	18	SY, TI
	2N2487	SPR	pnp,ED,ge	*360	60	100	0.8	*15	100	*20	3	*3	18	
	2N2488	SPR	pnp,ED,ge	*360	60	100	0.8	*15	100	*20	3	3	18	
	2N3828	TI	npn,EP,si	*360	300	125	3	40	100	*30-200	0.1	*5	92	
	2N2956	MO	pnp,EM,ge	*375	300	100	4	*40	100	*40-120	10	*2.5	18	TI
	2N3856A	GE	npn,PEP,si	*375	200	100	2.67	30	100	*100-200	0.5	*2.5	98	IEC
	2N3856	GE	npn,PE,si	*375	200	100	2.67	18	100	*100-200	0.5	*2.5	98	
	2N706	FA	npn,DD,si	*400	1.0W	175	6.7	*25	–	*45	0.005	*5	18	SY, MO, TR, GI, AMP, SPR, ITT, RCA, CDC, IEC
HF 75	2N706B	MO	npn,EP,si	*400	1W	175	6-7	*25	–	*20-60	0.005	*5	18	FA, SY, GI, TR, ITT
	2N706C	FA	npn,DD,si	*400	1.2W	200	6.9	15	50	*40	0.010	*4	18	GI, TR
	2N707	FA	npn,DD,si	400	1.0W	175	6.7	*56	–	*12	0.005	*5	18	TRWS, MO, GI
	2N708	FA	npn,DP,si	*400	1.2W	200	6.9	15	–	*50	0.004	*4	18	FA, SY, MO, TR, GI, AMP, TI, ITT, IEC
	2N828	MO	pnp,EM,ge	*400	300	100	0.4	*15	200	40	0.4	*3.5	18	SY, TI, RCA, LAN
	2N828A	MO	pnp,EM,ge	*400	300	100	4	*15	200	*40	0.4	*2.2	18	TI
	2N829	MO	pnp,EM,ge	*400	300	100	4	*15	200	*80	0.4	*2.2	18	TI
	2N916	FA	npn,DP,si	*400	1200	200	6.9	25	–	*100	0.005	*5	18	TRWS, AMP, NA, MO, TI, AL, IEC
	2N2096		pnp,ED,ge	*400	750	100	10	*25	500	*40	6	*15	31	MO
HF 76	2N2097		pnp,ED,ge	*400	750	100	10	*40	500	*70	6	*15	31	MO
	2N2099		pnp,ED,ge	*400	750	100	10	*25	500	*40	6	*15	9	MO, TI
	2N2100		pnp,ED,ge	*400	750	100	10	*40	500	*70	6	*15	9	MO, TI
	2N2957	MO	pnp,EM,ge	*400	300	100	4	*40	100	*100	–	*2.5	18	
	2N2996	TI	pnp,ge	*400	75	100	1	*15	50	35	5	*3	72	
	2N2997	TI	pnp,ge	*400	75	100	1	*30	50	50	5	*1.8	72	
	2N3279	MO	pnp,EM,ge	*400	100	100	1.33	20	50	*10-70	5	*1.0	18	TI
	2N3280	MO	pnp,EM,ge	*400	100	100	1.33	20	50	*10-70	5	*1.2	18	TI
	2N3299	FA	npn,PE,si	*400	3W	200	17.2	30	–	*75	0.0002	*6.0	5	ITT
	2N3300	FA	npn,PE,si	*400	3W	200	17.2	30	–	*220	0.0002	*6.0	5	ITT
HF 77	2N3301	FA	npn,PE,si	*400	1.8W	200	10.3	30	–	*75	0.0002	*6.0	18	ITT
	2N3302	FA	npn,PE,si	*400	1.8W	200	10.3	30	–	*220	0.0002	*6.0	18	ITT
	2N3327	NSC	npn	400	20W	200	134	65	2.0A	*10	500mA	*30	60	NA
	2N3337	FA	npn,PE,si	*400	500	200	2.86	40	–	*30	0.025	*1.6	–	
	2N3338	FA	npn,PE,si	*400	500	200	2.86	40	–	*30	0.025	*1.6	–	
	2N3339	FA	npn,PE,si	*400	500	200	2.86	40	–	*30	0.025	*1.6	–	
	2N3371	TI	pnp,ge	*400	150	100	2	*25	100	25-500	7	*4	18	
	2N3576	TI	pnp,EP,si	*400	360	175	2.4	15	200	*40-120	0.01	*4.5	18	
	2N3632	RCA	npn,si	*400	23W	200	130	40	3A	–	250	*20	60	RCA "Overlay" emitter type, MO, VEC, AMP, NA
HF 78	2N3688	FA	npn,PL,si	*400	500	125	5	40	4	30-70	5	1.1	–	R0110 package
	2N3689	FA	npn,PL,si	400	500	125	5	40	4	30-70	5	1.1	–	R0110 package
	2N3690	FA	npn,PL,si	400	500	125	5	40	4	30-70	5	1.1	–	R0110 package
	2N3728	FA	npn,DPE,si	400	1.6W	200	9.15	30	500	*30-280	0.010	–	–	
	2N3729	FA	npn,DPE,si	400	1.6W	200	9.15	30	500	*30-280	0.010	–	–	
	2N3733	RCA	npn,si	400	23W	200	130	–	3A	–	*250	*20	60	Vces = 40; overlay type, VEC, MO
	2N4411	MO	pnp,si	*400	250	200	1.43	12	25	*40-160	†5000	–	72	
	2N4419	TI	npn,EP,si	*400	250	125	2.5	12	200	*30	0.4	+4	92	
	2N834	MO	npn,EP,DD,si	*450	500	175	2	*40	200	5	0.01	*2.8	18	SY, TR, GI, FA, NA, SPR, ITT, CDC, IEC
HF 79	2N982	SPR	pnp,MD,ge	*450	60	100	0.8	*20	100	*100	1	*1.9	18	
	2N983	SPR	pnp,MD,ge	*450	60	100	0.8	*15	100	*85	1	*1.9	18	
	2N1562	MO	pnp,DM,ge	*450	3W	100	40	25	250	9	10	*10	–	
	2N2168	SPR	pnp,MD,ge	*450	60	100	0.8	*20	100	*100	1	*1.9	9	
	2N2169	SPR	pnp,MD,ge	*450	60	100	0.8	*15	100	*85	1	*1.9	9	
	2N960	MO	pnp,EM,ge	*460	300	100	4	*15	–	*40	0.3	*4	18	SY, TI, RCA
	2N961	MO	pnp,EM,ge	*460	300	100	4	*12	–	*40	0.3	*4	18	TI, RCA
	2N962	MO	pnp,EM,ge	*460	300	100	4	*12	–	*40	–	0.3	18	SY, TI, RCA
	2N964	MO	pnp,EM,ge	*460	300	100	4	*15	–	*70	0.3	*4	18	SY, TI, RCA
	2N964A	MO	pnp,EM,ge	*460	300	100	4	*15	–	*80	0.3	*4	18	SY, TI
HF 80	2N965	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	0.3	*4	18	SY, TI, RCA
	2N966	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	0.3	*4	18	SY, TI, RCA
	2N502	*SPR	pnp,MD,ge	500	60	85	1	*20	50	45	3	*1.0	9	*PH orig Reg
	2N700	MO	pnp,DM,ge	*500	–	100	1	*25	50	4	2	1.5	17	
	2N835	MO	npn,PE,si	*500	500	175	2	*25	200	4.5	0.01	*2.8	18	ITT, IEC
	2N1561	MO	pnp,DM,ge	*500	3W	100	40	25	250	10	10	*10	–	
	2N2095	SPR	pnp,ED,ge	*500	1W	100	13.3	*30	300	–	2	*6.5	31	PG = 6 dB @ 160 MHz
	2N2098	SPR	pnp,ED,ge	*500	1W	100	13.3	*30	300	–	2	*6.5	9	PG = 6 dB @ 160 MHz
	2N2480A	–	npn,PE,si	*500	2W	200	11.4	*80	500	*35	0.01	*20	5	diff amp, MO, TRWS, CDC, GE
	2N2883	FA	npn,PE,si	*500	1750	200	10	200	300	*30	0.1	*1.0	5	TI
	2N2884	FA	npn,PE,si	*500	1750	200	10	20	300	*30	0.1	*1.0	5	TI

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} *f_T (MHz)	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (μA)	C_{oe} *C_{ob} (pF)		
HF 81	2N3227	SPR	npn,PE,si	*500	1200	200	6.85	*40	500	*30	0.2	*4	18	IEC
	2N3375	RCA	npn,si	*500	11.6W	200	660	40	1.5A	–	100	*10	60	RCA "Overlay" emitter type, MO, VEC, AMP, NA
	2N3553	RCA	npn,si	*500	7W	200	1.14	40	1	–	100	*10	39	RCA "Overlay" emitter type, MO, VEC, AMP
HF 82	2N3924	MO	npn,A*,si	*500	7000	200	40	18	500	5	100	*12.5	39	*Annular, AMP
	2N3925	MO	npn,A*,si	*500	10,000	200	57.1	18	1000	5	100	*12.5	102	*Annular
	2N3926	MO	npn,A*,si	*500	11,600	200	66.3	18	1500	5	100	*12.5	60	*Annular, AMP
	2N3927	MO	npn,A*,si	*500	23,200	200	132.5	18	3000	5	250	*25	60	*Annular, AMP
	2N3961	MO	npn,si	*500	10,000	200	57.2	40	1000	5	1000	*10	102	
	2N4012	RCA	npn,si	*500	11.6W	200	66	–	1.5A	–	*0.1	*10	60	Vces = 40; overlay type, MO
	2N4418	TI	npn,EP,si	*500	250	125	2.5	15	200	*40-120	0.4	+4	92	
	2N4440	RCA	npn,si	*500	11.6 W	200	66	40	1.5 A	–	0.1 mA	*10	60	
	2N869A	FA	pnp,PE,si	*550	1200	200	6.85	18	200	*75	0.00005	*3.0	18	
	2N1195	–	pnp,DM,ge	*550	250	100	3.33	*30	40.0	13.0	2.0	4.0	5	MO, TI
HF 83	2N2368	FA	npn,EP,si	*550	1200	200	6.85	15	500	*40	0.1	*2.5	18	SPR, MO, TI, AL, AMP, CDC, ITT, IEC
	2N3013	FA	npn,PE,si	*550	1.2W	200	6.85	15	–	*60	–	*5	52	TI, ITT, IEC
	2N3014	FA	npn,PE,si	*550	1.2W	200	6.85	20	–	*60	–	*5	52	TI, ITT
	2N4072	MO	npn,AE,si	*550	350	200	2.0	20	100	*10	0.1	*4	18	
	2N4073	MO	npn,AE,si	*550	1500	200	8.57	20	150	*10	0.1	*4	5	
	2N709/46	SY	npn,si	600	400	200	–	*15	–	*20-120	0.005	*3.0	46	TR
	2N709/51	SY	npn,si	600	300	200	–	*15	–	*20-120	0.005	*3.0	51	TR
	2N769	*SPR	pnp,MD,ge	*600	35	100	0.467	*12	100	*55	0.3	*1.5	18	*PH orig Reg
	2N976	SPR	pnp,MD,ge	*600	100	100	1.33	*15	100	*80	1.0	*1.5	18	*PH orig Reg
HF 84	2N2998	TI	pnp,ge	*600	75	100	1	*15	20	20-500	5	*1.7	72	
	2N3049	TI	npn,PE,si	*600	1.4W	200	9.33	*25	100	*20	0.01	*8	–	Flat Pack, SPR, TI, MO
	2N3320	SPR	pnp,ge	*600	75	100	1.0	10	100	*40	5	*3	18	
	2N3321	SPR	pnp,ge	*600	75	100	1.0	*12	100	*80	5	3.5	18	
	2N3322	SPR	pnp,ge	*600	75	100	1.0	*12	100	*25	5	3.5	18	
	2N3399	AMP	pnp,MS,ge	*600	80	90	1.1	*20	7	*10	1	1.27	18	4 lead low Noise
	2N3423	FA	npn,PE,si	*600	1.2W	200	3.44	15	50	*20-200	0.010	1.7	–	AL, MO
	2N3424	FA	npn,PE,si	*600	1.2W	200	3.44	15	50	*20-200	0.010	1.7	–	AL, MO
	2N3544	MO	npn,E,si	*600	400	175	2.67	*25	100	*25	0.1	*2.5	18	
	2N3683	KMC	–	*600	200	200	1.74	*30	30	*150	0.05	*2.0	72	
HF 85	2N3995	TI	pnp,ge	*600	300	140	4	*20	100	150-450	3	*4	39	
	2N4430	TRWS	npn,si	600	10,000	–65 to 200	–	40	1000	20-200	0.05	5	–	
	2N4431	TRWS	npn,si	600	18,000	–65 to 200	–	40	2000	20-200	0.05	10	–	
	2N4252	TI	npn,EP,si	*600	200	175	1.33	18	50	*50	0.05	+0.45	72	
	2N4253	TI	npn,EP,si	*600	200	175	1.33	18	50	*30-150	0.05	+0.45	72	
	2N4254	TI	npn,EP,si	*600	200	175	1.33	18	50	*50	0.05	+0.65	92	
	2N4255	TI	npn,EP,si	*600	200	175	1.33	18	50	*30-150	0.05	+0.65	92	
	2N502A	*SPR	pnp,MD,ge	620	75	100	1	*30	50	45	3.0	*1.0	9	*PH orig Reg
	2N502B	*SPR	pnp,MD,ge	620	75	100	1	*30	50	50	3.0	*1.0	9	*PH orig Reg
	2N2369	FA	npn,PE,si	*650	1200	200	6.85	15	500	*80	0.1	*2.5	18	TR, MO, SPR, NUC, TI, AL, AMP, CDC, ITT, IEC
HF 86	2N3303	FA	npn,PE,si	650	3W	200	17	12	1A	*60	100	*6.0	–	MO, TI
	2N4876	TI	npn,EP,si	*650	720	175	4.8	30	200	20	0.5	+3.5	39	
	2N2369A	FA	npn,PE,si	*675	1.2W	200	6.85	15	200	*65	0.05	*23	18	SPR, TI, AL, AMP, CDC, ITT
	2N2708	RCA	npn,EP,si	*700	200	200	–	35	–	180	0.01	1.5	–	AL, AMP
	2N2962	SPR	pnp,ED,ge	*700	3000	100	40	*40	300	–	1.5	7	37	PG = 6 dB @ 160 MHz
	2N2963	SPR	pnp,ED,ge	*700	3000	100	40	*40	300	–	1.5	7	37	PG = 5 dB @ 160 MHz
	2N2964	SPR	pnp,ED,ge	*700	3000	100	40	*30	300	–	1.5	*7	37	PG = 6 dB @ 160 MHz
	2N2965	SPR	pnp,ED,ge	*700	3000	100	40	*30	300	–	1.5	*7	37	PG = 5 dB @ 160 MHz
	2N3304	FA	pnp,PE,si	*700	500	200	2.0	6.0	–	*63	0.010	*1.9	18	TI, MO
	2N3784	MO	pnp,EM,ge	*700	150	100	2	20	20	*20-200	5	*1	72	
HF 87	2N3785	MO	pnp,EM,ge	*700	150	100	2	12	20	*15-200	5	*1	72	
	2N3948	MO	npn,si	*700	1000	200	5.71	20	400	*15	0.1	*4.5	39	RF
	2N4428	TRWS	npn,si	700	3.5W	–65 to 200	–	35	425	20-200	0.02	3.5	39	
	2N4429	TRWS	npn,si	700	5000	–65 to 200	–	35	425	20-200	0.02	3.5	–	
	2N3137	FA	npn,PE,si	*750	1000	200	5.71	20	–	*70	12	*2.8	5	MO
	2N3564	FA	npn,PE,si	*750	500	125	5.0	15	–	*70	0.05	*2.5	–	CDC, IEC, PH
	2N709	FA	npn,PE,si	*800	0.5W	200	5	6.0	–	*55	0.005	*2.5	18	SY, AL, TI, RCA, VEC, AMP
	2N709A	FA	npn,PE,si	*800	500	200	5	6.0	–	*60	0.005	*2.5	18	SY. TR, VEC, TI
	2N709A/46	SY	npn,si	800	400	200	–	*15	–	*30-90	5	*3.0	46	
	2N709A/51	SY	npn,si	800	400	200	–	*15	–	*30-90	0.005	*3.0	51	
HF 88	2N917	FA	npn,DP,si	*800	300	200	1.71	15	–	50	0.0005	*1.5	18	AL, TI, TRWS, NA, IEC
	2N3866	RCA	npn,si	*800	5000	200	28.5	30	400	–	20	*3	39	VEC, MO
	2N3783	MO	pnp,EM,ge	*800	150	100	2	20	20	*20-200	5	*1	72	TI
	2N3832	TI	npn,EP,si	*800	200	200	1.14	6	35	*25-125	0.01	+0.85	72	
	2N4427	RCA	npn,si	*800	3.5 W	200	20	20	0.4 A	–	*20	*4	39	
	2N4875	TI	npn,EP,si	*800	720	175	4.8	25	200	20	0.5	+3.5	39	
	2N2966	PH	–	*850	60	100	0.5	20	100	*15	1	1	18	UHF amplifier
	2N3600	RCA	npn,PE,si	*850	300	–	–	*30	–	*20	0.01	1.7	–	AMP
	2N743/46	SY	npn,si	900	400	200	–	*20	200	*20-60	10	5	46	GI, TR
	2N743/51	SY	npn,si	900	300	200	–	*20	200	*20-60	70	5	51	TR

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 89	2N744/46	SY	npn,si	900	400	200	–	*20	200	*40-120	10	5	46	GI, TR
	2N744/51	SY	npn,si	900	300	200	–	*20	200	*40-120	10	5	51	TR
	2N918	FA	npn,PE,si	*900	300	200	1.71	15	50	*50	0.0002	*1.4	18	MO, AL, TI, NUC, TRWS, VEC, NA, IEC
	2N2729	FA	npn,PE,si	*900	0.8W	200	4.56	15	50	*50	0.0001	*2.4	46	AL, IEC
HF 90	2N3478	RCA	npn,PE,si	900	200	200	–	*30	–	*25	0.02	*2	–	
	2N3563	FA	npn,PE,si	*900	500	125	5.0	12	–	50	0.05	*1.4	–	CDC, IEC, PH
	2N3662	GE	npn,PEP,si	900	200	100	2.67	*18	25	*75	0.5	1.2	98	CDC
	2N3663	GE	npn,PEP,si	900	200	100	2.67	*30	25	*75	0.5	1.2	98	CDC
	2N4874	TI	npn,EP,si	*900	720	175	4.8	20	200	20	0.5	+3.5	39	
	2N700A	MO	pnp,DM,ge	*1000	–	100	1	*25	50	4	2	1.4	17	
	2N955	RCA	pnp,MS,ge	*1000	150	100	–	*12	150	*30	5	*4	18	TI
	2N2748	SY	npn,si	1000	300	200	–	15	–	40-120	0.005	3.0	†	†TO-18, 46, 51, VEC
	2N2808	RA	npn,si	*1000	200	300	1.15	10	25	*20	0.01	*0.7	18	4 Leads
	2N2809	RA	npn,si	*1000	200	300	1.15	15	25	*20	0.01	*0.7	18	4 Leads
HF 91	2N2810	RA	npn,si	*1000	200	300	1.15	10	25	*20	0.01	*0.7	18	4 Leads
	2N2857	RCA	npn,PE,si	*1000	300	200	–	*30	20	*30-150	0.01	1.3	–	AMP, KMC
	2N3572	TI	npn,PL,si	*1000	200	200	1.14	13	50	20-300	0.01	0.85	–	4 Lead sim to TO-18, KMC
	2N3839	RCA	npn,PE,si	1000	300	200	1.14	*30	40	50-220	0.01	0.6	72	
	2N4259	RCA	npn,EP,si	1000	175	175	1.17	*40	–	70-280	0.01	0.35	104	
	2N2929	MO	pnp,EP,ge	*1100	750	100	10	10	100	*10-100	5	*2.5	5	
	2N2808A	RA	npn,si	*1200	200	300	1.15	10	25	*20	0.01	*0.7	18	4 Leads
	2N2809A	RA	npn,si	*1200	200	300	1.15	15	25	*20	0.01	*0.7	18	4 Leads
	2N2810A	RA	npn,si	*1200	200	300	1.15	10	25	*20	0.01	*0.7	18	4 Leads
	2N3571	TI	npn,PL,si	*1200	200	200	1.14	15	50	20-200	0.01	0.85	–	4 Lead sim to TO-18, KMC
HF 92	2N3880	KMC	–	*1200	200	200	1.74	*30	30	*150	0.01	*1.8	72	
	2N3633	TR	npn,si	1300	300	200	1.71	6	50	*75	0.005	*2.5	18	
	2N3953	KMC	–	*1300	*200	200	1.74	*15	30	*200	0.1	*2.0	72	
	2N3959	MO	npn,si	*1300	750	200	4.3	12	30	*40-200	†0.005	*2.5	18	
	2N2999	TI	pnp,ge	*1400	75	100	1	*15	20	15	5	1.7	72	
	2N3570	TI	npn,PL,si	*1500	200	200	1.14	15	50	20-150	0.75	–	–	4 Lead sim TO-18, KMC
	2N3932	RCA	npn,PE,si	*1600	175	175	1.12	30	–	40-150	0.01	0.55	–	
	2N3933	RCA	npn,PE,si	*1600	175	175	1.12	40	–	60-200	0.01	0.55	–	
	2N3960	MO	npn,si	*1600	750	200	4.3	12	30	*40-200	†0.005	*2.5	18	
	2N4260	MO	pnp,AE,si	*1600	200	200	1.14	15	30	*30-150	†0.005	*2.5	72	
HF 93	2N4261	MO	pnp,AE,si	*2000	200	200	1.14	15	30	*30-150	†0.005	*2.5	72	
	2N2480	GE	npn,PE,si	2500	2W	200	11.4	*75	500	*20	0.05	*20	5	diff amp, MO, SPR, TRWS, CDC
	2N144	SY	npn,AL,ge	–	1000	75	–	*60	800	*10.5	500	–	13	
	2N231	*SPR	pnp,SBT,ge	–	9	55	0.9	*4.5	3	66	3	–	24	*PH orig Reg
	2N262	RCA	pnp,ge	–	80	71	–	*34	–	–	5	–	7	
	2N374	RCA	pnp,DR,ge	–	80	71	–	*25	–	–	8	–	7	
	2N656	TI	npn,si	–	4	200	22.8	60	–	*30	10	–	–	TRWS, FA, TR, AMP, CDC, GE, NA, STC, SSP
	2N657	TI	npn,si	–	4	200	2.28	100	–	*30	10	–	–	TRWS, FA, TR, AMP, CDC, GE, NA, STC, SSP
HF 94	2N706A	TI	npn,si	–	300	175	2.0	20	50	2	10	*5	18	FA, SY, MO, TR, GI, ITT, RCA, CDC
	2N710	TI	pnp,ge	–	300	100	4.0	*15	50	6	3	–	18	SY, MO
	2N715	TI	npn,si	–	500	175	3.33	35	100	1	1	*6	18	NA
	2N716	TI	npn,si	–	500	175	3.33	40	100	*10	1	*6	18	NA
	2N738	TI	npn,si	–	500	175	3.33	80	50	20	1	*10	18	TR
	2N739	TI	npn,si	–	500	175	3.33	80	50	40	1	*10	18	TR, SSD
	2N740	TI	npn,si	–	500	175	3.33	80	50	80	1	*10	18	TR, AL, SSD
	2N743	TI	npn,si	–	300	175	2	12	200	*20	1	*5	18	FA, SY, GI, TR, ITT, IEC
	2N744	TI	npn,si	–	300	125	2	12	200	9	1	*5	18	FA, SY, MO, TR, GI, ITT, IEC
HF 95	2N753	TI	npn,si	–	300	175	2	20	50	*40	0.5	*5	18	FA, SY, MO, TR, GI, ITT, CDC, IEC
	2N781	SY	pnp,EP,ge	–	300	100	–	*15	200	*25	3	–	18	AL, TI
	2N782	SY	pnp,EP,ge	–	300	100	–	*12	200	*20	3	–	18	TI
	2N797	TI	npn,ge	–	150	100	2	7	150	6	1	*4	18	
	2N849/TI430	TI	npn,si	–	300	175	2	15	50	6	0.5	*5	50	
	2N850/TI431	TI	npn,si	–	300	175	2	15	50	6	0.5	*5	50	
	2N851/TI422	TI	npn,si	–	300	175	2	12	200	9	–	*5	50	
	2N852/TI423	TI	npn,si	–	300	175	2	12	200	9	–	*5	50	
	2N929	TI	npn,si	–	300	175	2	45	30	60	0.01	*8	18	FA, GI, SPR, AL, TR, MO, UC, NA, IEC, SSD
HF 96	2N930	TI	npn,si	–	300	175	2	45	30	150	0.01	*8	18	FA, GI, SPR, AL, TR, NUC, MO, UC, NA, SSD, IEC
	2N985	TI	pnp,ge	–	150	100	2	7	200	*60	3	*6	18	SY, MO
	2N998	FA	npn,DP,si	–	1800	200	10.3	60	500	*5000	0.01	*25	18	AL, GE, NA, MO
	2N1052	TR	npn,PL,si	–	600	175	6	*200	200	*20-80	–	–	5	
	2N1141	TI	pnp,ge	–	750	100	10	*35	100	*40	0.7	–	–	MO, SY
	2N1141A	TI	pnp,ge	–	750	100	10	*35	100	15.6	4	–	–	SY
	2N1142	TI	pnp,ge	–	750	100	10	*30	100	*40	0.7	–	–	SY, MO
	2N1142A	TI	pnp,ge	–	750	100	10	*30	100	15.6	4	–	–	SY
	2N1143	TI	pnp,ge	–	750	100	10	*25	100	*40	0.7	–	–	SY, MO

High-Frequency *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $^*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (mA)	h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^\dagger I_{CEX}$ (μA)	C_{oe} $^*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 97	2N1143A	TI	pnp,ge	–	750	100	10	*30	100	15.6	4	–	–	SY
	2N1247	TR	npn,PLE,si	–	30	150	0.24	6	5	*15	0.005	*20	5	GE
	2N1507	TI	npn,si	–	600	175	4	*60	1000	*100	1	*35	5	TRWS, CDC, TI
	2N1564	TI	si,npn	–	600	175	4	60	50	20	1	*10	5	TRWS, TR, NA
	2N1565	TI	npn,si	–	600	175	4	60	50	40	1	*10	5	TRWS, TR, NA
HF 98	2N1566	TI	npn,si	–	600	175	4	60	50	80	1	*10	5	TRWS, TR, NA
	2N1572	TI	npn,si	–	600	175	4	80	50	20	1	*10	5	TR
	2N1573	TI	npn,si	–	600	175	4	80	5	40	1	*10	5	TR
	2N1574	TI	npn,si	–	600	175	4	80	50	80	1	*10	5	TR
	2N1646	TI	pnp,ge	–	150	100	2	*15	50	*20	3	*5	–	
	2N1742	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	9	*PH orig Reg
	2N1743	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	9	*PH orig Reg
	2N1744	*SPR	–	–	60	125	–	*20	–	*33	1	–	9	*PH orig Reg
	2N1745	*SPR	–	–	60	125	–	*20	–	*33	1	–	9	*PH orig Reg
	2N1754	*SPR	pnp,MD,ge	–	50	100	0.8	*13	100	*20	1.0	*1.5	9	*PH orig Reg, GI
HF 99	2N1865	*SPR	pnp,MD,ge	–	60	100	0.8	*20	50	70	1.0	–	9	*PH orig Reg
	2N1866	*SPR	pnp,MD,ge	–	60	100	0.8	*35	50	70	1.0	–	9	*PH orig Reg
	2N1867	*SPR	pnp,MD,ge	–	60	100	0.8	*35	50	50	1.0	–	9	*PH orig Reg
	2N1868	*SPR	pnp,MD,ge	–	60	100	0.8	*20	50	*33	1.5	–	9	*PH orig Reg
	2N1960	SY	pnp,ge	–	150	100	–	*15	200	*25	3.0	–	46	
	2N1961	SY	pnp,EP,ge	–	150	100	–	*12	200	*20	3.0	–	46	
	2N1990	FA	npn,DD,si	–	2W	150	16	*100	1A	*30	1.0	–	5	TRWS, CDC, SY, GI, AMP, AL, NUC
	2N2188	TI	pnp,ge	–	125	85	2.1	25	30	40	3	*2.5	–	
	2N2189	TI	pnp,ge	–	125	85	2.1	25	30	60	3	*2.5	–	
	2N2190	TI	pnp,ge	–	125	85	2.1	25	30	40	3	*2.5	–	IEC
HF 100	2N2191	TI	pnp,ge	–	125	85	2.1	25	30	60	3	*2.5	–	
	2N2192A	GE	npn,PE,si	–	2.8W	200	16	40	1A	*100-300	0.010	*20	5	CDC, GI, FA, NA, MO, AL, TI
	2N2360	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	12	RF Amp, *PH orig Reg
	2N2361	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	12	RF mixer, *PH orig Reg
	2N2362	*SPR	–	–	60	125	–	*20	–	*33	1	–	12	RF osc, *PH orig Reg
	2N2389	TI	npn,si	–	450	200	2.57	*75	500	35	0.01	*25	50	
	2N2395	TI	npn,si	–	450	200	2.57	40	300	*20	0.01	*30	50	
	2N2399	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	12	RF mixer, *PH orig Reg
	2N2398	*SPR	–	–	60	125	–	*20	–	*33	0.8	–	12	RF amp, *PH orig Reg
	2N2410	TI	npn,si	–	800	200	4.57	30	800	*30	0.3	*11	5	FA, NA
HF 101	2N2411	TI	pnp,si	–	300	200	1.72	20	100	*20	0.01	*5	18	IEC
	2N2412	TI	pnp,si	–	300	200	1.72	20	100	*40	0.01	*5	18	IEC
	2N2413	TI	npn,si	–	300	175	2	18	200	*30	0.1	*5	18	
	2N2415	TI	pnp,ge	–	75	100	1	10	20	15	5	*2	18	MO
	2N2416	TI	pnp,ge	–	75	100	1	10	20	10	5	*2	18	MO
	2N2485	NA	npn,D,si	–	8700	175	50	120	–	–	1.0	*12	5	VHF Power 5W @ 100 MHz
	2N2486	NA	npn,D,si	–	8700	175	50	140	–	–	1.0	*12	5	VHF Power 3W @ 200 MHz
	2N2635	TI	npn,ge	–	150	100	2	12	100	*45	5	*5	18	SY, MO
	2N2649	NA	npn,D,si	–	8700	175	50	65	–	–	1.0	*12	5	2W @ 130 MHz
	2N2650	NA	npn,D,si	–	8700	175	50	140	–	–	1.0	*12	5	VHF Power 4.5W @ 130 MHz
HF 102	2N2723	SSD	n,PL	–	800	200	4.6	60	40	*2000	0.010	–	18	Darlington amp, SPR, MO
	2N2724	SSD	n,PL	–	800	200	4.6	60	40	*7000	0.010	–	18	Darlington amp, SPR, MO
	2N2725	SSD	n,PL	–	800	200	4.6	45	30	*2000	0.002	–	18	Darlington amp, SPR, MO
	2N2861	TI	pnp,si	–	300	200	1.72	20	100	50	0.01	*6	18	
	2N2862	TI	pnp,si	–	300	200	1.72	20	100	25	0.01	*6	18	
	2N2863	TI	npn,si	–	800	200	4.57	25	1000	*30	0.5	*13	5	
	2N2864	TI	npn,si	–	800	200	4.57	25	1000	*20	–	*13	5	
	2N2865	TI	npn,si	–	200	200	1.14	13	50	20	0.01	*25	–	AL
	2N2936	TI	npn,si	–	300	175	2	55	30	150	0.01	*8	–	AMP, SPR
	2N2937	TI	npn,si	–	300	175	2	55	30	150	0.01	*8	–	AMP, GI, SPR
HF 103	2N3016	BE	npn,PE,si	–	25,000	150	420	50	2500	*60-150	0.1	*50	5	SSP
	2N3017	BE	npn,PE,si	–	25W	150	420	50	5A	*60-150	0.1	*50	†	†MT27
	2N3018	BE	npn,PE,si	–	25,000	150	420	50	10,000	*60-150	0.1	*50	–	Isolated Collector
	2N3138	NA	npn,D,si	–	20,000	200	125	65	2000	–	500	30	24	VHF Power 7.5W @ 70 MHz
	2N3139	NA	npn,D,si	–	20,000	200	125	140	200	–	500	*30	24	VHF Power 14W @ 70 MHz
	2N3140	NA	npnD,si	–	20,000	200	125	65	2000	–	500	*30	24	VHF Power 4W @ 130 MHz
	2N3141	NA	npn,D,si	–	20,000	200	125	140	2000	–	500	*30	24	VHF Power 8W @ 130 MHz
	2N3142	NA	npn,D,si	–	25,000	200	142	65	2000	–	500	*30	16	VHF Power 5.4W @ 70 MHz
	2N3143	NA	npn,D,si	–	25,000	200	142	140	2000	–	500	*30	16	VHF Power 8.3W @ 70 MHz
	2N3144	NA	npn,D,si	–	25,000	200	142	65	2000	–	500	*30	16	VHF Power 4.0W @ 130 MHz
HF 104	2N3145	NA	npn,D,si	–	25,000	200	142	140	2000	–	500	*30	16	VHF Power 6.0W @ 130 MHz
	2N4315	AMP	npn,DPE,si	–	400	200	2.66	25	50	250	0.01	*6	77	

Selected devices from the Amperex Total Capability...

SEMICONDUCTORS

for RF Applications:

Low Power to 1500 MHz with Low Noise (3db) and Low Intermodulation Distortion:
Use the Amperex 2N5054 and A210 families.

High Gain, Extremely Low Feedback IF Amplifiers for frequencies through 60 MHz:
Use the Amperex A467 and A473 families.

General purpose RF and IF Amplifiers for AM/FM and TV Applications:
Use the Amperex A415, A484 and A494 families.

High Power to 36 watts at 175 MHz at 12.0V and 28.0V:
Use the Amperex A202 and 2N3632 families.

To 22 watts at 450 MHz or 8 watts at 1 GHz:
Use the Amperex 1N4885 Varactor family.

for Drive Applications:

In Video Circuitry:
Use the Amperex A779 family.

In Indicator and Memory Circuits:
Use the Amperex A983 SCS family.

In Control Circuitry:
Use the Amperex A903 SCR family.

In Audio/Power Circuitry:
Use the Amperex A523 family.

for Small Signal and Logic Applications:

To amplify low level signals to output levels between 1 μA and 500 mA:
Use the Amperex 2N2484, 2N2222 and 2N2920 families.

Chopping or switching low level signals to output levels of up to 100 mA:
Use the Amperex 2N2569 and 2N2369 families.

To amplify at impedance levels of 10,000 megohms with low noise and high gain.
Use the Amperex A190 and A192 families of FET's.

for Diode and Rectifier Applications:

In High Speed Switching:
Use the Amperex A23 diode.

In Controlled Avalanche (12.5KV) CRT Focus Rectifier Circuits:
Use the Amperex A74.

In High Voltage Power Supplies up to 800V DC Output.
Use the Amperex BY127 Rectifier family.

In Bridge Rectifiers up to 400V DC Output:
Use the Amperex BY123 Bridge Rectifier Assembly.

for Audio Applications:

Small Signal Silicon:
Use the Amperex A104 series in TO-18 and the A747 series in the plastic autosert package.

Silicon Power:
Use the Amperex A515 in high voltage applications and the A522, A523 and A572 for high power.

Complementary Germanium Pairs:
Use the Amperex 2N4136 pair for 2-watt systems and the 2N4107 or 2N4079 pairs for higher power.

...for all your solid state design requirements

MICROELECTRONICS

Linear Monolithic Integrated Circuits for:

Small Signal Amplifiers up to 600 KHz:
Use the Amperex TAA103, TAA263, TAA293.

High Gain Audio Preamplifiers for Playback/Record:
Use the Amperex TAA310.

High Input Impedance, High Gain, Preamplifiers:
Use the Amperex TAA320 BiFET. (A bipolar transistor and MOS/FET on a single chip.)

Hybrid Integrated Circuits for:

Control and Analog Amplification DC to 2MHz:
Use the Amperex ATF401 Operational Amplifier.

Custom Circuits for best combination of economy, performance and size:
Use the Amperex Hybrid IC capability to fulfill your custom design requirements.

LDS (Leadless Inverted Devices)

For your custom, in-house, hybrid integrated circuit designs, Amperex offers the discrete semiconductors listed on the facing page, and many more, packaged in Amperex LIDS: *Use the Amperex LDA Amplifier, LDD Diode and LDS Switching Families.*

Write for our latest condensed catalog. It includes basic specifications and application references on the entire line of transistors, diodes, integrated circuits and LIDS. Amperex Electronic Corporation, Semiconductor and Receiving Tube Division, Department 371, Slatersville, Rhode Island 02876.

Amperex®

TOMORROW'S THINKING IN TODAY'S PRODUCTS

ON READER SERVICE CARD CIRCLE 64

Power one watt and above

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
				P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)		
P 1	2N341A	TR	npn,PL,si	0.25	0.003	175	125	0.15	*20-80	0.001	10000	11	ETC
	2N709	FA	npn,PE,si	0.5	0.005	200	6.0	–	*55	0.000005	80000	18	SY, TI,TR, VEC, AMP
	2N2038	TR	npn,PL,si	0.6	0.0055	175	45	0.5	*12-36	0.015	2000	5	ETC
	2N2039	TR	npn,PL,si	0.6	0.0055	175	75	0.5	*12-36	0.015	2000	5	ETC
	2N2040	TR	npn,PL,si	0.6	0.0055	175	45	0.5	*30-90	0.015	2000	5	ETC
P 2	2N2041	TR	npn,PL,si	0.6	0.0055	175	75	0.5	*30-90	0.015	2000	5	ETC
	2N957	FA	npn,DD,si	0.8	0.0065	150	20	–	*60	10	*250000	18	TRWS, AMP, IEC
	2N339	TI	npn,si	1	0.008	150	55	0.06	9	0.001	–	11	TR, ETC
	2N340	TI	npn,si	1	0.008	150	85	0.06	9	0.001	–	11	TR
	2N341	TI	npn,si	1	0.008	150	85	0.06	9	0.001	–	11	TR
	2N342	TI	npn,si	1	0.008	150	60	0.06	9	0.001	–	11	TR
	2N342A	TI	npn,si	1	0.008	150	85	0.06	9	0.001	–	11	TR
	2N342B	TI	npn,si	1	0.008	150	85	0.06	9	0.001	–	11	
	2N343	TI	npn,si	1	0.008	150	60	0.06	28	0.001	–	11	TR
	2N343A	TI	npn,si	1	0.008	150	60	0.06	15	0.001	–	11	TR
P 3	2N343B	TI	npn,si	1	0.008	150	65	*0.06	28	0.001	–	11	TR
	2N706	FA	npn,DD,si	1	0.0067	175	*25	–	*45	0.000005	400000	18	ITT,SPR,SY,MO,TR,AMP GI, NUC, CDC, IEC
	2N707	FA	npn,DD,si	1	0.0067	175	*56	–	*12	0.000005	400000	18	TRWS, MO, GI
	2N2106	GE	npn,si	1	0.008	200	*60	1	12-36	0.2	15000	5	TR, TI
	2N2107	GE	npn,si	1	0.008	200	*60	1	30-90	0.2	15000	5	TR, TI
	2N2108	GE	npn,si	1	0.008	200	*60	1	75-200	0.2	15000	5	TR, TI
	2N3948	MO	npn,si	1	0.006	200	20	0.4	*15	0.00001	700,000	39	
	2N708	FA	npn,DP,si	1.2	0.0069	200	15	–	*50	0.000004	400000	18	ITT,SY,MO,TR,GI,AMP, NA, NUC, TI, CDC, IEC
P 4	2N869	FA	pnp,DP,si	1.2	0.00686	200	18	–	*60	0.000005	*200000	18	MO, AL, IEC
	2N914	FA	npn,PE,si	1.2	0.0069	200	15	–	*55	0.000004	*370000	18	ITT,MO,TR,GI,NUC,SPR,TI, AMP, IEC
	2N915	FA	npn,DP,si	1.2	0.0069	200	50	–	*100	0.000005	*300000	18	NA, MO, AL, IEC
	2N916	FA	npn,DP,si	1.2	0.0069	200	25	–	*100	0.000005	*400000	18	TRWS, NA, MO, TI, AL, IEC
	2N947	FA	npn,DP,si	1.2	0.0069	200	*20	0.1	*40	10	*250000	18	
	2N995	FA	pnp,PE,si	1.2	0.0069	200	15	–	*70	0.000001	*150000	18	TR, MO, TI, AL, IEC
	2N996	FA	pnp,PE,si	1.2	0.00685	200	12	–	*75	0.0002	*230000	18	TR, AMP, IEC
	2N2368	FA	npn,PE,si	1.2	0.0685	200	15	0.5	*40	0.001	550000	18	TR,AL,MO,SPR,TI,AMP,CDC, ITT, IEC
P 5	2N2369	FA	npn,PE,si	1.2	0.00685	200	15	0.5	*80	0.001	*650000	18	TR, MO, AL, NUC, SPR, TI, CDC, IEC
	2N978	FA	pnp,DD,si	1.25	0.010	150	20	–	*30	0.001	*60000	18	TR
	2N717	FA	npn,DD,si	1.5	0.010	175	*60	–	*40	0.00001	60000	18	TRWS, CDC, TR, GI, AMP NA, TI, IEC
	2N718	FA	npn,DD,si	1.5	0.010	175	*60	–	*75	1	80	18	TRWS, CDC, SY, MO, TR, GI, AMP, AL, NA, ITT, IEC
	2N719	FA	npn,DD,si	1.5	0.010	175	*120	–	*40	0.001	60000	18	TRWS, CDC, TR, GI, AMP, TI
	2N720	FA	npn,DD,si	1.5	0.010	175	*120	–	*80	0.001	80000	18	TRWS, CDC, TR, GI, AMP, AL, NA, TI, CDC
P 6	2N721	FA	pnp,DD,si	1.5	0.010	175	35	–	*60	0.001	*60000	18	KSC, TR, CDC, NA, IEC
	2N722	FA	pnp,DD,si	1.5	0.010	175	35	–	*50	0.001	*90000	18	KSC, MO, TR, NA, IEC
	2N4105	AMP	npn,ge	1.6	2.5	90	*25	1.0	*200	0.025	*1.0	1	
	2N4106	AMP	pnp,ge	1.6	2.5	90	*25	1.0	*200	0.025	*1.0	1	
	2N718A	FA	npn,DP,si	1.8	0.0103	200	*75	–	*80	0.0000003	80000	18	CDC, TR, AMP, AL, GI, RCA, NA, MO, TRWS, TI
	2N719A	FA	npn,DP,si	1.8	0.0103	200	*120	–	*40	0.000005	60000	18	TRWS, CDC, AMP, AL, GI, TR, TI
	2N720A	FA	npn,DP,si	1.8	0.0103	200	*120	–	*80	0.000005	60000	18	TRWS, CDC, GI, AMP, AL, RCA, TR, TI
P 7	2N870	FA	npn,DP,si	1.8	0.0103	200	60	–	*75	0.000004	80000	18	CDC, GI, AMP, AL, TI, IEC
	2N871	FA	npn,DP,si	1.8	0.0103	200	60	–	*130	0.000004	100000	18	CDC, GI, AMP, AL, RCA, NA, TI, IEC
	2N910	FA	npn,DP,si	1.8	0.0103	200	60	–	140	0.000005	*80000	18	TRWS, CDC, AL, TI, NA
	2N911	FA	npn,DP,si	1.8	0.0103	200	60	–	70	0.000005	*70000	18	TRWS, CDC, AL, TI, CDC
	2N912	FA	npn,DP,si	1.8	0.0103	200	60	–	45	0.000005	*60000	18	TRWS, CDC, AL, TI
	2N696	FA	npn,DD,si	2	0.0133	175	*60	–	*40	0.00001	–	5	TRWS, TR, GI, AMP, CDC, NA. TI, ITT, IEC
	2N697	FA	npn,DD,si	2	0.0133	175	*60	–	*75	0.00001	–	5	TRWS, MO, TR, GI, AMP, CDC, ITT, IEC
P 8	2N699	FA	npn,DD,si	2	0.0133	175	*120	–	*80	0.00001	–	5	TRWS, SY, TR, GI, AMP, CDC, RCA, NA, TI
	2N1131	FA	pnp,DD,si	2	0.0133	175	35	0.6	*30	0.00001	*70000	5	MO, TI, NA, IEC
	2N1132	FA	pnp,DD,si	2	0.0133	175	35	0.6	*45	0.00001	*90000	5	MO, TI, NA, IEC
	2N1252	FA	npn,DD,si	2	0.0133	175	*30	–	*35	0.0001	*80000	5	SY, TR, NA, IEC
	2N1253	FA	npn,DD,si	2	0.0133	175	*30	–	*45	0.0001	*110000	5	NA, IEC
	2N1420	FA	npn,DD,si	2	0.0133	175	*60	–	*700	0.00001	100000	5	TRWS, CDC, MO, TR, SI, NA, AMP, TI, IEC
	2N1837	TRWS	npn,PL,si	2	0.013	175	*80	0.50	*40-120	0.0005	4500	5	CDC
	2N1838	TRWS	npn,PL,si	2	0.013	175	*45	0.50	*40-150	0.0015	2300	5	CDC

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 9	2N1839	TRWS	npn,PL,si	2	0.013	175	*45	0.50	*12-50	0.0015	3500	5	CDC
	2N1840	TRWS	npn,PL,si	2	0.013	175	*25	0.50	*10-100	0.30	2000	5	CDC
	2N1983	FA	npn,DD,si	2	0.016	150	25	–	100	0.001	30000	5	AMP, ETC, AL, CDC
	2N1984	FA	npn,DD,si	2	0.016	150	25	–	80	0.001	30000	5	AMP, ETC, AL, CDC
	2N1985	FA	npn,DP,si	2	0.016	150	25	–	60	0.001	30000	5	AMP, ETC, AL, CDC
P 10	2N1986	FA	npn,DD,si	2.0	0.016	150	25	–	150	0.001	50000	5	GI, AMP, ETC, AL, CDC
	2N1987	FA	npn,DD,si	2	0.016	150	25	–	50	0.001	50000	5	GI, AMP, ETC, AL, CDC
	2N1988	FA	npn,DD,si	2	0.016	150	45	–	*75	0.001	50000	5	GI, ETC, AL, CDC
	2N1989	FA	pnp,DD,si	2	0.016	150	45	–	*40	0.001	50000	5	STC, ETC, AL, CDC
	2N1990	FA	npn,DD,si	2	0.016	150	*100	1.0	*30	0.001	–	5	SY, GI, AMP, AL, CDC, IEC
	2N1991	FA	pnp,DD,si	2	0.016	150	*30	–	*30	0.001	50000	5	TR, MO, CDC
	2N2303	FA	pnp,DD,si	2	0.0133	175	35	–	*90	0.001	70000	5	TR, MO, TI, IEC
	2N3241A	RCA	npn,DPE,si	2	0.02	175	25	–	*150	0.1	*175	104	
	2N3242A	RCA	npn,DPE,si	2	0 02	175	40	–	*200	0.01	*175	104	
	2N4074	RCA	npn,DPE,si	2	0.2	175	40	0.3	*150	0.01	*80	104	
P 11	2N1335	TRWS	pnp,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1336	TRWS	npn,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1337	TRWS	npn,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1338	TRWS	npn,PL,si	2.8	0.019	175	*80	0.30	*10-150	0.001	–	5	
	2N1339	TRWS	npn,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1340	TRWS	npn,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1341	TRWS	npn,PL,si	2.8	0.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1342	TRWS	npn,PL,si	2.8	0.019	175	*150	0.30	*12	0.01	–	5	
	2N1409	TRWS	npn,PL,si	2.8	0.0187	175	*30	0.50	*15-45	0.010	5000	5	GI
	2N1410	TRWS	npn,PL,si	2.8	0.0187	175	*45	0.50	*30-90	0.010	2500	5	GI
P 12	2N2192A	GE	npn,si	2.8	0.016	200	40	1	100-300	0.01	130000	5	CDC, GI, MO, FA, NA, AL, TI
	2N2193A	GE	npn,PE,si	2.8	0.016	200	50	1	40-120	1	–	5	CDC, FA, GI, MO, NA, AL, TI
	2N2194A	GE	npn,PE,si	2.8	0.016	200	40	1	*20-60	1	–	5	CDC, FA, GI, MO, NA, AL, TI
	2N2195A	GE	npn,PE,si	2.8	0.016	200	25	1	20	0.01	130000	5	CDC, FA, GI, MO, AL, TI
	2N2243A	GE	npn,PE,si	2.8	0.016	200	80	1	*40-120	0.1	–	5	CDC, TI, AL, NA
	2N698	FA	npn,DP,si	3	0.0172	200	60	–	*40	0.000005	–	5	TRWS, TR, GI, AMP, CDC
	2N1206	TR	npn,PL,si	3	0.025	175	60	0.15	*20-80	0.001	10,000	5	TI
	2N1207	TR	npn,PL,si	3	0.025	175	125	0.15	*20-80	0.001	10,000	5	TI
	2N1505	TRWS	npn,PL,si	3	0.175	175	*50	0.5	*7-100	0.05	20000	5	NUC, NA
	2N1506	TRWS	npn,PL,si	3	0.175	175	*60	0.5	*10-100	0.01	20000	5	NUC, STC, RCA, NA
P 13	2N1561	MO	pnp,DM,ge	3	0.04	100	25	0.25	10	0.01	*500	–	
	2N1562	MO	pnp,DM,ge	3	0.04	100	25	0.25	9	0.01	*450	–	
	2N1613	FA	npn,DP,si	3	0.0172	200	*75	–	*80	0.000003	80000	5	TRWS, CDC, MO, TR, GI, AMP, AL, RCA, TI, IEC
	2N1692	MO	pnp,DM,ge	3	0.04	100	25	0.25	10	0.01	*500	–	
	2N1693	MO	pnp,DM,ge	3	0.04	100	0.04	0.25	9	0.01	450	–	
	2N1711	FA	npn,DT,si	3	0.0172	200	*75	–	*130	0.0000003	100000	5	TRWS, CDC, MO, TR, GI, AMP, NA, RCA, IEC
	2N1893A	TRWS	npn,PL,si	3	0.017	200	*140	0.50	*40-120	0.0001	3000	5	GI, TR, NA, TI, AL
	2N1973	FA	npn,DP,si	3	0.00456	200	60	–	140	0.000005	80000	5	TRWS, AMP, TR, CDC
P 14	2N1974	FA	npn,DP,si	3	0.0172	200	60	–	70	0.000005	70000	5	AL, TRWS, AMP, TR, CDC
	2N1975	FA	npn,DP,si	3	0.0172	200	60	–	45	0.000005	60000	5	TRWS, AMP, TR, CDC
	2N2049	FA	npn,DP,si	3	0.0172	200	*75	–	*130	0.000004	86000	5	AL, CDC
	2N3732	RCA	pnp,DJ,ge	3	0.1	85	*–100	3	–	0.2	–	3	
	2N1506A	TRWS	npn,PL,si	3.5	0.200	200	*80	0.5	*10-100	0.0005	20000	5	VEC, NA
	2N497	TI	npn,TD,si	4	0.0228	200	60	1	*12-36	0.01	*20	5	TRWS, STC, CDC, GE, NA
	2N498	TI	npn,TD,si	4	0.0228	200	100	1	*12-36	0.01	*20	5	TRWS, STC, CDC, GE, NA
	2N656	TI	npn,si	4	0.0228	200	60	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC,STC SSP, GE, NA
	2N657	TI	npn,si	4	0.0228	200	100	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, STC, GE, NA
P 15	2N1445	TI	npn,TD,si	4	0.0228	200	120	1	*20-80	0.01	*20	5	
	2N1943	TI	npn,TD,si	4	0.0228	200	60	1	*30-90	0.01	*20	5	
	2N2657	SOL	npn,si	4	0.04	200	*80	5.0	*40-120	100	20000	5	TI, AMP, SSP, NA
	2N2658	SOL	npn,si	4	0.04	200	*100	5.0	*40-120	0.0001	20000	5	TI, AMP, SSP, NA
	2N3469	SOL	npn,si	4	0.04	200	35	5	*100	0.0001	*20,000	5	TI
	2N497A	GE	npn,si	5	0.0286	200	60	1	12-36	0.010	15,000	5	SSP, TR, TI
	2N498A	GE	npn,si	5	0.0286	200	100	1	12-36	0.01	15,000	5	TR, SSP, TI
	2N656A	GE	npn,si	5	0.0286	200	60	1	30-90	0.010	15,000	5	TR, SSP, TI, NA
	2N657A	GE	npn,si	5	0.0286	200	100	1	30-90	0.01	15,000	5	TR, SSP, TI, NA
	2N699B	FA	npn,DD,si	5	0.0286	200	80	–	*80	0.3	–	5	GI, TRWS, CDC
P 16	2N1067	–	npn,si	5	0.33	175	*60	0.5	*15-75	0.5	10	8	STC
	2N1479	RCA	npn,si	5	0.0286	200	40	1.5	*20-60	0.01	50	5	STC, TR
	2N1480	RCA	npn,si	5	0.0286	200	55	1.5	*20-60	0.01	50	5	STC, TR
	2N1481	RCA	npn,si	5	0.0286	200	40	1.5	*35-100	0.01	50	5	STC, TR
	2N1482	RCA	n pn,si	5	0.0286	200	55	1.5	*35-100	0.01	50	5	STC, TR
	2N1615	TR	npn,PL,si	5	0.045	175	100	0.2	*25	0.002	2000	5	CDC
	2N1700	RCA	npn	5	0.0286	200	40	1	*20-80	0.075	40	5	STC, TR, TI
	2N2017	GE	npn,si	5	0.0285	200	60	1	*15-200	0.01	–	5	CDC, TR, TI
	2N2282	BE	pnp,ge	5	0.066	110	30	3	*20	–	–	37	
	2N2283	BE	pnp,ge	5	0.066	110	60	3	*20	100	–	37	

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} $^*V_{CBO}$ (V)	I_c (A)	h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^\dagger I_{CEX}$ (mA)	f_{ae} $^*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 17	2N2284	BE	pnp,ge	5	0.066	110	100	3	*20	100	–	37	
	2N2270	RCA	npn,si	5	0.0286	200	45	1	*50-200	50	1000	5	CDC, GI, TR, NA
	2N2297	FA	npn,PE,si	5	0.0286	200	35	1.0	*50	0.2	90000	5	TR, NA, AL
	2N2350A	GE	npn,PE,si	5	0.0285	200	25	1	*20	0.1	–	46	
	2N2351A	GE	npn,PE,si	5	0.0285	200	50	1	*40-120	1	–	46	NA
P 18	2N2352A	GE	npn,PE,si	5	0.0285	200	40	1	20-60	1	–	46	NA
	2N2353A	GE	npn,PE,si	5	0.0285	200	25	1	*20	1	–	46	NA
	2N2364A	GE	npn,PE,si	5	0.0285	200	80	1	*40-120	0.0001	–	46	
	2N2726	GE	npn,si	5	0.0266	200	*200	1	*30-90	0.01	–	5	TI
	2N2727	GE	npn,si	5	0.0266	200	*200	1	*75-150	0.01	–	5	TI
	2N2890	FA	npn,PE,si	5	0.0286	200	80	–	55	0.000002	*50000	5	TI, NA
	2N2891	FA	npn,PE,si	5	0.0286	200	80	–	*80	0.000002	*50000	5	TI, NA
	2N3016	BE	–	5	–	–	*100	2.5	*60-150	0.001	–	5	
	2N3056	FA	npn,DPE,si	5	0.286	200	*100	1	*120	0.010	80,000	46	
	2N3056A	FA	npn,DPE,si	5	0.286	200	*140	1	*120	0.010	200 MHz	46	
P 19	2N3057	FA	npn,DPE,si	5	0.286	200	*100	1	*300	0.010	100 MHz	46	
	2N3057A	FA	npn,DPE,si	5	0.286	200	*140	1	*300	0.010	200 MHz	46	
	2N3114	FA	npn,DP,si	5	0.0286	200	150	–	*60	0.3	*54000	5	MO, TRWS, TI, NA
	2N3374	VEC	npn,PE,si	5	0.286	200	80	0.5	2.9	0.00001	–	5	
	2N3439	RCA	npn,si	5	0.33	200	350	1	*40-160	*0.02	–	5	
	2N3440	RCA	npn,si	5	0.33	200	250	1	*40-160	*0.05	–		
	2N3660	TR	pnp,si	5	0.028	200	30	2	50	0.00001	30 MHz	5	TI
	2N3661	TR	pnp,si	5	0.028	200	50	2	50	0.00001	30 MHz	5	TI
	2N3665	TR	npn,si	5	0.028	200	80	1	*80	0.00005	60 MHz	5	TI
	2N3665	FA	npn,DPE,si	5	0.0286	200	*120	1	*120	150	60,000	5	TI
P 20	2N3666	FA	npn,DPE,si	5	0.0286	200	*120	1	*300	150	60,000	5	TI
	2N3699	MO	pnp,AE,si	5	0.0286	200	60	3	*35-150	0.001	*60 MHz	5	TI
	2N3731	RCA	pnp,DJ,ge	5	0.16	85	*–320	10	–	0.2	–	3	
	2N3916	FA	npn,DP,si	5	0.040	150	150	10	*150	–	50,000	5	
	2N3719	MO	pnp,AE,si	6	0.034	200	40	3	*25-180	0.01	*60000	5	TI
	2N3720	MO	pnp,AE,si	6	0.034	200	60	3	*25-180	0.01	*60000	5	TI
	2N4234	MO	pnp,si	6	0.034	200	40	3.0	30-150	*1.0	*3000	5	
	2N4235	MO	pnp,si	6	0.034	200	60	3.0	*30-150	*1.0	*3000	5	
	2N4236	MO	pnp,si	6	0.034	200	80	3.0	*30-150	*1.0	*3000	5	
	2N326	SY	npn,AL,ge	7	–	85	*35	2	*15-60	0.5	0.15	3	
P 21	2N3593	GE	npn,MS,si	7	0.04	175	*200	1	*30-90	0.001	–	–	
	2N3594	GE	npn,MS,si	7	0.04	175	*200	1	*75-150	0.001	–	–	
	2N4862	SOL	npn,PL,si	7	25	200	120	2	50-150	0.1	80,000	46	
	2N4863	SOL	npn,PL,si	7	25	200	120	2	50-150	0.1	80,000	5	
	2N1183	RCA	pnp,ge	7.5	0.1	100	20	3	*20-60	0.25	10	8	
	2N1183A	RCA	pnp,ge	7.5	0.1	100	30	3	*20-60	0.25	10	8	
	2N1183B	RCA	pnp,ge	7.5	0.1	100	40	3	*20-60	0.25	10	8	
	2N1184	RCA	pnp,ge	7.5	0.1	100	20	3	*40-120	0.25	10	8	
	2N1184A	RCA	pnp,si	7.5	0.1	100	30	3	*40-120	0.25	10	8	
	2N1184B	RCA	pnp,ge	7.5	0.1	100	40	3	*40-120	0.25	10	8	
P 22	2N4077	AMP	npn,ge	7.5	0.12	90	*32	1.0	*150	0.025	*1.0	–	
	2N4078	AMP	pnp,ge	8.0	0.13	90	*32	1.0	*150	0.018	*1.0	–	
	2N122	TI	npn,si	8.75	0.07	150	*120	0.14	*3	0.01	–	–	
	2N2033	STC	npn,si	8.75	0.5	200	*80	3	*20	0.15	–	5	
	2N2034	STC	npn,si	8.75	0.5	200	*80	3	*20	0.15	–	5	
	2N2631	RCA	npn,si	8.75	0.05	200	60	1.5	*50-250	0.0001	1500	39	VEC, TI
	2N2858	STC	npn,si	8.75	–	–	*100	3	*20	–	–	5	
	2N2859	STC	npn,si	8.75	–	–	*120	3	*20	–	–	5	
	2N2881	STC	pnp	8.75	0.05	200	60	2.0	*20-60	–	–	5	CT, TI
	2N2882	STC	pnp	8.75	0.05	200	100	2.0	*20-60	–	–	5	CT, TI
P 23	2N2911	STC	npn	8.75	0.05	200	125	3.0	*20-60	–	–	5	TI
	2N3202	STC	pnp,si	8.75	0.05	200	–40	–3	*20-60	†0.075	–	5	CT
	2N3203	STC	pnp,si	8.75	0.05	200	–60	–3	*20-60	†0.075	–	5	CT
	2N3204	STC	pnp,si	8.75	0.05	200	–80	–3	*20-60	†0.075	–	5	CT
	2N3208	STC	pnp,si	8.75	0.05	200	–40	–2	*20-60	†0.075	–	5	CT
	2N1068		npn,si	10	0.067	175	*60	1.5	*15-75	0.5	10	8	STC, KSC
	2N1714	TI	npn,si	10	0.134	175	60	1	*20	1	–	–	SSP
	2N1715	TI	npn,si	10	0.134	175	100	1	*20	1	–	–	BE, SSP
	2N1716	TI	npn,si	10	0.134	175	60	1	*40	1	–	–	SSP
	2N1717	TI	npn,si	10	0.134	175	100	1	*40	1	–	–	SSP
P 24	2N1718	TI	npn,si	10	0.134	175	60	1	*20	1	–	–	SSP
	2N1719	TI	npn,si	10	0.134	175	100	1	*20	1	–	–	SSP
	2N1720	TI	npn,si	10	0.134	175	60	1	*40	1	–	–	SSP
	2N1721	TI	npn,si	10	0.134	175	100	1	*40	1	–	–	SSP
	2N2017	TI	–	10	–	–	*100	5	*30	–	–	†	†MT-27
	2N2067	ITT	pnp,AJ,ge	10	–	100	*40	3.0	–	–	7	†	†MS7, KSC
	2N2067B	ITT	pnp,AJ,ge	10	–	100	*40	3.0	–	–	7	†	†MS7, KSC
	2N2067G	ITT	pnp,AJ,ge	10	–	100	*40	3.0	–	–	7	†	†MS7, KSC
	2N2067-0	ITT	pnp,AJ,ge	10	–	100	*40	3.0	–	–	7	†	†MS7, KSC
	2N2067W	ITT	pnp,AJ,ge	10	–	100	*40	3.0	–	–	7	†	†MS7, KSC

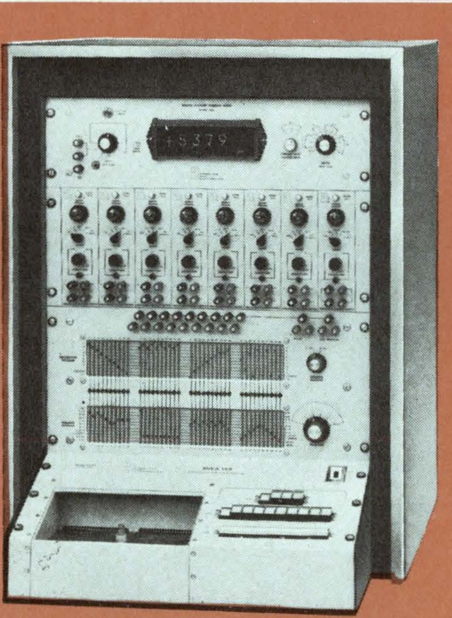
Circle as many numbers on the reader-service card as you like.

ON READER-SERVICE CARD CIRCLE 65 ➤

NEW

semi-automatic integrated circuit analyzer

MICA 150



COMPUTER TEST CORPORATION

Now the integrated circuit user can get all the flexibility and performance of an expensive, large scale IC test system in an accurate and reliable DC bench top analyzer.

The new MICA-150 Modular Integrated Circuit Analyzer tests all IC configurations of up to 40 pins with unique programming, fast pushbutton sequencing and built-in DVM readout.

Fast, Versatile Programming Two independent 10x40 crossbar switches and rapid pushbutton sequencing provide up to 40 tests on a single device without re-programming. For example, it's now quick and easy to check a 10 pin device using four completely different test programs without resetting any switches to advance the test from pin-to-pin or program-to-program. Additional flexibility allows the built-in DVM to measure current on one pin of the device and voltage on another—all pre-programmed.

Universal Test Adapters Through use of universal test adapters, the MICA-150 is designed to check ICs according to the number of pins of a particular package, not device or circuit type. Adapters are available for diode, transistor, TO-5, flat-pack, dual in-line and other package configurations, and can also be provided for Kelvin connections.

Accurate Digital Readout Specifically designed for the MICA-150 analyzer, the built-in Digital Volt/Ammeter has a conservatively rated readout accuracy of 0.1% with a four digit display. Other features include automatic ranging and polarity selection, self-calibration, automatic voltage or current readout selection. Measures currents as low as 1 nanoamp, voltages to 1 mv.

Modular Design Modular construction allows users to select an economical, customized tester without obsolescence problems. Maximum capacity of eight function generators permits later expansion, including modules for AC and pulse testing, without additional modifications.

Variable Soak Time Marginal device operation can be easily detected through use of an adjustable test time control which provides a period for thermal stabilization prior to measurement. A continuous position on the control allows parameters to be varied while observing results.

Precision, Wide Range Power Supplies Highly precise supplies utilize multi-turn calibrated potentiometer controls with high resolution and repeatability. Constant current supplies are continuously variable from 0-100 ma with voltage compliance adjustable to 100v. Constant voltage supplies are variable from 0-100v with automatic current limiting to 100 ma to provide device protection.

QUICK ACTION REPLY

Detailed technical literature on the MICA-150 will be mailed immediately upon receipt of this request.

Attn.: A. Norman Into, Marketing Manager
Computer Test Corporation, Three Computer Drive
Cherry Hill, N.J. 08034 • Phone: (609) 424-2400

Name______________________________

Company______________________________

Address______________________________

City________________State________Zip________

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 25	2N2068	ITT	pnp,AJ,ge	10	–	100	*80	3.0	–	–	7	†	†MS7, KSC
	2N2068-0	ITT	pnp,AJ,ge	10	–	100	*80	3.0	–	–	7	†	†MS7, KSC
	2N2068G	TI	pnp,AJ,ge	10	–	100	*80	3.0	–	–	7	†	†MS7, KSC
	2N3418	TI	npn,EP,si	10	0.133	175	60	5	*20-60	0.00003	*40	5	NA
	2N3419	TI	npn,EP,si	10	0.133	175	80	5	*20-60	0.00003	*40	5	SSP, NA
P 26	2N3420	TI	npn,EP,si	10	0.133	175	60	5	*40-120	0.00003	*40	5	NA
	2N3421	TI	npn,EP,si	10	0.133	175	80	5	*40-120	0.00003	*40	5	NA
	2N3730	RCA	pnp,DJ,ge	10	0.33	85	*200	–3A	–	0.2	–	3	
	2N4041	TRWS	–	10	0.06	200	40	0.5	10-80	0.2	–	–	MT59 package
	2N4063	RCA	npn,si	*10	0.066	200	250	1	*40-160	*20	–	5	
	2N4064	RCA	npn,si	10	0.066	200	350	1	*40-60	*0.05	–	–	
	2N301	RCA	pnp,AJ,ge	11	–	85	*40	3	*70	3	–	3	DE, KSC, BE, ITT, LAN, TI
	2N301A	RCA	pnp,AJ,ge	11	–	85	60	3	*70	3	–	3	DE, KSC, BE, ITT, TI
	2N3212	DE	ge	12	7	110	80	5	*30-90	1	30	37	
	2N3213	DE	pnp,AD,ge	12	7	110	60	5	30-90	1	30	37	
P 27	2N3214	DE	pnp,AD,ge	12	7	110	40	5	*30-90	1	30	37	
	2N3215	DE	pnp,AD,ge	12	7	110	30	5	*30-90	1	30	37	
	2N2147	RCA	pnp,DR,ge	12.5	–	100	*60	5	*100	1	4000	3	LAN
	2N2148	RCA	pnp,DR,ge	12.5	–	100	*75	5	*100	1	3000	3	LAN
	2N2035	STC	npn,si	14.3	0.143	200	*80	3	*20	150	–	8	
	2N1709	TRWS	npn,PL,si	15	0.1	175	*75	2.0	*7.5-75	0.01	2000	8	NUC
	2N1710	TRWS	npn,PL,si	15	0.1	175	*60	2	*7.5-75	0.05	1600	8	NUC
	2N2196	GE	npn,si	15	0.0667	200	*80	1	*30-90	0.075	–	–	Special Heat Sink
	2N2197	GE	npn,si	15	66.7	175	*80	1	*200	–	–	–	
	2N2201	GE	npn,si	15	0.067	175	100	1	*30-90	0.05	15000	–	
P 28	2N2202	GE	npn,si	15	0.067	175	100	1	30-90	0.05	15000	–	
	2N2203	GE	npn,si	15	0.067	175	100	1	30-90	0.05	15000	–	
	2N2204	GE	npn,si	15	0.067	175	100	1	30-90	0.05	15000	–	
	2N2239	GE	npn,si	15	0.120	200	*60	1	*30-200	10	–	5	Special Heat Sink
	2N2611	GE	npn,si	15	0.067	175	100	1	12-36	0.05	15000	–	
	2N2781	TRWS	npn,PL,si	15	0.1	175	*75	2	*7.5-75	0.50	1870	8	
	2N2782	TRWS	npn,PL,si	15	0.1	175	*100	2.0	*7.5-75	0.50	1870	8	
	2N2783	TRWS	npn,PL,si	15	0.1	175	*100	2	*7.5-75	0.01	1870	8	
	2N2874	TRWS	npn,PL,si	15	0.1	175	*75	2	*7.5-75	0.01	1870	8	
	2N2987	TI	npn,P,si	15	0.15	200	80	1	*25-75	0.000025	*30	5	
P 29	2N2988	TI	npn,P,si	15	0.15	200	100	1	*25-75	0.000025	*30	5	
	2N2989	TI	npn,P,si	15	0.15	200	80	1	*60-120	0.000025	*30	5	
	2N2990	TI	npn,P,si	15	0.15	200	100	1	*60-120	0.000025	*30	5	
	2N2991	TI	npn,P,si	15	0.15	200	80	1	*25-75	0.000025	*30	††	††MT 13
	2N2992	TI	npn,P,si	15	0.15	200	100	1	*25-75	0.000025	*30	††	††MT 13
	2N2993	TI	npn,P,si	15	0.15	200	80	1	*60-120	0.000025	*30	††	††MT 13
	2N2994	TI	npn,P,si	15	0.15	200	100	1	*60-120	0.000025	*30	††	††MT 13
	2N2995	GE	npn,si	15	0.0667	175	100	1	*90	0.01	–	–	TI
	2N3589	GE	npn,MS,si	15	0.0667	175	*200	1	*30-90	0.001	–	–	
	2N3590	GE	npn,MS,si	15	0.0667	175	*200	1	*75-150	0.001	–	–	
P 30	2N3591	GE	npn,MS,si	15	0.0667	175	*200	1	*30-90	0.001	–	–	
	2N3592	GE	npn,MS,si	15	0.0667	175	*200	1	*95-150	0.001	–	–	
	2N3595	GE	npn,MS,si	15	0.0667	175	*200	1	*30-90	0.001	–	–	
	2N3596	GE	npn,MS,si	15	0.0667	175	*200	1	*75-150	0.001	–	–	
	2N3919	FA	npn,DPE,si	15	0.200	150	*120	10	120	–	80,000	3	
	2N3920	FA	npn,DPE,si	15	0.200	150	*120	10	300	–	80,000	3	
	2N4000	TI	npn,EP,si	15	0.15	200	80	1	30-120	0.002	40,000	5	
	2N4001	TI	npn,EP,si	15	0.15	200	100	1	40-120	0.002	40,000	5	
	2N4300	TI	npn,PE,si	15	0.15	200	80	2	*30-120	0.01	*40,000	5	
	2N2525	TRWS	npn,PL,si	16	0.091	200	*100	1	*>10	–	10000	–	
P31	2N2835	AMP	pnp,AJ,ge	16	0.25	90	32	1	*30	–	10	–	Special
	2N4040	TRWS	–	17.5	0.1	200	40	1.0	10-80	0.2	–	–	MT59 package
	2N156	KSC	pnp,ge	20	0.333	100	*30	3	*25	1.0	4.0	13	
	2N158	KSC	pnp,ge	20	0.333	100	*60	3	*21	1.0	4.0	13	
	2N158A	KSC	pnp,ge	20	0.333	100	*80	3	*21	1.0	4.0	13	
	2N1042	TI	pnp,ge	20	0.267	100	*40	3.5	*20	0.125	–	–	SY,KSC,BE
	2N1043	TI	pnp,ge	20	0.267	100	*60	3.5	*20	0.125	–	–	SY, KSC, BE
	2N1044	TI	pnp,ge	20	0.267	100	*80	3.5	*20	0.125	–	–	SY, KSC, BE
	2N1045	TI	pnp,ge	20	0.267	100	*100	3.5	*20	0.125	–	–	KSC, BE
	2N2552	TI	pnp,ge	20	0.267	100	*40	3	18	0.125	–	–	KSC, BE
P 32	2N2553	TI	pnp,ge	20	0.267	100	*60	3	18	0.125	–	–	BE, KSC
	2N2554	TI	pnp,ge	20	0.267	100	*80	3	18	0.125	–	–	KSC, BE
	2N2555	TI	pnp,ge	20	0.267	100	*100	3	18	0.125	–	–	KSC, BE
	2N2556	TI	pnp,ge	20	0.267	100	*40	3	18	0.125	–	–	KSC, SY, BE
	2N2557	TI	pnp,ge	20	0.267	100	*60	3	18	0.125	–	–	KSC, SY, BE
	2N2558	TI	pnp,ge	20	0.267	100	*80	3	18	0.125	–	–	KSC, SY, BE
	2N2559	TI	pnp,ge	20	0.267	100	*100	3	18	0.125	–	–	KSC, SY, BE
	2N2560	TI	pnp,ge	20	0.267	100	*40	3.5	25	0.125	–	–	KSC, BE, NA
	2N2561	TI	pnp,ge	20	0.267	100	*60	3.5	25	0.125	–	–	KSC, BE
	2N2562	TI	pnp,ge	20	0.267	100	*80	3.5	25	0.125	–	–	KSC, BE

Circle as many numbers on the reader-service card as you like.

Power *(continued)*

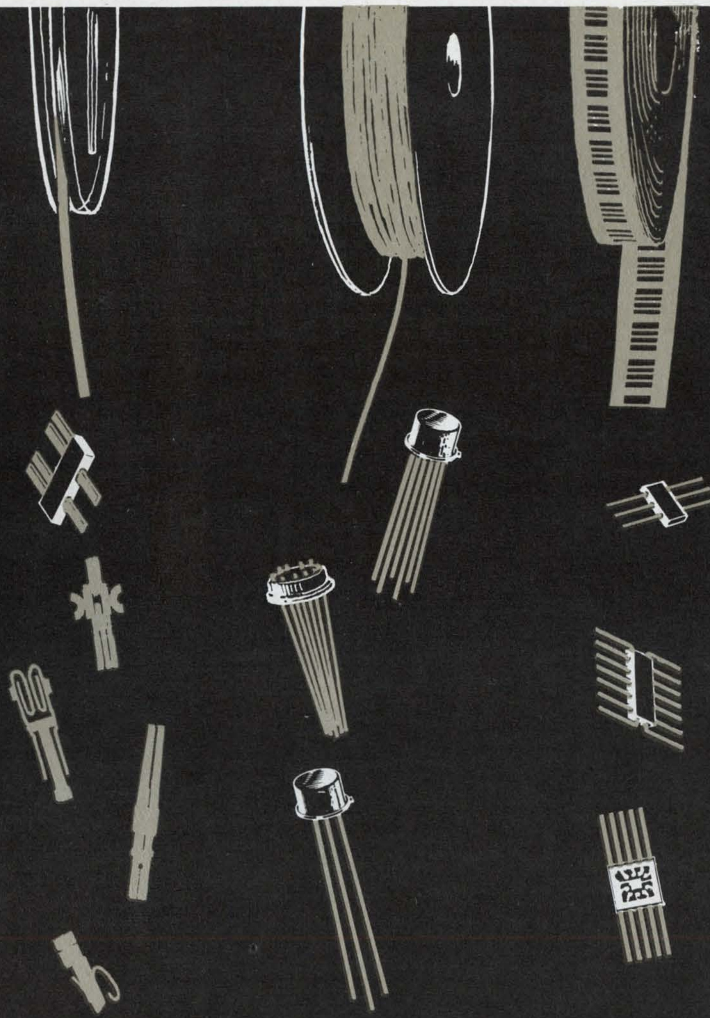
				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	f_{ae} *f_T (kHz)	Package Outline (TO-)	Remarks
P 33	2N2563	TI	pnp,ge	20	0.267	100	*100	3.5	25	0.125	–	–	KSC, BE
	2N2697	SOL	npn,si	20	0.2	200	*80	5.0	*40-120	0.0001	20000	–	
	2N2698	SOL	npn,si	20	0.2	200	*100	5.0	*40-120	0.0001	20000	–	
	2N2875	TR	pnp,PLE,si	20	0.14	175	50	2	*15-60	0.001	–	–	
	2N3738	MO	npn,si	20	0.133	175	225	0.250	*40-120	0.1	*15000	66	
P 34	2N3739	MO	npn,si	20	0.133	175	300	0.250	*40-120	0.1	*15000	66	
	2N3766	MO	npn, si	20	0.133	175	60	1	*40-160	0.1	*15000	66	
	2N3767	MO	npn,si	20	0.133	175	80	1	*40-160	0.1	*15000	66	
	2N3917	FA	npn,DPE,si	20	5	150	40	10	10	0.00001	*2500	3	
	2N4296	RCA	npn,TDP,si	20	0.133	175	250	1	*50-150	0.1	*30	66	
	2N4297	RCA	npn,TDP,si	20	0.133	175	250	1	*75-300	0.1	*30	66	
	2N4298	RCA	npn,TDP,si	20	0.133	175	350	1	*25-75	0.1	*30	66	
	2N4299	RCA	npn,TDP,si	20	0.133	175	350	1	*50-150	0.1	*30	66	
	2N234A	BE	pnp,ge	25	0.5	90	25	3	–	–	–	3	KSC, TI
	2N235A	BE	pnp,ge	25	0.5	90	*50	3	–	7	–	3	KSC, ITT, TI
P 35	2N235B	BE	pnp,ge	25	0.5	90	*50	3	–	–	–	3	ITT, TI
	2N285A	BE	pnp,ge	25	0.5	95	–	3	–	–	–	3	TI
	2N285B	BE	pnp,ge	25	0.5	95	–	3	–	–	–	3	TI
	2N399	BE	–	25	–	–	–	3	*34-40	–	–	3	KSC
	2N401	BE	–	25	–	–	–	3	31-36	–	–	3	KSC
	2N418	BE	–	25	–	–	–	5	*40	–	–	3	KSC, ITT
	2N419	BE	–	25	–	–	–	3	35	–	–	3	KSC
	2N420	BE	–	25	–	–	–	5	*40	–	–	3	ITT, KSC
	2N420A	BE	–	25	–	–	–	5	*40	–	–	3	KSC
	2N1218	SY	npn,AL,ge	25	–	100	*45	3	*40-160	3	7	3	
P 36	2N1483	RCA	npn, si	25	.143	200	40	3	*20-60	.015	40	8	STC
	2N1484	RCA	npn,si	25	.143	200	55	3	*20-60	.015	40	8	STC
	2N1485	RCA	npn,si	25	.143	200	40	3	*35-100	.015	40	8	STC
	2N1486	RCA	npn,si	25	.143	200	55	3	35-100	.015	40	8	STC
	2N2308	STC	npn	25	.143	200	80	3	*20-60	.250	–	8	STC
	2N2887	TRWS	npn,PL,si	25	.143	200	*100	1.2	*15-80	–	5000	–	MO, NA
	2N3018	BE	–	25	–	–	*100	10	*40	–	–	*	*MT10A
	2N3021	MO	pnp,AE,si	25	1.67	175	30	3	*20-60	–	100,000	3	
	2N3022	MO	pnp,AE,si	25	1.67	175	45	3	*20-60	–	100,000	3	
	2N3023	MO	pnp,AE,si	25	1.67	175	60	3	*20-60	–	100,000	3	
P 37	2N3024	MO	pnp,AE,si	25	1.67	175	30	3	*50-180	–	100,000	3	
	2N3025	MO	pnp,AE,si	25	1.67	175	45	3	*50-180	–	100,000	3	
	2N3026	MO	pnp,AE,si	25	1.67	175	60	3	*50-180	–	100,000	3	
	2N3230	TI	npn,si	25	0.143	200	60	7	*2000 20,000	0.1	–	–	Darlington Type
	2N3231	TI	npn,si	25	0.143	200	80	7	*2000 20,000	0.1	–	–	Darlington Type
	2N3441	RCA	npn,si	25	0.143	200	140	3	*20-80	5	–	66	
	2N3740	MO	pnp,si	25	.143	200	60	1	*30-100	0.1	*4000	66	
	2N3741	MO	pnp,si	25	.143	200	80	1	*30-100	0.1	*4000	66	
P 38	2N3838	TI	npn,EP,si	25	.143	200	60	7	*2 K-20 K	0.01	40,000	–	Darlington, MO
	2N3837	TI	npn,EP,si	25	.143	200	80	7	*2 K-20 K	0.01	40,000	–	Darlington
	2N1755	ITT	–	28	–	95	25	3	30	1	15	–	KSC
	2N1756	ITT	–	28	–	95	40	3	30	1	15	–	KSC
	2N1757	ITT	–	28	–	95	55	3	30	1	15	–	KSC
	2N1758	ITT	–	28	–	95	65	3	30	1	15	–	KSC
	2N1759	ITT	–	28	–	95	25	3	60	1	15	–	KSC
	2N1760	ITT	–	28	–	95	40	3	60	1	15	–	KSC
	2N1761	ITT	–	28	–	95	55	3	60	1	15	–	KSC
	2N1762	ITT	–	28	–	95	65	3	60	1	15	–	KSC
P 39	2N4864	SOL	npn,PL,si	28	6	200	120	2	50-150	0.1	80,000	66	
	2N1978	FA	npn,DP,si	30	0.172	200	*60	–	*30	.01	*50000	–	
	2N2150	TI	npn,TD,si	30	0.4	175	80	2	*20-60	0.01	*20	21	NA, SOL
	2N2151	TI	npn,TD,si	30	0.4	175	80	2	*40-120	0.01	*20	††	††MT 21, NA, SOL
	2N2869	RCA	pnp,AJ,ge	30	–	100	*60	10	*90	0.5	–	3	LAN, TI
	2N2870	RCA	pnp,A,ge	30	–	100	50	10	*90	0.5	450	3	LAN, TI, KSC
	2N2877	SOL	npn,si	30	0.3	200	*80	5	*20-60	.0001	30,000	–	TI, SSP, NA
	2N2878	SOL	npn,si	30	0.3	200	*80	5	*40-120	.0001	50000	–	TI, SSP, NA
	2N2879	SOL	npn,si	30	0.3	200	*100	5	*20-60	.0001	30000	–	TI, SSP, NA
	2N2880	SOL	npn,si	30	0.3	200	*100	5	*40-120	.0001	50000	–	TI, SSP, NA
P 40	2N2892	FA	npn,PE,si	30	–	200	80	–	*55	.0002	*50000	–	AMP, TI, NA
	2N2893	FA	npn,PE,si	30	–	200	80	–	*80	0.0002	*50000	–	AMP, TI, NA
	2N3220	GE	npn,si	30	0.4	175	80	2	80	0.1	–	–	TI
	2N3221	GE	npn,si	30	0.4	175	80	2	160	0.1	–	–	TI
	2N3222	GE	npn,si	30	0.4	175	60	2	8	0.1	–	–	TI
	2N3744	SOL	npn,si	30	.3	200	*60	5	*20-60	.0001	*30,000	–	hex isolated col, TI
	2N3745	SOL	npn,si	30	.3	200	*80	5	*20-60	.0001	*30,000	–	hex isolated col., TI
	2N3746	SOL	npn,si	30	.3	200	*100	5	*20-60	.0001	*30,000	–	hex isolated col., TI
	2N3747	SOL	npn,si	30	.3	200	*60	5	*40-120	.0001	*40,000	–	hex isolated col., TI
	2N3748	SOL	npn,si	30	.3	200	*80	5	*40-120	.0001	*40,000	–	hex isolated col., TI

Valuable reprints are FREE if you circle them on the reader-service card.

Power *(continued)*

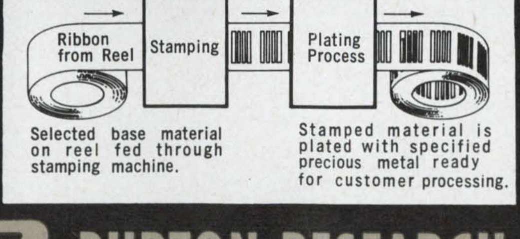
Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
				P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$f_{\alpha e}$ $*f_T$ (kHz)		
P 41	2N3749	SOL	npn,si	30	.3	200	*100	5	*40-120	.0001	*40,000	–	hex isolated col., TI
	2N3750	SOL	npn,si	30	.3	200	*60	5	*100-300	.0001	*50,000	–	hex isolated col., TI
	2N3751	SOL	npn,si	30	.3	200	*80	5	*100-300	.0001	*50,000	–	hex isolated col., TI
	2N3752	SOL	npn,si	30	.3	200	*100	5	*100-300	.0001	*50,000	–	hex isolated col., TI
	2N3850	SSP	npn,TDP	30	0.4	200	*100	5	*150	.0001	*40	59	TI
P 42	2N3851	SSP	npn,TDP	30	0.4	200	*60	5	*90	.0001	*30	59	TI
	2N3852	SSP	npn,TDP	30	0.4	200	*60	5	*150	.0001	*40	59	TI
	2N3853	SSP	npn,TDP	30	0.4	200	*60	5	*90	.0001	*30	59	TI
	2N3996	TI	npn,EP,si	30	0.3	200	80	5	40-120	0.005	40,000	–	7/16 stud-Isol
	2N3997	TI	npn,EP,si	30	0.3	200	80	5	80-240	0.005	40,000	–	7/16 stud-Isol
	2N3998	TI	npn,EP,si	30	0.3	200	80	5	40-120	0.005	40,000	–	7/16 stud
	2N3999	TI	npn,EP,si	30	0.3	200	80	5	80-240	0.005	40,000	–	7/16 stud
	2N4075	FA	npn,DPE,si	30	.171	200	80	3	30-90	.0001	*30,000	59	
	2N4076	FA	npn,DPE,si	30	.171	200	80	3	50-150	.0001	*30,000	59	
	2N538	SOL	pnp,ge	34	0.46	100	*80	3.5	*20-50	2	200	–	KSC
P 43	2N538A	SOL	pnp,ge	34	0.46	100	*80	3.5	*20-50	2	200	–	KSC
	2N539	SOL	pnp,ge	34	0.46	100	*80	3.5	*30-75	2	200	–	KSC
	2N539A	SOL	pnp,ge	34	0.46	100	*80	3.5	*30-75	2	200	–	KSC
	2N540	SOL	pnp,ge	34	.46	100	*80	3.5	*45-113	2	200	–	KSC
	2N540A	SOL	pnp,ge	34	0.46	100	*80	3.5	*45-113	2	200	–	
	2N1202	SOL	pnp,ge	34	0.46	100	*80	3.5	*200	2	200	–	KSC
	2N1203	SOL	pnp,ge	34	0.46	100	*120	3.5	*25-75	2	200	–	KSC
	2N1261	SOL	pnp,ge	34	0.46	100	*80	3.5	*20-50	2	200	–	KSC
	2N1262	SOL	pnp,ge	34	0.46	100	*80	3.5	*30-75	2	200	–	KSC
	2N1263	SOL	pnp,ge	34	0.46	100	*80	3.5	*45-113	2	200	–	KSC
P 44	2N1501	SOL	pnp,ge	34	0.46	100	*60	3.5	*25-100	2	200	–	KSC
	2N1502	SOL	pnp,ge	34	0.46	100	*40	3.5	*25-100	2	200	–	KSC
	2N400	BE	–	35	–	–	–	3	*30-40	–	–	3	KSC
	2N1011	BE	pnp,ge	35	0.5	95	*80	5	*30-75	15	–	3	DE, KSC, MO, ITT, TI
	2N2836	AMP	pnp,AJ,ge	35	.66	90	55	3.5	*30	.1	–	3	
	2N3583	RCA	npn,si	35	0.2	200	175	*5	40	*10	–	66	
	2N3584	RCA	npn,si	35	0.2	200	250	*5	*25-100	*5	–	66	
	2N3585	RCA	npn,si	35	0.2	200	300	5	*25-100	*5	*10,000	66	
	2N3878	RCA	npn,si	35	0.2	200	50	10(peak)	*50-200	*5	*60,000	66	
	2N4240	RCA	npn,si	35	0.2	200	175	2	*30-150	*5	*15 MHz	66	
P 45	2N663	KSC	pnp,AJ,ge	37.5	2	100	25	4	*25-75	4	15	3	
	2N665	MO	pnp,AJ,ge	37.5	2	100	40	5	*40-80	10	20	3	KSC
	2N3154	ITT	–	37.5	–	100	25	3	60	1	15	–	KSC
	2N3155	ITT	–	37.5	–	100	40	3	60	1	15	–	KSC
	2N3156	ITT	–	37.5	–	100	55	3	60	1	15	–	KSC
	2N3157	ITT	–	37.5	–	100	65	3	60	1	15	–	KSC
	2N3158	ITT	–	37.5	–	100	25	3	30	1	10	–	KSC
	2N4241	AMP	pnp,ge	37.5	0.5	100	*32	5.0	*50	45	5	3	
	2N1047	TI	npn,si	40	0.228	200	*80	0.500	*12	0.015	–	–	STC, TR
	2N1047A	TI	pnp,si	40	0.228	200	80	0.500	*12	0.350	–	–	STC, TR
P 46	2N1047B	TI	npn,si	40	0.228	200	80	0.750	*12	0.050	–	–	TI, STC
	2N1047C	TI	npn,si	40	0.228	200	80	1	*12	0.010	–	–	
	2N1048	TI	npn,si	40	0.228	200	*120	0.500	*12	0.015	–	–	STC, TR
	2N1048A	TI	npn,si	40	0.228	200	120	0.500	*12	0.350	–	–	STC, TR
	2N1048B	–	npn,si	40	0.228	200	120	0.750	*12	0.100	–	–	TI, STC
	2N1048C	TI	npn,si	40	0.228	200	120	1	*12	0.010	–	–	
	2N1049	TI	pnp,si	40	0.228	200	*80	0.500	*30	0.015	–	–	STC, TR
	2N1049A	TI	npn,si	40	0.228	200	80	0.500	*30	0.350	–	–	STC, TR
	2N1049B	TI	npn,si	40	0.228	200	80	0.750	*30	0.050	–	–	TI, STC
	2N1049C	TI	npn,si	40	0.228	200	80	1	*30	0.010	–	–	
P 47	2N1050	TI	npn,si	40	0.228	200	*120	0.500	*30	0.015	–	–	STC, TR
	2N1050A	TI	npn,si	40	0.228	200	120	0.500	*30	0.350	–	–	STC, TR
	2N1050B		npn,si	40	0.228	200	120	0.750	*30	0.100	–	–	STC, TI
	2N1050C	TI	npn,si	40	0.228	200	120	1	*30	0.010	–	–	
	2N1647	TR	npn,PL,si	40	0,267	175	*80	3	*15-45	0.1	3000	–	STC
	2N1648	TR	npn,PL,si	40	0,267	175	120	3	*15-45	0,1	2000	–	STC
	2N1649	TR	npn,PL,si	40	0,267	175	*80	3	*30-90	0.1	3000	–	STC
	2N1650	TR	npn,PL,si	40	0,267	175	120	3	*20	0.1	2000	–	STC
	2N1690	TI	npn,si	40	0.228	200	80	500	*20	0.015	–	–	STC
	2N1691	TI	npn,si	40	0.228	200	120	500	*20	0.015	–	–	STC
P 48	2N2018	TR	npn,PL,si	40	0,267	175	*150	2	*15	0,1	2000	–	
	2N2019	TR	npn	40	0,267	175	*200	2	*15	0,1	2000	–	
	2N2020	TR	npn,PL,si	40	0,267	175	*150	2	*25	0,1	3000	–	
	2N2021	TR	npn,PL,si	40	.267	175	*200	2	*25	.1	3000	–	
	2N2632	SOL	npn,si	40	.4	200	*90	5.0	*40-120	0.0001	20000	–	
	2N2633	SOL	npn,si	40	.4	200	*120	5.0	*40-120	0.0001	20000	–	
	2N2634	SOL	npn,si	40	.4	200	*150	5.0	*40-120	0.0001	20000	–	
	2N2828	STC	npn	40	.229	200	60	3	*20-60	–	–	*	*$\frac{7}{8}$" Hex, TI
	2N2829	STC	npn	40	.229	200	60	3	*20-60	–	–	*	*$\frac{7}{8}$" Hex, TI
	2N2902	TI	npn,TD,si	40	0.228	200	120	2	*30-90	0.25	*2	57	

Get detailed spec sheets and application notes: use the reader-service card!



Many parts can be plated better, faster, and more economically with BURTON'S NEW CONTINUOUS PRECIOUS METAL PLATING PROCESS

Burton's new **CONTINUOUS** precious metal plating process normally reduces cost of precious metal substantially by putting the plating only where you want it. In addition, some parts can be plated and manufactured ready for your use (see inset)! If you use precious metal plated parts of any kind this outstanding advancement in plating techniques may save you time and money while greatly improving quality. Why not find out about it? We'd be glad to send you complete information.



BRL

BURTON RESEARCH LABORATORIES, INC.

11240 PLAYA / CULVER CITY, CALIFORNIA / (213) 391-6325

A Division of Burton Silver Plating Company

ON READER-SERVICE CARD CIRCLE 66

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 49	2N3199	STC	pnp,si	40	0.229	200	−40	−3	*20-60	†0.075	–	59	CT
	2N3200	STC	pnp,si	40	0.229	200	−60	−3	*20-60	†0.075	–	59	CT
	2N3201	STC	pnp,si	40	0.229	200	−80	−3	*20-60	†0.075	–	59	CT
	2N3205	STC	pnp,si	40	0.229	200	−40	−2	*20-60	†0.075	–	59	CT
	2N3206	STC	pnp,si	40	0.229	200	−60	−2	*20-60	†0.075	–	59	CT
P 50	2N3207	STC	pnp,si	40	0.229	200	−100	−2	*20-60	†0.075	–	59	CT
	2N3551	TI	npn,TD,si	40	0.53	175	60	12	*20-90	10	*40	–	
	2N4004	TI	npn,EP,si	40	0.4	200	80	20	*30-150	1	30,000	–	Thin-Pac
	2N4005	TI	npn,EP,si	40	0.4	200	100	20	*30-150	1	30,000	–	Thin-Pac
	2N3552	TI	npn,EP,si	40	0.53	175	80	12	*20-90	10	40,000	–	Isol Thin-Pac
	2N3851	TI	npn,EP,si	40	0.53	175	60	12	*20-90	10	40,000	–	Isol Thin-Pac
	2N2266	SOL	pnp,ge	43	0.5	125	*100	5	*25-75	2	200	–	KSC
	2N2267	SOL	pnp,ge	43	0.5	125	*120	5	*25-75	2	200	–	KSC
	2N2268	SOL	pnp,ge	43	0.5	125	*100	5	*25-75	2	200	–	
	2N2269	SOL	pnp,ge	43	0.5	125	*120	5	*25-75	2	200	–	
P 51	2N1120	BE	pnp,ge	45	0.667	95	*80	15	30-120	15	–	41	MO, ITT, TI
	2N456A	TI	pnp,ge	50	0.667	100	*40	7	*40	0.5	–	3	DE, BE, MO, ITT, KSC
	2N457A	TI	pnp,ge	50	0.667	100	*60	7	*40	0.5	–	3	DE, KSC, BE, MO, ITT
	2N458A	TI	pnp,ge	50	0.667	100	*80	7	*40	0.5	4	3	DE, BE, MO, ITT, KSC
	2N463	†KSC	pnp,AJ,ge	50	.67	100	*60	5	*20-100	0.3	5	32	† WE Orig Reg
	2N678	BE	pnp,ge	50	0.66	100	*15	15	*50-100	2	–	3	KSC, TI, ITT
	2N678A	BE	pnp,ge	50	0.66	100	*25	15	*50-100	2	–	3	TI, ITT, KSC
	2N678B	BE	pnp,ge	50	0.66	100	*60	15	*50-100	5	–	3	TI, ITT, KSC
	2N678C	BE	pnp,ge	50	0.66	100	*60	15	*50-100	5	–	3	TI, ITT
	2N1014		pnp,ge	50	100	–	*100	–	*20	–	–	–	KSC
P 52	2N1021	TI	pnp,ge	50	0.714	75	*100	5	*60	0.10	–	3	DE, KSC, BE, MO, ITT
	2N1022	TI	pnp,ge	50	0.714	95	*120	5	*60	0.13	–	3	DE, KSC, BE, MO, ITT
	2N1069		npn,ge	50	.33	175	45	4	*10-50	1	10	3	STC, BE
	2N1070		npn,ge	50	.33	175	45	4	*10-50	1	10	3	STC, BE
	2N1430	BE		50	–	–	40	10	*30-100	–	–	41	
	2N1722	TI	npn,si	50	0.667	175	80	5	*20	0.5	–	53	STC, TR, BE
	2N1722A	TI	npn,si	50	0.67	175	120	5	*30	0.1	–	53	BE, STC
	2N1723	TI	npn,si	50	0.67	175	80	5	*50	0.1	–	53	BE
	2N1724	TI	npn,si	50	0.667	175	80	5	*20	0.5	–	–	STC, TR, BE, MO, GE, SOL
	2N1724A	TI	npn,si	50	0.67	175	120	5	*30	0.1	–	–	BE, STC, GE
P 53	2N1725	TI	npn,si	50	0.67	175	80	5	*50	0.1	–	–	BE, MO, TR, GE
	2N1905	RCA	pnp,AJ,ge	50	–	100	*60	3	*90	0.15	*7500	3	LAN
	2N1906	RCA	pnp,AJ,ge	50	–	100	*100	3	*125	0.15	*7500	3	LAN
	2N2811	SOL	npn,si	50	0.5	200	*80	10	*20-60	.0001	20000	–	TI
	2N2812	SOL	npn,si	50	0.5	200	*80	10	*40-120	.0001	30000	–	TI
	2N2813	SOL	npn,si	50	0.5	200	*120	10	*20-60	.0001	20000	–	TI
	2N2814	SOL	npn,si	50	0.5	200	*120	10	*40-120	.0001	30000	61	TI
	2N4301	TI	npn,PE,si	50	0.5	200	80	10	*30-120	0.01	*40,000	61	
	2N236A	BE	pnp,ge	60	0.83	100	–	3	–	–	–	3	KSC, TI
	2N236B	BE	pnp,ge	60	0.83	100	–	3	–	–	–	3	TI, KSC
P 54	2N1073	BE	pnp,ge	60	0.833	*110	*-25	-10	*20-60	15	–	41	DE, MO
	2N1073A	BE	pnp,ge	60	0.833	*110	*-60	-10	*20-60	20	–	41	DE, MO
	2N1073B	BE	pnp,ge	60	0.833	+110	*-100	-10	*20-60	20	–	41	DE, MO
	2N1079	TR	npn,PL,si	60	.34	175	*60	3	*20-80	10	10,000	53	TI
	2N1080	TR	npn,PL,si	60	.34	175	*60	3	*20-80	10	10,000	53	TI
	2N1210	TR	npn,PL,si	60	0.40	175	60	5	*15-75	10	3000	–	BE, STC, TI
	2N1211	TR	npn,PL,si	60	0.40	175	*80	5	*15-75	10	3000	53	BE, TI, STC
	2N1616	TR	npn,PL,si	60	0.40	175	60	5	*15-75	10	3000	–	STC, BE, TI
	2N1617	STC	npn,si	60	0.40	175	*80	5	*15-75	†1	–	61	
	2N1618	TR	npn,PL,si	60	0.40	175	*100	5	*15-75	10	3000	–	STC, BE, TI
P 55	2N1620	TR	npn,PL,si	60	0.40	175	*100	5	*15-75	10	3000	53	STC, BE, TI
	2N1907	TI	pnp,ge	60	2	100	*100	20	*20	0.5	–	3	
	2N1908	TI	pnp,ge	60	2	100	*130	20	*20	0.5	–	3	
	2N2288	BE	–	60	–	–	–	10	*20-60	–	–	3	
	2N2289	BE	–	60	–	–	–	10	*20-60	–	–	3	
	2N2290	BE	–	60	–	–	–	10	*20-60	–	–	3	
	2N2291	BE	–	60	–	–	–	10	*50-120	–	–	3	ETC
	2N2292	BE	–	60	–	–	–	10	*50-120	–	–	3	ETC
	2N2293	BE	–	60	–	–	–	10	*50-120	–	–	3	ETC
	2N2294	BE	–	60	–	–	–	10	*50-120	–	–	41	
P 56	2N2295	BE	–	60	–	–	–	10	*50-120	–	–	41	
	2N2296	BE	–	60	–	–	–	10	50-120	–	–	41	
	2N2137	MO	pnp,AJ,ge	62.5	0.83	100	20	3	*30-60	2	20	3	
	2N2137A	MO	pnp,AJ,ge	62.5	0.83	100	20	3	*30-60	2	20	3	
	2N2138	MO	pnp,AJ,ge	62.5	0.83	100	30	3	*30-60	2	20	3	
	2N2138A	MO	pnp,AJ,ge	62.5	0.83	100	30	3	*30-60	2	20	3	
	2N2139	MO	pnp,AJ,ge	62.5	0.83	100	45	3	*30-60	2	20	3	
	2N2139A	MO	pnp,AJ,ge	62.5	0.83	100	45	3	*30-60	2	20	3	
	2N2140	MO	pnp,AJ,ge	62.5	0.83	100	60	3	*30-60	2	20	3	
	2N2140A	MO	pnp,AJ,ge	62.5	0.83	100	60	3	*30-60	2	20	3	

Complete listing of semiconductor manufacturers starts on page 86.

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 57	2N2141	MO	pnp,AJ,ge	62.5	0.83	100	65	3	*30-60	2	20	3	
	2N2141A	MO	pnp,AJ,ge	62.5	0.83	100	65	3	*30-60	2	20	3	
	2N2142	MO	pnp,AJ,ge	62.5	0.83	100	20	3	*50-100	2	20	3	
	2N2142A	MO	pnp,AJ,ge	62.5	0.83	100	20	3	*50-100	2	20	3	
	2N2143	MO	pnp,AJ,ge	62.5	0.83	100	30	3	*50-100	2	20	3	
P 58	2N2143A	MO	pnp,AJ,ge	62.5	0.83	100	30	3	*50-100	2	20	3	ETC
	2N2144	MO	pnp,AJ,ge	62.5	0.83	100	45	3	*50-100	2	20	3	
	2N2144A	MO	pnp,AJ,ge	62.5	0.83	100	45	3	*50-100	2	20	3	ETC
	2N2145	MO	pnp,AJ,ge	62.5	0.83	100	60	3	*50-100	2	20	3	ETC
	2N2145A	MO	pnp,AJ,ge	62.5	0.83	100	60	3	*50-100	2	20	3	ETC
	2N2146	MO	pnp,AJ,ge	62.5	0.83	100	65	3	*50-100	2	20	3	ETC
	2N2146A	MO	pnp,AJ,ge	62.5	0.83	100	65	3	*50-100	2	20	3	ETC
	2N554	MO	pnp,AJ,ge	65	0.72	90	*15	3	55	10	6	3	ITT, TI, DE
	2N555	MO	pnp,AJ,ge	65	0.72	90	*30	3	55	20	6	3	DE, KSC, ITT, TI
	2N4070	SOL	npn,si	65	.66	200	*120	10	*40-120	.0001	*20,000	3	
P 59	2N4071	SOL	npn,si	65	.66	200	*200	10	*40-120	.0001	*20,000	3	
	2N3223	GE	npn,si	70	0.4	175	60	2	160	0.1	–	–	TI
	2N3950	MO	npn,si	70	0.4	200	35	3.3	–	10	*150,000	60	
	2N4895	FA	npn,PE,si	70	–	200	*120	5	*40-120	–	50	39	
	2N4896	FA	npn,PE,si	70	0.8	200	120	5	*100-300	–	80,000	39	
	2N4897	FA	npn,PE,si	70	0.8	200	150	5	*40-120	–	50,000	39	
	2N1487	RCA	npn,si	75	.429	200	40	6	*15-45	.025	30	3	STC, BE, TI
	2N1488	RCA	npn,si	75	.429	200	55	6	*15-45	.025	30	3	STC, BE, TI
	2N1489	RCA	npn,si	75	.429	200	40	6	*25-75	.025	30	3	STC, BE, TI
	2N1490	RCA	npn,si	75	.429	200	55	6	*25-75	.025	30	3	STC, BE, TI
P 60	2N1511	STC	npn,si	75	.429	200	40	6	*15-45	.025	30	36	
	2N1512	STC	npn,si	75	.429	200	55	6	*15-45	.025	30	36	
	2N1513	STC	npn,si	75	.429	200	40	6	*25-75	.025	30	36	
	2N1514	STC	npn,si	75	.429	200	55	6	*25-75	.025	30	36	
	2N1703	STC	npn,si	75	200	.429	40	5	*15-60	.2	25	36	
	2N2305	STC	npn,si	75	0.43	200	*60	6	*15-60	0.20	–	3	
	2N2912	MO	pnp,EP,ge	75	1	110	6	25	*75	0.2	–	8	75 W @ 35°C
	2N3171	STC	pnp,si	75	0.43	200	–40	–3	*12-36	†10	–	3	
	2N3172	STC	pnp,si	75	0.43	200	–60	–3	*12-36	†10	–	3	
	2N3173	STC	pnp,si	75	0.43	200	–80	–3	*12-36	†10	–	3	
P 61	2N3174	STC	pnp,si	75	0.43	200	–100	–3	*12-36	†10	–	3	
	2N3183	STC	pnp,si	75	0.43	200	–40	–5	*10-30	†10	–	3	
	2N3184	STC	pnp,si	75	0.43	200	–60	–5	*10-30	†10	–	3	
	2N3185	STC	pnp,si	75	0.43	200	–80	–5	*10-30	†10	–	3	
	2N3186	STC	pnp,si	75	0.43	200	–100	–5	*10-30	†10	–	3	
	2N3195	STC	pnp,si	75	0.43	200	–40	–5	*10-30	†10	–	3	
	2N3196	STC	pnp,si	75	0.43	200	–60	–5	*10-30	†10	–	3	
	2N3197	STC	pnp,si	75	0.43	200	–80	–5	*10-30	†10	–	3	
	2N3198	STC	pnp,si	75	0.43	200	–100	–5	*10-30	†10	–	3	
	3N45	SOL	pnp,ge	75	1	100	*60	12	*30-120	3	600	15	
P 62	3N46	SOL	pnp,ge	75	1	100	*80	12	*20-80	3	300	15	
	3N47	SOL	pnp,ge	75	1	100	*40	12	*30-120	3	500	15	
	3N48	SOL	pnp,ge	75	1	100	*60	12	*20-80	3	300	15	
	2N3264	RCA	npn,si	†84	0.66	200	90	25	*20-80	10	–	–	†Tc=75C, YI
	2N3266	RCA	npn,si	*84	0.66	200	90	25	*20-80	10	–	63	TI
	2N389	TI	npn,si	85	0.485	200	–	1.5	12	–	–	53	TR, STC, BE
	2N389A	STC	npn,si	85	0.485	0.200	*60	3	*12-60	–	–	53	
	2N424	TI	npn,si	85	0.485	200	–	0.75	12	–	–	53	TR, STC, BE
	2N1210	TI	npn,TD,si	85	0.425	200	60	2	*15	0.25	*2	53	STC, TI
	2N1235	TI	npn,si	85	0.485	200	*100	2	*12	10	–	53	
P 63	2N1250	STC	npn,si	85	0.485	200	60	5	*15-60	10	–	53	
	2N1260	TI	npn,si	85	0.485	200	*120	2	*12	10	–	53	
	2N1616A	STC	npn,si	85	0.485	200	60	7.5	*10	†0.20	–	61	
	2N1617A	STC	npn,si	85	0.485	200	*80	7.5	*10	†0.20	–	61	
	2N1618A	STC	npn,si	85	0.485	200	*100	7.5	*10	†0.20	–	61	
	2N2383	STC	npn	85	.5	200	60	3	*20-60	–	–	–	STC
	2N2384	STC	npn	85	.5	200	60	3	*20-60	–	–	*	*$\frac{11}{16}$" Hex
	2N2526	MO	pnp,AD,ge	85	1	110	80	10	*20-50	3	12	3	
	2N2527	MO	pnp,AD,ge	85	1	110	120	10	*20-50	3	12	3	
	2N2528	MO	pnp,AD,ge	85	1	110	160	10	*20-50	3	12	3	
P 64	2N2832	MO	pnp,EP,ge	85	1	110	50	20	*25-100	.3	50	3	
	2N2833	MO	pnp,EP,ge	85	1	110	75	20	*25-100	.3	50	3	
	2N2834	MO	pnp,EP,ge	85	1	110	100	20	*25-100	.3	50	3	
	2N2908	STC	npn	85	.45	200	*80	5	*12-60	–	–	53	TI
	2N3163	STC	pnp,si	85	0.46	200	–40	–3	*12-36	†10	–	61	
	2N3164	STC	pnp,si	85	0.46	200	–60	–3	*12-36	†10	–	61	
	2N3165	STC	pnp,si	85	0.46	200	–80	–3	*12-36	†10	–	61	
	2N3166	STC	pnp,si	85	0.46	200	–100	–3	*12-36	†10	–	61	
	2N3167	STC	pnp,si	85	0.46	200	–40	–3	*12-36	†10	–	53	
	2N3168	STC	pnp,si	85	0.46	200	–60	–3	*12-36	†10	–	53	

Need a FREE personal copy of this Directory? Circle number **419.**

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (mA)	$f_{\alpha e}$ $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 65	2N3169	STC	pnp,si	85	0.46	200	–80	–3	*12-36	†10	–	53	
	2N3170	STC	pnp,si	85	0.46	200	–100	–3	*12-36	†10	–	53	
	2N3175	STC	pnp,si	85	0.46	200	–40	–5	*10-30	†10	–	61	
	2N3176	STC	pnp,si	85	0.46	200	–60	–5	*10-30	†10	–	61	
	2N3177	STC	pnp,si	85	0.46	200	–80	–5	*10-30	†10	–	61	
P 66	2N3178	STC	pnp,si	85	0.46	200	–100	–5	*10-30	†10	–	61	
	2N3179	STC	pnp,si	85	0.46	200	–40	–5	*10-30	†10	–	53	
	2N3180	STC	pnp,si	85	0.46	200	–60	–5	*10-30	†10	–	53	
	2N3181	STC	pnp,si	85	0.46	200	–80	–5	*10-30	†10	–	53	
	2N3182	STC	pnp,si	85	0.46	200	–100	–5	*10-30	†10	–	53	
	2N3187	STC	pnp,si	85	0.46	200	–40	–5	*10-30	†10	–	61	
	2N3188	STC	pnp,si	85	0.46	200	–60	–5	*10-30	†10	–	61	
	2N3189	STC	pnp,si	85	0.46	200	–80	–5	*10-30	†10	–	61	
	2N3190	STC	pnp,si	85	0.46	200	–100	–5	*10-30	†10	–	61	
	2N3191	STC	pnp,si	85	0.46	200	–40	–5	*10-30	†10	–	53	
P 67	2N3192	STC	pnp,si	85	0.46	200	–60	–5	*10-30	†10	–	53	
	2N3193	STC	pnp,si	85	0.46	200	–80	–5	*10-30	†10	–	53	
	2N3194	STC	pnp,si	85	0.46	200	–100	–5	*10-30	†10	–	53	
	2N3577	TI	npn,TD,si	85	0.565	175	80	2	*12-60	0.1	*10	53	
	2N3611	MO	pnp,AJ,ge	85	1	110	25	7	*35-70	0.04	–	3,41	TI
	2N3612	MO	pnp,AJ,ge	85	1	110	35	7	*35-70	0.04	–	3,41	TI
	2N3613	MO	pnp,AJ,ge	85	1	110	25	7	*60-120	0.04	–	3,41	
	2N3614	MO	pnp,AJ,ge	85	1	110	35	7	*60-120	0.04	–	3,41	TI
	2N3615	MO	pnp,AJ,ge	85	1	110	50	7	*30-60	0.06	–	3,41	TI
	2N3616	MO	pnp,AJ,ge	85	1	110	60	7	*30-60	0.06	–	3,41	TI
P 68	2N3617	MO	pnp,AJ,ge	85	1	110	50	7	*45-90	0.06	–	3,41	
	2N3618	MO	pnp,AJ,ge	85	1	110	60	7	*45-90	0.06	–	3,41	TI
	2N176	MO	pnp,AJ,ge	90	1.2	100	*40	3	*25-90	–	7	3	DE, KSC, ITT, TI
	2N178	MO	pnp,ge	90	1.43	90	30	3	*15-45	3	5	3	KSC, TI
	2N250A	TI	pnp,ge	90	0.42	100	*40	7	*35	1	–	3	KSC, BE, ITT
	2N251A	TI	pnp,ge	90	1.2	100	*60	7	*35	2	–	3	KSC, BE, ITT, TI
	2N257	CL	–	90	–	100	35	5	–	2	5	3	KSC, BE, TI
	2N268	ITT	–	90	–	100	60	5	–	2	6	3	KSC, BE
	2N268A	ITT	–	90	–	100	60	5	20	2	–	3	KSC, BE, TI
	2N297A	ITT	–	90	–	100	60	5	20	2	–	3	MO, KSC, BE, DE, TI
P 69	2N350A	MO	pnp,AJ,ge	90	1.2	100	*50	3	20-60	3	5	3	KSC, BE, TI
	2N351A	MO	pnp,AJ,ge	90	1.2	100	*50	4	*25-90	3	5	3	KSC, ITT, TI
	2N375	MO	pnp,AJ,ge	90	1.2	100	*80	3	*35-90	20	7	3	
	2N376A	MO	pnp,AJ,ge	90	1.2	100	*50	5	*35-120	3	5	3	KSC, ITT, TI
	2N627	MO	pnp,AJ,ge	90	1.2	100	*40	10	*10-30	20	8	3	KSC
	2N628	MO	pnp,ge	90	1.2	100	*60	10	*10-30	20	8	3	KSC
	2N629	MO	pnp,AJ,ge	90	1.2	100	*80	10	*10-30	20	8	3	KSC
	2N637	BE	–	90	–	–	30	5	30-60	–	–	3	KSC, TI
	2N637A	BE	–	90	–	–	55	5	*30-60	–	–	3	KSC, TI
	2N637B	BE	–	90	–	–	65	5	*30-60	–	–	3	KSC, TI
P 70	2N638	BE	–	90	–	–	30	5	*20-40	–	–	3	KSC, TI
	2N638A	BE	–	90	–	–	65	5	*30-60	–	–	3	KSC, TI
	2N638B	BE	–	90	–	–	65	5	*20-40	–	–	3	KSC, TI
	2N669	MO	pnp,AJ,ge	90	1.6	100	*40	3	90	3	5	3	DE, KSC, TI
	2N677	BE	pnp,ge	90	0.66	100	20	15	*20-60	–	–	3	KSC, TI, ITT
	2N677A	BE	pnp,ge	90	0.66	100	30	15	*20-60	–	–	3	KSC, TI, ITT
	2N677B	BE	pnp,ge	90	0.66	100	60	15	*20-60	–	–	3	KSC, TI, ITT
	2N677C	BE	pnp,ge	90	0.66	100	70	15	*20-60	–	–	3	KSC, TI, ITT
	2N1031	BE	pnp,ge	90	1.25	100	*50	15	*20-60	15	–	41	TI, ITT
	2N1031A	BE	pnp,ge	90	1.25	100	*60	15	*20-60	15	–	41	TI, ITT
P 71	2N1031B	BE	pnp,ge	90	1.25	100	*90	15	*20-60	15	–	41	TI, ITT
	2N1031C	BE	pnp,ge	90	1.25	100	*100	15	*20-60	15	–	41	TI, ITT
	2N1032	BE	pnp,ge	90	1.25	100	*50	15	*50-100	15	–	41	ITT
	2N1032A	BE	pnp,ge	90	1.25	100	*60	15	*50-100	15	–	41	ITT
	2N1032B	BE	pnp,ge	90	1.25	100	*90	15	50-100	15	–	41	ITT
	2N1032C	BE	pnp,ge	90	1.25	100	*100	15	*50-100	15	–	41	ITT
	2N1136	BE	–	90	–		30	5	*50-100	–	–	3	KSC, ITT, TI
	2N1136A	BE	–	90	–	–	55	5	*50-100	–	–	3	KSC, ITT, TI
	2N1136B	BE	–	90	–	–	65	5	*50-100	–	–	3	KSC, ITT, TI
	2N1137	BE	–	90	–	–	30	5	75-150	–	–	3	KSC, ITT, TI
P 72	2N1137B	BE	–	90	–	–	65	5	*75-150	–	–	3	KSC, ITT, TI
	2N1138	BE	–	90	–	–	30	5	100-200	–	–	3	KSC, ITT
	2N1138A	BE	–	90	–	–	55	5	100-200	–	–	3	KSC, ITT
	2N1138B	BE	–	90	–	–	65	5	100-200	–	–	3	KSC, ITT
	2N1146	ITT	–	90	–	100	20	15	60	4	4	3	BE
	2N1146A	ITT	–	90	–	100	30	15	–	4	4	3	KSC, BE
	2N1146B	ITT	–	90	–	100	60	15	60	4	4	3	KSC, BE
	2N1146C	ITT	–	90	–	100	75	15	60	4	4	3	KSC, BE
	2N1147	ITT	–	90	–	100	20	15	60	4	4	3	BE, TI
	2N1147A	ITT	–	90	–	100	30	15	–	4	4	3	KSC, BE, TI

Reader-Service cards are good all year.

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 73	2N1147B	ITT	–	90	–	100	60	15	60	4	4	3	KSC, BE, TI
	2N1147C	ITT	–	90	–	100	75	15	60	4	4	3	KSC, BE, TI
	2N1162	MO	pnp,AJ,ge	90	1.2	100	*50	25	*65	3	4	–	BE, ITT
	2N1162A	MO	pnp,AJ,ge	90	1.2	100	*50	25	*65	–	4	3	BE
	2N1163	MO	pnp,AJ,ge	90	1.2	100	*50	25	*65	–	4	3	BE, ITT
P 74	2N1163A	MO	pnp,AJ,ge	90	1.2	100	*50	25	*65	–	4	3	BE
	2N1164	MO	pnp,AJ,ge	90	1.2	100	*80	25	*65	–	4	3	BE, ITT
	2N1164A	MO	pnp,AJ,ge	90	1.2	100	*80	25	65	–	4	3	BE
	2N1165	MO	pnp,AJ,ge	90	1.2	100	*80	25	*65	–	4	3	BE, ITT
	2N1165A	MO	pnp,AJ,ge	90	1.2	100	*80	25	*65	–	4	3	BE
	2N1166	MO	pnp,AJ,ge	90	1.2	100	*100	25	*65	–	4	3	BE, ITT
	2N1166A	MO	pnp,AJ,ge	90	1.2	100	*100	25	*65	–	4	3	BE
	2N1167	MO	pnp,AJ,ge	90	1.2	100	*100	25	*65	–	4	3	BE, ITT
	2N1167A	MO	pnp,AJ,ge	90	1.2	100	*100	25	*65	–	4	3	BE
	2N1359	MO	pnp,AJ,ge	90	1.2	100	*50	3	*35-90	3	10	3	KSC, BE
P 75	2N1360	MO	pnp,AJ,ge	90	1.2	100	*50	3	*60-140	3	8.5	3	KSC, BE
	2N1362	MO	pnp,AJ,ge	90	1.2	100	*100	3	*35-90	3	10	3	KSC, BE
	2N1363	MO	pnp,AJ,ge	90	1.2	100	*100	3	*60-140	3	8.5	3	KSC, BE
	2N1364	MO	pnp,AJ,ge	90	1.2	100	*120	3	*35-90	3	10	3	KSC, BE
	2N1365	MO	pnp,AJ,ge	90	1.2	100	*120	3	*60-140	3	8.5	3	KSC, BE
	2N1529	MO	pnp,AJ,ge	90	1.2	100	*40	5	*20	2	10	3	KSC, BE
	2N1529A	MO	pnp,AJ,ge	90	1.2	100	*40	5	*20	2	10	3	KSC, BE
	2N1530	MO	pnp,AJ,ge	90	1.2	100	*60	5	*20	2	10	3	KSC, BE
	2N1530A	MO	pnp,AJ,ge	90	1.2	100	*60	5	*20	2	10	3	KSC, BE
	2N1531	MO	pnp,AJ,ge	90	1.2	100	*80	5	*20	2	10	3	KSC, BE
P 76	2N1531A	MO	pnp,AJ,ge	90	1.2	100	*80	5	*20	2	10	3	KSC, BE
	2N1532	MO	pnp,AJ,ge	90	1.2	100	*100	5	*20	2	10	3	KSC, BE
	2N1532A	MO	pnp,AJ,ge	90	1.2	100	*100	5	*20	2	10	3	KSC, BE
	2N1533	MO	pnp,AJ,ge	90	1.2	100	*120	5	*20	2	10	3	KSC, BE
	2N1534	MO	pnp,AJ,ge	90	1.2	100	*40	5	*35	2	8.5	3	DE, KSC, BE, ITT
	2N1534A	MO	pnp,AJ,ge	90	1.2	100	*60	5	*35	2	8.5	3	KSC, BE
	2N1535	MO	pnp,AJ,ge	90	1.2	100	*60	5	*35	2	8.5	3	DE, KSC, BE, ITT
	2N1536	MO	pnp,AJ,ge	90	1.2	100	*80	5	*35	2	8.5	3	DE, KSC, BE, ITT
	2N1536A	MO	pnp,AJ,ge	90	1.2	100	*80	5	*35	2	8.5	3	KSC, BE
	2N1537	MO	pnp,AJ,ge	90	1.2	100	*100	5	*35	2	8.5	3	KSC, BE, ITT, DE
P 77	2N1537A	MO	pnp,AJ,ge	90	1.2	100	*100	5	*35	2	8.5	3	KSC, BE
	2N1538	MO	pnp,AJ,ge	90	1.2	100	*120	5	*35	2	8.5	3	KSC, BE, ITT
	2N1539	MO	pnp,AJ,ge	90	1.2	100	*40	5	*50	2	4	3	DE, KSC, BE, TI, ITT
	2N1539A	MO	pnp,AJ,ge	90	1.2	100	*40	5	*50	2	4	3	KSC, BE
	2N1540	MO	pnp,AJ,ge	90	1.2	100	*60	5	*50	2	4	3	DE, KSC, BE, TI, ITT
	2N1540A	MO	pnp,AJ,ge	90	1.2	100	*60	5	*50	2	4	3	KSC, BE
	2N1541	MO	pnp,AJ,ge	90	1.2	100	*80	5	*50	2	4	3	DE, KSC, BE, TI, ITT
	2N1541A	MO	pnp,AJ,ge	90	1.2	100	*80	5	*50	2	4	3	KSC, BE
	2N1542	MO	pnp,AJ,ge	90	1.2	100	*100	5	*50	2	4	3	DE, KSC, BE, TI, ITT
	2N1542A	MO	pnp,AJ,ge	90	1.2	100	*100	5	*50	2	4	3	KSC, BE
P 78	2N1543	MO	pnp,AJ,ge	90	1.2	100	*120	5	*50	2	4	3	DE, KSC, BE, TI, ITT
	2N1544	MO	pnp,AJ,ge	90	1.2	100	*40	5	*75	2	4	3	DE, KSC, BE, ITT
	2N1544A	MO	pnp,AJ,ge	90	1.2	100	*40	5	*75	2	4	3	KSC, BE
	2N1545	MO	pnp,AJ,ge	90	1.2	100	*60	5	*75	2	4	3	DE, KSC, BE, ITT
	2N1545A	MO	pnp,AJ,ge	90	1.2	100	*60	5	*75	2	4	3	KSC, BE
	2N1546	MO	pnp,AJ,ge	90	1.2	100	*80	5	*75	2	4	3	DE, KSC, BE, ITT
	2N1546A	MO	pnp,AJ,ge	90	1.2	100	*80	5	*75	2	4	3	KSC, BE
	2N1547	MO	pnp,AJ,ge	90	1.2	100	*100	5	*75	2	4	3	DE, KSC, BE, ITT
	2N1547A	MO	pnp,AJ,ge	90	1.2	100	*100	5	*75	2	4	3	KSC, BE
	2N1549	MO	pnp,AJ,ge	90	1.2	100	20	15	*10	3	10	3	KSC, BE, ITT
P 79	2N1548	MO	pnp,AJ,ge	90	1.2	100	*120	5	*75	2	4	3	KSC, BE, ITT
	2N1549A	MO	pnp,AJ,ge	90	1.2	100	20	15	*10	3	10	3	KSC, BE
	2N1550	MO	pnp,AJ,ge	90	1.2	100	30	15	*10	3	10	3	KSC, BE, ITT
	2N1551	MO	pnp,AJ,ge	90	1.2	100	40	15	*10	3	10	3	KSC, BE, ITT
	2N1551A	MO	pnp,AJ,ge	90	1.2	100	40	15	*10	3	10	3	KSC, BE
	2N1552	MO	pnp,AJ,ge	90	1.2	100	50	15	*10	3	10	3	KSC, BE, ITT
	2N1552A	MO	pnp,AJ,ge	90	1.2	100	50	15	*10	3	10	3	KSC, BE
	2N1553	MO	pnp,AJ,ge	90	1.2	100	20	15	*30	3	6	3	KSC, BE, TI, ITT, DE
	2N1553A	MO	pnp,AJ,ge	90	1.2	100	20	15	*30	3	6	3	KSC, BE
	2N1554	MO	pnp,AJ,ge	90	1.2	100	30	15	*30	3	6	3	KSC, BE, TI, ITT, DE
P 80	2N1554A	MO	pnp,AJ,ge	90	1.2	100	30	15	*30	3	6	3	KSC, BE
	2N1555	MO	pnp,AJ,ge	90	1.2	100	40	15	*30	3	6	3	KSC, BE, TI, ITT, DE
	2N1555A	MO	pnp,AJ,ge	90	1.2	100	40	15	*30	3	6	3	KSC, BE
	2N1556	MO	pnp,AJ,ge	90	1.2	100	50	15	*30	3	6	3	KSC, BE, TI, ITT, DE
	2N1556A	MO	pnp,AJ,ge	90	1.2	100	50	15	*30	3	6	3	KSC, BE
	2N1557	MO	pnp,AJ,ge	90	1.2	100	20	15	*50	3	5	3	KSC, BE, ITT, DE
	2N1557A	MO	pnp,AJ,ge	90	1.2	100	20	15	*50	3	5	3	KSC, BE
	2N1558	MO	pnp,AJ,ge	90	1.2	100	30	15	*50	3	5	3	KSC, BE, ITT, DE
	2N1558A	MO	pnp,AJ,ge	90	1.2	100	30	15	*50	3	5	3	KSC, BE
	2N1559	MO	pnp,AJ,ge	90	1.2	100	40	15	*50	3	5	3	KSC, BE, ITT, DE

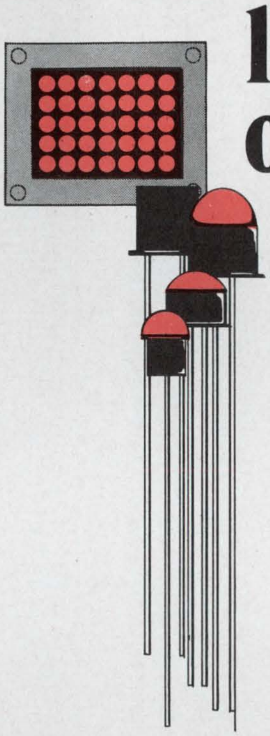
Circle as many numbers on the reader-service card as you like.

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (mA)	fae $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 81	2N1559A	MO	pnp,AJ,ge	90	1.2	100	40	15	*50	3	5	3	KSC, BE
	2N1560	MO	pnp,AJ,ge	90	1.2	100	50	15	*50	3	5	3	KSC, BE, ITT, DE
	2N1560A	MO	pnp,AJ,ge	90	1.2	100	50	15	*50	3	5	3	KSC, BE
	2N2061A	ITT	–	90	–	100	15	5	20	2	5	3	
	2N2062A	ITT	–	90	–	100	15	5	50	2	1	3	
P 82	2N2063A	ITT	–	90	–	100	20	5	20	2	5	3	
	2N2064A	ITT	–	90	–	100	20	5	50	2	1	3	
	2N2065A	ITT	–	90	–	100	40	5	20	5	5	3	
	2N2066A	ITT	–	90	–	100	40	5	50	5	1	3	
	2N2423	ITT	–	90	–	100	75	5	20	5	3	3	KSC
	3N49	SOL	pnp,ge	94	1.25	100	*60	15	*30-120	3	600	–	
	3N50	SOL	pnp,ge	94	1.25	100	*80	15	*20-80	3	300	–	
	3N51	SOL	pnp,ge	94	1.25	100	*40	15	*30-120	3.0	500	–	
	3N52	SOL	pnp,ge	94	1.25	100	*60	15	*20-80	3.0	300	–	
	2N2285	BE	–	100	–	–	30	25	*20	–	–	3	
P 83	2N2286	BE	–	100	–	–	60	25	*20	–	–	3	
	2N2287	BE	–	100	–	–	80	25	*20	–	–	3	
	2N3597	SOL	npn,si	100	1	200	*60	20	*40-120	0.0001	30000	*	*7/8" hex, TI
	2N3598	SOL	npn,si	100	1	200	*80	20	*40-120	0.0001	30000	*	*7/8" hex, TI
	2N3599	SOL	npn,si	100	1	200	*100	20	*40-120	0.0001	30000	*	*7/8" hex, TI
	2N4002	TI	npn,EP,si	100	1	200	80	30	20-80	1	30,000	63	
	2N4003	TI	npn,EP,si	100	1	200	100	30	*20-80	1	*30,000	63	
	2N3442	RCA	npn,si	117	0.668	200	140	10	*20-70	5	–	3	
	2N3445	MO	npn,AE,si	117	0.66	200	80	7.5	*20-60	0.1	–	3	
	2N3446	MO	npn,AE,si	117	0.66	200	60	7.5	*20-60	0.1	–	3	
P 84	2N3447	MO	npn,AE,si	117	0.66	200	80	7.5	*40-120	0.1	–	3	
	2N3448	MO	npn,AE,si	117	0.66	200	60	7.5	*40-120	0.1	–	3	
	2N3487	MO	npn,AE,si	117	0.66	200	60	7.5	*20-60	0.025	–	61	TI
	2N3488	MO	npn,AE,si	117	0.66	200	80	7.5	*20-60	0.025	–	61	TI
	2N3489	MO	npn,AE,si	117	0.66	200	100	7.5	*15-45	0.025	–	61	TI
	2N3490	MO	npn,AE,si	117	0.66	200	60	7.5	*40-120	0.025	–	61	TI
	2N3491	MO	npn,AE,si	117	0.66	200	80	7.5	*40-120	0.025	–	61	TI
	2N3492	MO	npn,AE,si	117	0.66	200	100	7.5	*30-90	0.025	–	61	TI
	2N4347	RCA	npn,si	117	0.67	200	120	10	*20-70	1	*0.8 MHz	3	
	2N4348	RCA	npn,si	120	0.68	200	120	30	*15-60	*2	*0.7 MHz	3	
P 85	2N1899	TRWS	npn,PL,si	125	1.0	150	*140	10	5.0	10	2500	–	
	2N1900	TRWS	npn,PL,si	125	1	150	*140	10	*>8	10	5000	–	
	2N1901	TRWS	npn,PL,si	125	1	150	*140	10	5	10	2000	–	
	2N1902	TRWS	npn,PL,si	125	1	150	*140	10	5	10	5000	–	
	2N1903	TRWS	npn,PL,si	125	1	150	*140	10	*>8	10	5000	–	
	2N1904	TRWS	npn,PL,si	125	1	150	*140	10	5	10	2000	–	
	2N3076	TRWS	npn,PL,si	125	1.0	150	*140	10	5	25	2000	–	
	2N3263	RCA	npn,si	†125	1	200	60	25	*25-75	4	–	–	† Tc = 75C, TI
	2N3265	RCA	npn,si	†125	1	200	60	25	*25-75	4	–	63	† Tc= 75C, TI
	2N2733	SOL	pnp,ge	141	1.67	110	*80	65	*30-120	5.0	350	–	
P 86	2N2734	SOL	pnp,ge	141	1.67	110	*60	65	*30-120	5.0	350	–	
	2N2735	SOL	pnp,ge	141	1.67	110	*40	65	*30-120	5.0	350	–	
	2N2736	SOL	pnp,ge	141	1.67	110	*80	65	*30-120	5.0	350	–	
	2N2737	SOL	pnp,ge	141	1.67	110	*60	65	*30-120	5.0	350	–	
	2N2738	SOL	pnp,ge	141	1.67	110	*40	65	*30-120	5.0	350	–	
	2N173	DE	pnp,AJ,ge	150	.5	100	45	15	*37-70	4	10	36	MO, RCA
	2N174	DE	pnp,AJ,ge	150	.5	100	55	15	*25-50	4	10	36	MO, RCA
	2N174A	DE	pnp,AJ,ge	150	.5	100	40	15	*40-80	8	10	36	MO
	2N277	DE	pnp,AJ,ge	150	.5	100	25	15	*35-70	8	10	36	MO, RCA
	2N278	DE	pnp,AJ,ge	150	.5	100	30	15	*35-70	4	10	36	MO, RCA
P 87	2N441	DE	pnp,AJ,ge	150	.5	100	25	15	*20-40	8	10	36	MO, RCA
	2N442	DE	pnp,AJ,ge	150	.5	100	30	15	*20-40	4	10	36	MO, RCA
	2N443	DE	pnp,AJ,ge	150	.5	100	45	15	*20-40	4	10	36	MO, RCA
	2N511	TI	pnp,ge	150	2	100	*40	25	*20	0.5	–	–	
	2N511A	TI	pnp,ge	150	2	100	*60	25	*20	0.5	–	–	
	2N511B	TI	pnp,ge	150	2	100	*80	25	*20	0.5	–	–	
	2N512	TI	pnp,ge	150	2	100	*40	25	*20	0.5	–	–	
	2N512A	TI	pnp,ge	150	2	100	*60	25	*20	0.5	–	–	
	2N512B	TI	pnp,ge	150	2	100	*80	25	*20	0.5	–	–	
	2N513	TI	pnp,ge	150	2	100	*40	25	*20	0.5	–	–	
P 88	2N513A	TI	pnp,ge	150	2	100	*60	25	*20	0.5	–	–	
	2N513B	TI	pnp,ge	150	2	100	*80	25	*20	0.5	–	–	
	2N514	TI	pnp,ge	150	2.14	95	40	25	*40	0.2	–	–	
	2N514A	TI	pnp,ge	150	2.14	95	50	25	*40	0.2	–	–	
	2N514B	TI	pnp,ge	150	2.14	95	60	25	*40	0.2	–	–	
	2N1015C	WH	npn,AJ,si	150	1.43	150	150	7.5	*10	10	25	–	STC
	2N1099	DE	pnp,AJ,ge	150	.5	100	55	15	*35-70	4	10	36	MO, RCA
	2N1100	DE	pnp,AJ,ge	150	.5	100	65	15	*25-50	4	10	36	MO, RCA
	2N1358	DE	pnp,AJ,ge	150	0.5	100	-80	-15	*40-80	-4	100	36	RCA, MO
	2N1412	DE	pnp,AJ,ge	150	0.5	100	100	15	*25-50	4	10	36	RCA, MO

Reader-Service cards are good all year.

Monsanto's new semiconductor light sources offer you 13 important features



Monsanto semiconductor light sources are solid state devices. They have no filaments to burn out. They emit visible or infrared light. The optical properties of the output light make them well-suited to a host of applications. Check these features:

Physical

- Unusually long life
- Miniature size
- Rugged

Electrical

- Low voltage operation (1.6v)
- Low current requirement (5-100 ma)
- Low power consumption
- Fast switching (10 nsec)
- Linear output
- Forward bias operation

Optical

- Adjustable light output (0-100 ft. lamb.)
- Narrow band width (half width 400Å)
- Selective wave length (6000-9000Å)
- Epoxy lens for light magnification and collimation

We'd like to tell you more. Call (314) OXford 4-2136, or write: Monsanto Company, 800 N. Lindbergh Boulevard, St. Louis, Missouri 63166.

Monsanto®

ELECTRONICS

ON READER-SERVICE CARD CIRCLE 87

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
				P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)		
P 89	2N1412USN	DE	pnp,AJ,ge	150	.5	100	60	15	*25-50	4	10	36	MO
	2N1936	TI	npn,si	150	2	175	60	20	*12	–	–	–	
	2N1937	TI	npn,si	150	2	175	80	20	*12	–	–	–	
	2N2015	RCA	npn,si	150	.855	200	50	10	*15-50	.05	25	36	STC
	2N2016	RCA	npn,si	150	.855	200	65	10	*15-50	.05	25	36	STC
P 90	2N2226	WH	npn,AJ,si	150	2	150	50	10	*100	10	10	†	†MT 1
	2N2227	WH	npn,AJ,si	150	2	150	100	10	*100	10	10	†	†MT 1
	2N2228	WH	npn,AJ,si	150	2	150	150	10	*100	10	10	†	†MT 1
	2N2229	WH	npn,AJ,si	150	2	150	200	10	*100	10	10	†	†MT 1
	2N2230	WH	npn,AJ,si	150	2.0	150	50	10	*400	10	7	†	†MT 1
	2N2231	WH	npn,AJ,si	150	2.0	150	100	10	*400	10	7	†	†MT 1
	2N2232	WH	npn,AJ,si	150	2.0	150	150	10	*400	10	7	†	†MT 1
	2N2233	WH	npn,AJ,si	150	2.0	150	200	10	*400	10	7	†	†MT 1
	2N2338	RCA	npn,si	150	0.855	200	40	7.5	*15-60	0.2	20	36	
	2N3429	WH	npn,AJ,si	150	1.33	175	*50	7.5	*10	10	30	–	
P 91	2N3430	WH	npn,AJ,si	150	1.33	175	*100	7.3	*10	10	30	–	
	2N3431	WH	npn,AJ,si	150	1.33	175	*150	7.5	*10	10	30	–	
	2N3432	WH	npn,AJ,si	150	1.33	175	*200	7.5	*10	10	30	–	
	2N3433	WH	npn,AJ,si	150	1.33	175	*250	7.5	*10	10	30	–	
	2N3434	WH	npn,AJ,si	150	1.33	175	*30	7.5	*10	10	30	–	
	2N3470	WH	npn,AJ,si	150	2	150	*50	10	*100	10	10	–	
	2N3471	WH	npn,AJ,si	150	2	150	*100	10	*100	10	10	–	
	2N3472	WH	npn,AJ,si	150	2	150	*150	10	*100	10	10	–	
	2N3473	WH	npn,AJ,si	150	2	150	*200	10	*100	10	10	–	
	2N3474	WH	npn,AJ,si	150	2	150	*50	10	*400	10	10	–	
P 92	2N3475	WH	npn,AJ,si	150	2	150	*100	10	*400	10	10	–	
	2N3476	WH	npn,AJ,si	150	2	150	*150	10	*400	10	10	–	
	2N3477	WH	npn,AJ,si	150	2	150	*200	10	*400	10	10	–	
	2N3713	MO	npn,si	150	.857	200	60	10	*25-90	†1	*4000	3	
	2N3714	MO	npn,si	150	.857	200	80	10	*25-90	†1	*4000	3	
	2N3715	MO	npn,si	150	.857	200	60	10	*50-150	†1	*4000	3	
	2N3716	MO	npn,si	150	.857	200	80	10	*50-150	†1	*4000	3	
	2N3771	RCA	npn,si	150	0.855	200	40	30	*15-60	2	*700	3	SOL
	2N3772	RCA	npn,si	150	0.855	200	60	30	*15-60	5	*700	3	SOL
	2N3773	RCA	npn,si	150	.855	200	140	30	*15-60	2	*500	3	SOL
P 93	2N3789	MO	pnp,si	150	.857	200	60	10	*25-90	†1	*4000	3	
	2N3790	MO	pnp,si	150	.857	200	80	10	*25-90	†1	*4000	3	
	2N3791	MO	pnp,si	150	.857	200	60	10	*50-150	†1	*4000	3	
	2N3792	MO	pnp,si	150	.857	200	80	10	*50-150	†1	*4000	3	
	2N3846	TI	npn, TDM, si	150	2	175	200	20	*15-60	2	10,000	63	
	2N3847	TI	npn, TDM,si	150	2	175	300	20	*15-60	2	10,000	63	
	2N3848	TI	npn, TDM,si	150	2	175	200	20	*15-60	2	10,000	63	
	2N3849	TI	npn, TDM,si	150	2	175	300	20	*15-60	2	10,000	63	
	2N3146	TI	pnp,ge	150	2	100	*150	15	*30-90	10	–	3	
	2N3147	TI	pnp,ge	150	2	100	180	15	30-90	10	–	3	
P 94	2N2075	MO	pnp,AJ,ge	170	2	110	65	15	*25-100	4	5	36	DE
	2N2075A	MO	pnp,AJ,ge	170	2	110	65	15	*25-100	4	5	36	
	2N2076	MO	pnp,AJ,ge	170	2	110•	55	15	*25-100	4	5	36	DE
	2N2076A	MO	pnp,AJ,ge	170	2	110	55	15	*25-100	4	5	36	
	2N2077	MO	pnp,AJ,ge	170	2	110	45	15	*25-100	4	5	36	DE
	2N2077A	MO	pnp,AJ,ge	170	2	110	45	15	*25-100	4	5	36	
	2N2078	MO	pnp,AJ,ge	170	2	110	25	15	*25-100	4	5	36	DE
	2N2078A	MO	pnp,AJ,ge	170	2	110	25	15	*25-100	4	5	36	
	2N2079	MO	pnp,AJ,ge	170	2	110	65	15	*40-160	4	5	36	DE
	2N2079A	MO	pnp,AJ,ge	170	2	110	65	15	*40-160	4	5	36	
P 95	2N2080	MO	pnp,AJ,ge	170	2	110	55	15	*40-160	4	5	36	DE
	2N2080A	MO	pnp,AJ,ge	170	2	110	55	15	*40-160	4	5	36	
	2N2081	MO	pnp,AJ,ge	170	2	110	45	15	*40-160	4	5	36	DE
	2N2081A	MO	pnp,AJ,ge	170	2	110	45	15	*40-160	4	5	36	
	2N2082	MO	pnp,AJ,ge	170	2	110	25	15	*40-160	4	5	36	DE
	2N2082A	MO	pnp,AJ,ge	170	2	110	25	15	*40-160	4	5	36	
	2N2152	MO	pnp,AJ,ge	170	2	110	30	30	*50-100	4	2.7	36	
	2N2152A	MO	pnp,AJ,ge	170	2	110	30	30	*50-100	4	2.7	36	
	2N2153	MO	pnp,AJ,ge	170	2	110	45	30	*50-100	4	2.7	36	
	2N2153A	MO	pnp,AJ,ge	170	2	110	45	30	*50-100	4	2.7	36	
P 96	2N2154	MO	pnp,AJ,ge	170	2	110	60	30	*50-100	4	2.7	36	
	2N2154A	MO	pnp,AJ,ge	170	2	110	60	30	*50-100	4	2.7	36	
	2N2156	MO	pnp,AJ,ge	170	2	110	30	30	*80-160	4	2.7	36	
	2N2156A	MO	pnp,AJ,ge	170	2	110	30	30	*80-160	4	2.7	36	
	2N2157	MO	pnp,AJ,ge	170	2	110	45	30	*80-160	4	2.7	36	
	2N2157A	MO	pnp,AJ,ge	170	2	110	45	30	*80-160	4	2.7	36	
	2N2158	MO	pnp,AJ,ge	170	2	110	60	30	*80-160	4	2.7	36	
	2N2158A	MO	pnp,AJ,ge	170	2	110	60	30	*80-160	4	2.7	36	
	2N2357	BR	–	170	–	–	30	50	*15	–	–	41	
	2N2358	BE	–	170	–	–	60	50	*15	–	–	41	

Get detailed spec sheets and application notes: use the reader-service card!

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 97	2N2359	BE	–	170	–	–	80	50	*50	–	–	41	
	2N2728	MO	pnp,AJ,ge	170	2	110	5	50	*40-130	–	4.5	36	
	2N2730	SOL	pnp,ge	170	2.0	110	*80	65	*30-120	5.0	350	36	
	2N2731	SOL	pnp,ge	170	2	110	*60	65	*30-120	5	350	36	
	2N2732	SOL	pnp,ge	170	2	110	*40	65	*30-120	5	350	36	
P 98	2N3311	MO	pnp,AJ,ge	170	2	110	20	5	60-120	0.3	1.0	36	
	2N3312	MO	pnp,AJ,ge	170	2	110	30	5	60-120	0.3	1.0	36	
	2N3313	MO	pnp,AJ,ge	170	2	110	40	5	60-120	0.3	1.0	36	
	2N3314	MO	pnp,AJ,ge	170	2	110	20	5	100-200	0.3	1.0	36	
	2N3315	MO	pnp,AJ,ge	170	2	110	30	5	100-200	0.3	1.0	36	
	2N3316	MO	pnp,AJ,ge	170	2	110	40	5	100-200	0.3	1.0	36	
	2N4048	MO	pnp,ge	170	2	110	30	60	*60-120	4	2	36	
	2N4049	MO	pnp,ge	170	2	110	45	60	*60-120	4	2	36	
	2N4050	MO	pnp,ge	170	2	110	60	60	*60-120	4	2	36	
	2N4051	MO	pnp,ge	170	2	110	30	60	*80-180	4	2	36	
P 99	2N4052	MO	pnp,ge	170	2	110	45	60	*80-180	4	2	36	
	2N4053	MO	pnp,ge	170	2	110	60	60	*80-180	4	2	36	
	2N2580	DE	pnp,DD,si	178	.7	150	400	10	10-40	–	50	36	
	2N2581	DE	npn,DD,si	178	.7	150	400	10	*10	-	50	36	
	2N2582	DE	npn,DD,si	178	.7	150	500	10	*10-40	–	50	36	
	2N2583	DE	npn,DD,si	178	.7	150	500	10	10	–	50	36	
	2N574	SOL	pnp,ge	187	2.5	100	*60	10	*9-22	7	100	–	
	2N574A	SOL	pnp,ge	187	2.5	100	*80	10	*9-22	20.	100	–	
	2N575	SOL	pnp,ge	187	2.5	100	*60	25	*19-42	7	150	–	
	2N575A	SOL	pnp,ge	187	2.5	100	*80	25	*19-42	20.	150	–	
P 100	2N1157	SOL	pnp,ge	187	2.5	100	*60	40	*38-84	7	200	–	
	2N1157A	SOL	pnp,ge	187	2.5	100	*80	40	*38-84	20.	200	–	
	2N2739	WH	npn,AJ,si	200	2	175	50	20	*10	15	14	†	†MT 1
	2N2740	WH	npn,AJ,si	200	2	175	100	20	*10	15	14	†	†MT 1
	2N2741	WH	npn,AJ,si	200	2	175	150	20	*10	15	14	–	
	2N2742	WH	npn,AJ,si	200	2	175	200	20	*10	15	14	–	
	2N2745	WH	npn,AJ,si	200	2	175	50	20	*10	15	14.5	†	†MT 1
	2N2746	WH	npn,AJ,si	200	2	175	100	20	*10	15	14.5	†	†MT 1
	2N2747	WH	npn,AJ,si	200	2	175	150	20	*10	15	14.5	†	†MT 1
	2N2748	WH	npn,AJ,si	200	2	175	200	20	*10	15	14.5	†	†MT 1
P 101	2N2751	WH	npn,AJ,si	200	2	175	50	20	*10	15	16	†	†MT 1
	2N2752	WH	npn,AJ,si	200	2	175	100	20	*10	15	16	†MT 1	
	2N2753	WH	npn,AJ,si	200	2	175	150	20	*10	15	16	†	†MT 1
	2N2754	WH	npn,AJ,si	200	2	175	200	20	*10	15	16	†	†MT 1
	2N2757	WH	npn,AJ,si	200	2	175	50	30	*10	15	14	†	†MT 33
	2N2758	WH	npn,AJ,si	200	2	175	100	30	*10	15	14	†	†MT 33
	2N2759	WH	npn,AJ,si	200	2	175	150	30	*10	15	14	†	†MT 33
	2N2760	WH	npn,AJ,si	200	2	175	200	30	*10	15	14	†	†MT 33
	2N2761	WH	npn,AJ,si	200	2	175	250	30	*10	15	14	†	†MT 33
	2N2763	WH	npn,AJ,si	200	2	175	50	30	*10	15	14.5	†	†MT 33
P 102	2N2764	WH	npn,AJ,si	200	2	175	100	30	*10	15	14.5	†	†MT 33
	2N2765	WH	npn,AJ,si	200	2	175	150	30	*10	15	14.5	†	†MT 33
	2N2766	WH	npn,AJ,si	200	2	175	200	30	*10	15	14.5	†	†MT 33
	2N2769	WH	npn,AJ,si	200	2	175	50	30	*10	15	16	†	†MT 33
	2N2770	WH	npn,AJ,si	200	1	175	100	30	10	15	16	–	
	2N2771	WH	npn,AJ,si	200	2	175	150	30	*10	15	16	†	†MT 33
	2N2772	WH	npn,AJ,si	200	2	175	200	30	*10	15	16	†	†MT 33
	2N2775	WH	npn,AJ,si	200	2	175	200	30	*10	15	16	†	†MT33
	2N2776	WH	npn,AJ,si	200	2	175	200	30	*10	15	16	†	†MT33
	2N2777	WH	npn,AJ,si	200	2	175	200	30	*10	15	16	†	†MT33
P 103	2N2778	WH	npn,AJ,si	200	2	175	200	30	*10	15	16	†	†MT33
	2N2815	STC	npn	200	1	200	80	20	*10-50	–	–	*	*7/8" hex, TI
	2N2816	STC	npn	200	1	1.0	100	20	*10-50	–	–	*	*7/8" hex, TI
	2N2817	STC	npn	200	1	200	150	20	*20-60	–	–	*	*7/8" hex, TI
	2N2818	STC	npn	200	1	200	200	20	*10-50	–	–	*	*7/8" hex, TI
	2N2819	STC	npn	200	1	200	80	25	*10-50	–	–	*	*7/8" hex, TI
	2N2820	STC	npn	200	1	200	100	25	*10-50	–	–	*	*7/8" Hex, TI
	2N2821	STC	npn	200	1	200	150	25	*10-50	–	–	*	*7/8" Hex, TI
	2N2822	STC	npn	200	1	200	200	25	*10-50	–	–	*	*7/8" Hex, TI
	2N2823	STC	npn	200	1	200	80	30	*10-40	–	–	*	*7/8" Hex, TI
P 104	2N2824	STC	npn	200	1	200	100	30	*10-40	–	–	*	*7/8" Hex, TI
	2N2825	STC	npn	200	1	200	150	30	*10-40	–	–	*	*7/8" Hex, TI
	2N2902	TI	npn,si	240	1.37	200	120	0.5	30	0.005	–	–	
	2N1809	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14	†	†MT 14
	2N1810	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14	†	†MT 14
	2N1811	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14	†	†MT 14
	2N1812	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14	†	†MT 14
	2N1813	WH	npn,AJ,si	250	2.22	175	250	30	*10	15	14	†	†MT 14
	2N1814	WH	npn,AJ,si	250	2.22	175	300	30	*10	15	14	†	†MT 14
	2N1816	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14.5	†	†MT 14

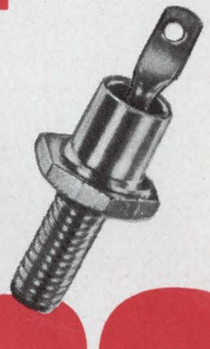
Need a FREE personal copy of this Directory? Circle number **419.**

Power *(continued)*

				MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$f_{\alpha e}$ $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 105	2N1817	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14.5	†	†MT 14
	2N1818	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14.5	†	†MT 14
	2N1819	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14.5	†	†MT 14
	2N1823	WH	npn,AJ,si	250	2.33	175	50	30	*10	15	16	†	†MT 14
	2N1824	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	16	†	†MT 14
P 106	2N1825	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	16	†	†MT 14
	2N1826	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	16	†	†MT 14
	2N1830	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14	†	†MT 14
	2N1831	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14	†	†MT 14
	2N1832	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14	†	†MT 14
	2N1833	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14	†	†MT 14
	2N2109	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14	†	†MT 17
	2N2110	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14	†	†MT 17
	2N2111	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14	†	†MT 17
	2N2112	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14	†	†MT 17
P 107	2N2113	WH	npn,AJ,si	250	2.22	175	250	30	*10	15	14	†	†MT 17
	2N2114	WH	npn,AJ,si	250	2.22	175	300	30	*10	15	14	†	†MT 17
	2N2116	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14.5	†	†MT 17
	2N2117	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14.5	†	†MT 17
	2N2118	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14.5	†	†MT 17
	2N2119	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14.5	†	†MT 17
	2N2123	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	16	†	†MT 17
	2N2124	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	16	†	†MT 17
	2N2125	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	16	†	†MT 17
	2N2126	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	16	†	†MT 17
P 108	2N2130	WH	npn,AJ,si	250	2.22	175	50	30	*10	15	14	†	†MT 17
	2N2131	WH	npn,AJ,si	250	2.22	175	100	30	*10	15	14	†	†MT 17
	2N2132	WH	npn,AJ,si	250	2.22	175	150	30	*10	15	14	†	†MT 17
	2N2133	WH	npn,AJ,si	250	2.22	175	200	30	*10	15	14	†	†MT 17
	2N3149	STC	npn	300	2	200	80	70	*10	–	–	*	*1 1/16" Hex
	2N3150	STC	npn	300	2	200	100	70	*10	–	–	*	*1 1/16" Hex
	2N3151	STC	–	300	2	200	150	70	*10	–	–	*	*1 1/16" Hex
	2N4865	SOL	npn,PL,si	350	0.5	200	80	100	10-40	0.1	20,000	–	
	2N4866	SOL	npn,PL,si	350	0.5	200	120	100	10-40	0.1	20,000	–	
	2N4079	AMP	2N4077 & 2N4078 combined to form matched complementary pair										
P 109	2N4107	AMP	2N4105 & 2N4106 combined to form matched complementary pair										
	2N4136	AMP	2N2430 & 2N2431 combined to form matched complementary pair										

Reader-Service cards are good all year.
Circle as many numbers on the reader-service card as you like.
Complete listing of semiconductor manufacturers starts on page 86.
Need a FREE personal copy of this Directory? Circle number **419.**
Get detailed spec sheets and application notes: use the reader-service card!

MEDIUM CURRENT RECTIFIERS



Only IRC offers so many types to choose from

...plus unmatched quality, price and delivery

IRC offers the industry's largest selection of medium current rectifiers. Satisfy all your MIL and industrial needs from one source. Choose from over 150 different JEDEC types—ratings from 1.5 to 35 amps, to 1500 PIV.

IRC's exclusive construction features mean superior quality and more dependable performance, as well as substantial cost savings. Electrical features include: chemically contoured junctions for guaranteed bulk avalanching, uniform forward characteristics and lowest reverse leakage. Mechanically, the cap header tube is pre-crimped and *brazed* to prevent leaks. The base, of highest torque copper, has a cold headed weld to eliminate leaks between the projection and the stud. The entire unit has a bright nickel finish that resists corrosion.

MIL TYPES

RATING	SERIES	MIL
0.3A, 1500V	1N1130, 1131	MIL-S-19500/259A
12A	1N1200A-1206A	MIL-S-19500/260A
35A	1N1184-1190	MIL-S-19500/297

AND ALSO... HIGH CURRENT RECTIFIERS

- All "1N" types. Forward or reverse polarity.
- 100 to 275 amps, to 1400 PIV
- 200°C junction capability
- Fatigue-free construction
- Metal-ceramic hermetic seal
- Highest torque copper stud

For data and prices on all IRC rectifiers, write to: IRC, Inc., Semiconductor Division (formerly North American Electronics), 71 Linden Street, West Lynn, Mass. 01905.

IRC®

Rewarding career opportunities are immediately available.

ON READER-SERVICE CARD CIRCLE 68

Low-Level Switching under one watt

					MAX. RATINGS					CHARACTERISTICS					
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ (μA)	C_{oe} $*C_{ob}$ (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 1	2N327A	RA	pnp,si	0.05	380	160	2.9	40	50	*15	0.1	*110	0.3	5	SSD, CT, STC, ETC, SPR, TI, NA
	2N328A	RA	pnp,si	0.05	380	160	2.9	35	50	*30	0.1	*110	0.5	5	SSD, CT, STC, ETC, TI, SPR, NA
	2N328B	SPR	pnp,PL,si	0.05	500	200	2.9	35	50	*30	0.001	110	0.5	5	
	2N329	RA	pnp,si	0.05	340	160	2.5	30	5	60	0.1	*100	1.0	5	
	2N329A	RA	pnp,si	0.05	380	160	2.9	30	50	*60	0.1	*110	0.6	5	SSD, CT, STC, ETC, SPR, TI, NA
LL 2	2N329B	SPR	pnp,PL,si	0.05	500	200	2.9	30	50	*60	0.001	110	0.6	5	
	2N1034	RA	pnp,si	0.05	250	160	1.85	40	50	15	1	*110	0.5	5	KSC, CT, ETC, SPR, NA, SSD
	2N1035	RA	pnp,si	0.05	250	160	1.85	35	50	30	1	*110	0.4	5	KSC, CT, ETC, SPR, NA, SSD
	2N1036	RA	pnp,si	0.05	250	160	1.85	30	50	60	1	*110	0.3	5	KSC, CT, ETC, SPR, NA, SSD
	2N1037	RA	pnp,si	0.05	250	160	1.85	35	50	25	1	*110	0.5	5	KSC, CT, ETC, SPR, SSD
	2N1275	RA	pnp,si	0.05	250	160	1.85	80	50	*15	1	*110	0.3	5	CT, SPR, NA, SSD
	2N1640	CT	pnp,SYM	*0.4	250	160	1.9	20	50	*6	0.01	*50	–	5	
	2N1641	CT	pnp,SYM	*0.8	250	160	1.9	10	50	*10	0.01	*50	–	5	
	2N519	GI	pnp,AJ,ge	1	100	85	1.67	*15	–	15	2	*14	–	5	TI
	2N519A	GI	pnp,AJ,ge	1	150	100	2.0	*20	–	15	2	*14	–	5	TI, IND
LL 3	2N943	SSD	AJ	1	250	175	1.67	18	50	–	0.002	*14	0.003	18	CT, Chopper Pairs, SPR
	2N946	SSD	AJ	1	250	175	1.67	80	50	–	0.004	*14	0.005	18	CT, Chopper Pairs, SPR
	2N944	SSD	AJ	1	250	175	1.67	18	50	–	0.003	*14	0.004	18	CT, Chopper Pairs, SPR
	2N945	SSD	AJ	1	250	175	1.67	50	50	–	0.004	*14	0.005	18	CT, Chopper Pairs, SPR
	2N1091	RCA	npn,AJ,ge	1	120	85	–	*25	400	*40	8	*25	–	5	GI
	2N1614	GE	pnp,AJ,ge	1	240	85	4	12	300	*32	25	–	90	–	
	2N3342	SSD	pnp,AJ	1	250	175	1.7	8	50	*30	0.02	*10	0.1	5	SPR
	2N3344	SSD	pnp,AJ	1	250	175	1.7	30	50	*25	0.002	*12	0.0012	5	SPR
	2N3345	SSD	pnp,AJ	1	250	175	1.7	50	50	*15	0.005	*12	0.003	5	SPR
	2N3346	SSD	pnp,AJ	1	250	175	1.7	50	50	*25	0.005	*12	0.0015	5	SPR
LL 4	2N3842	SPR	pnp,PE,si	*1	300	200	1.7	120	100	1	0.020	*9	–	18	Chopper
	2N3977	SPR	pnp,PE,si	1	400	200	2.3	10	100	*40	0.001	*14	0.10	46	Chopper
	2N3978	SPR	pnp,PE,si	1	400	200	2.3	20	100	*30	0.001	*14	0.10	46	Chopper
	2N3979	SPR	pnp,PE,si	1	400	200	2.3	35	100	*20	0.001	*14	0.15	46	Chopper
	2N1642	CT	pnp,SYM	*1.2	250	160	1.9	6	50	15	0.1	*50	–	5	
	2N594	TI	npn,AJ,ge	*1.5	150	85	2.5	20	300	50	5	17	–	5	
	2N3841	SPR	pnp,PE,si	*1.5	300	200	1.7	100	100	1.5	0.002	*9	–	18	Chopper
	2N3343	SSD	–	*2	250	175	1.85	25	50	20	0.003	25	0.003	5	
	2N524	GE	pnp,AJ,ge	2.5	225	85	5	30	500	*25-42	10	18	0.075	5	
	2N525	GE	pnp,AJ,ge	2.5	225	85	5	30	500	*34-65	10	*18	0.080	5	
LL 5	2N526	GE	pnp,AJ,ge	2.5	225	85	5	30	500	*53-90	10	*18	0.085	5	
	2N527	GE	pnp,AJ,ge	2.5	225	85	5	30	500	*72-121	10	*18	0.090	5	
	2N356	GI	npn,AJ,ge	3	100	85	2.0	*20	–	*20-50	5	*14	0.20	5	TI
	2N356A	GI	npn,AJ,ge	3	150	100	2.0	*30	–	*20-50	5	*14	0.20	5	TI
	2N426	TI	pnp,AJ,ge	3	150	100	2.5	*30	400	*30-60	25	*20	0.32	5	
	2N520	GI	pnp,AJ,ge	3	100	85	1.67	*15	–	20	2	*14	–	5	TI
	2N528A	GI	pnp,AJ,ge	3	150	100	2.0	*20	–	40	2	*14	–	5	
	2N585	RCA	npn,AJ,ge	3	120	71	–	*25	200	*20	3	–	0.1	9	GI
	2N595	TI	npn,AJ,ge	*3	150	85	2.5	15	300	75	5	17	–	5	
	2N1012	GI	npn,AJ,ge	3	150	100	2.0	*35	–	*40	5	*20	0.20	5	
LL 6	2N1051		npn,DD,si	3	500	150	4	40	100	30-100	0.1	*7	3.0	5	NA
	2N1694	GE	npn,ge	3	75	85	–	20	25	*50	1.5	6	–	5	
	2N2946	CT	pnp,si	*3	400	200	2.3	*40	100	*30	0.0005	*10	–	46	NA, SSD
	2N404		pnp,AJ,ge	4	150	85	–	24	100	*24	2	–	0.1	5	AMP, GI, TI, RCA, NUC, GE, IEC
	2N404A	RCA	pnp,AJ	4	150	85	–	35	100	24	2	–	0.1	5	NUC, TI
	2N1605	RCA	pnp,AJ,ge	4	150	100	–	*25	100	*40	5	*20	0.15	5	TI
	2N1605A	RCA	pnp,AJ,ge	4	200	100	–	*40	100	*40	10	*20	0.15	5	TI
	2N1808	TI	npn,AJ,ge	4	150	100	2.5	25	300	*125	5	*20	0.15	5	
	2N3857	NA	pnp,EP,si	*4	600	200	4.3	*45	100	*50-200	0.005	*10	0.1	8	
	2N1169	RCA	npn,AJ,ge	4.5	120	71	–	18	–	*20	10	19	–	5	
LL 7	2N1170	AMP	npn,AJ,ge	4.5	120	71	–	20	–	*20	8	19	–	5	
	2N315	GI	pnp,AJ,ge	5	100	85	2	*20	200	*15-30	2	*14	0.15	5	TI, IND
	2N315A	GI	pnp,AJ,ge	5	150	100	2	*25	200	*20-50	2	*14	0.15	5	TI, IND
	2N315B	GI	pnp,AJ,ge	5	150	100	2	*30	200	*20-50	2	*14	0.15	5	
	2N388	TI	pnp,AJ,ge	5	150	100	2	25	500	*60-180	10	*20	–	5	IEC
	2N388A	TI	pnp,AJ,ge	5	150	100	2	40	500	*60-180	10	*20	–	5	
	2N427	TI	pnp,AJ,ge	5	150	100	2.5	*30	400	*40-80	25	*20	0.32	5	
	2N596	TI	npn,AJ,ge	*5	150	85	2.5	10	300	100	5	17	–	5	
	2N858	*SPR	pnp,SP,si	*5	150	140	1.3	40	50	33	0.1	*5	0.07	18	*PH orig Reg, CT
	2N1090	RCA	npn,AJ,ge	5	120	85	–	*25	400	*30	8	*25	–	5	GI, TI
LL 8	2N2945	CT	pnp,si	*5	400	200	2.3	25	100	*40	0.0002	*10	–	46	NA, SSD
	2N2946A	TI	pnp,EP,si	*5	400	200	2.3	*40	100	*50	0.0005	*10	–	46	
	2N3677	CT	pnp,si	5	400	200	–	20	100	–	0.001	6	0.001	46	
	2N357	GI	npn,AJ,ge	6	100	85	2	*20	–	*20-50	5	*14	0.20	5	TI
	2N357A	GI	npn,AJ,ge	6	150	100	2	*30	–	*25-75	5	*14	0.20	5	TI
	2N859	*SPR	pnp,SP,si	*6	150	140	1.3	40	50	65	0.1	*5	0.06	18	*PH orig Reg, CT
	2N1173	IEC	npn,PE,si	6	250	100	2.0	30	200	25-75	5	14	0.20	18	
	2N1319	TI	pnp,AJ,ge	6	120	71	–	*20	400	*30	2.5	*20	0.2	5	
	2N2274	*SPR	pnp,SP,si	*6	150	140	1.3	25	50	*15	0.003	*6.0	–	18	Chopper, *PH orig Reg, CT
	2N2275	*SPR	pnp,SP,si	*6	150	140	1.3	25	50	*15	0.003	*6.0	–	18	M. Pair 2N2274*PH orig Reg, CT

Circle as many numbers on the reader-service card as you like.

Low-Level Switching *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS					CHARACTERISTICS				Package Outline (TO-)	Remarks
					P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)		
LL 9	2N2276	*SPR	pnp,SP,si	*6	150	140	1.3	*15	50	*15	0.003	*6.0	–	18	Chopper, *PH Orig Reg, CT
	2N2277	*SPR	pnp,SP,si	*6	150	140	1.3	*15	50	*15	0.003	*6.0	–	18	M. Pair 2N2276 *PH orig Reg, CT
	2N3840	SPR	pnp,PE,si	*6	400	200	2.3	50	100	1.5	0.0005	*9	–	46	Chopper
	3N123	SPR	pnp,PE,si	6	100	200	0.58	*30	20	–	0.01	*10	–	72	Dual
	2N3317	SPR	pnp,SP,si	*6.4	150	140	1.3	30	50	–	0.001	*9	–	18	Chopper, CT
LL 10	2N860	*SPR	pnp,SP,si	*6.5	150	140	1.3	25	50	33	0.1	*5	0.07	18	*PH orig Reg, CT
	2N2185		pnp,SP,si	*6.5	150	140	1.3	30	50	–	0.001	*6.0	–	18	Chopper, CT, SPR
	2N2186	*SPR	pnp,SP,si	*6.5	150	140	1.3	30	50	–	0.001	*6.0	–	18	M. Pair 2N2185; *PH orig Reg, CT
	2N2187		pnp,SP,si	*6.5	150	140	1.3	30	50	–	0.001	*6.0	–	18	M. Pair 2N2185; CT, SPR
	2N1000	GI	npn,AJ,ge	7	150	100	2.0	*40	–	*40	15	*20	0.25	5	
	2N1119	*SPR	pnp,SAT,si	*7.2	150	140	1.3	10	50	*25	0.001	*6.0	0.08	5	*PH orig Reg, CT
	2N861	*SPR	pnp,SP,si	*7.5	150	140	1.3	25	50	65	0.1	*5	0.06	18	*PH orig Reg, CT
	2N2278	*SPR	pnp,SP,si	*7.6	150	140	1.3	15	50	–	0.001	*6.0	–	18	Chopper *PH orig Reg, CT
	2N2279	*SPR	pnp,SP,si	*7.6	150	140	1.3	15	50	–	0.001	*6.0	–	18	M Pair 2N2278 *PH orig Reg, CT
	2N3318	SPR	pnp,SP,si	*7.6	150	140	1.3	15	50	–	0.001	*9	–	18	Chopper, CT
LL 11	2N414	RCA	pnp,AJ,ge	8	150	85	–	*30	200	80	2	*11	–	5	LAN, TI
	2N521	GI	pnp,AJ,ge	8	100	85	1.67	*15	–	35	2	*14	–	5	TI
	2N521A	GI	pnp,AJ,ge	8	150	100	2.0	*20	–	70	2	*14	–	5	TI, IND
	2N579		pnp,AJ,ge	8	120	71	–	*20	400	*30	5	–	0.2	9	GI, IND
	2N581	RCA	pnp,AJ,ge	8	150	85	–	*18	100	30	3	–	0.2	5	GI, TI, LAN, IND
	2N583		pnp,AJ,ge	8	120	85	–	*18	100	*30	3	–	0.2	1	GI, LAN
	2N862	*SPR	pnp,SP,si	*8	150	140	1.3	15	50	33	0.1	*5	0.07	18	*PH orig Reg, CT
	2N2970	SPR	pnp,SP,si	*8	150	140	1.3	*30	50	*10	0.01	*6.0	0.08	5	Symmetrical
	2N2971	SPR	pnp,SP,si	*8	150	140	1.3	*30	50	*10	0.01	*6	0.08	18	Symmetrical
	2N358	GI	npn,AJ,ge	9	100	85	2.0	*20	–	*20-50	5	*14	0.20	5	TI
LL 12	2N358A	GI	npn,AJ,ge	9	150	100	2.0	*30	–	*25-75	5	*14	0.20	5	TI, IEC
	2N428	TI	npn,AJ,ge	10	150	100	2.5	*30	400	*60	25	*20	0.32	5	IEC
	2N863	*SPR	pnp,SP,si	*10	150	140	1.3	15	50	65	0.1	*5	0.06	18	*PH orig Reg
	2N942	SSD	AJ	10	250	175	1.67	8	50	*25	0.0025	*14	0.004	18	CT, Chopper Pairs, SPR
	2N2165	SPR	pnp,SP,si	*10	150	140	1.3	30	50	–	0.020	*6	–	5	Chopper, CT
	2N2166	SPR	pnp,SP,si	*10	150	140	1.3	15	50	–	0.020	*6	–	5	Chopper, CT
	2N2944	CT	pnp,si	*10	400	200	2.3	*15	100	*80	0.0001	*10	–	46	NA, SSD
	2N2968	SPR	pnp,SP,si	*10	150	140	1.3	*30	50	*15	0.01	*6	0.06	5	Symmetrical
	2N2969	SPR	pnp,SP,si	*10	150	140	1.3	*30	50	*15	0.01	*6	0.06	18	Symmetrical
	2N2677	GE	npn,DG,si	*10	250	175	1.66	*45	25	*20-55	0.1	*3	1.5	46	
LL 13	2N2945A	TI	pnp EP si	*10	400	200	2 3	*25	100	*70	0 0002	*10	–	46	
	3N129	CT	pnp,EP,si	10	300	200	1.7	20	100	–	0.001	*6	0.00003	72	Dual emitter
	3N130	CT	pnp,EP,si	10	300	200	1.7	30	100	–	0.001	*6	0.00003	72	Dual emitter
	3N131	CT	pnp,EP,si	10	300	200	1.7	40	100	–	0.001	*6	0.00003	72	Dual emitter
	3N132	CT	pnp,EP,si	10	300	200	1.7	50	100	–	0.001	*6	0.00003	72	Dual emitter
	3N133	CT	pnp,EP,si	10	300	200	1.7	60	100	–	0.001	*6	0.00003	72	Dual emitter
	2N316	GI	pnp,AJ,ge	12	100	85	2.0	*20	200	*20-50	2	*14	0.18	5	IND
	2N316A	GI	pnp,AJ,ge	12	150	100	2.0	*25	200	*20-50	2	*14	0.18	5	IND
	2N3019	FA	npn,DPE,si	12	800	200	28.6	*140	100	5	–	12	0.2	5	NA
	2N3020	FA	npn,DPE,si	12	800	200	28.6	*140	100	4	–	12	0.2	5	
LL 14	2N3319	SPR	pnp,SP,si	*12	150	140	1.3	*10	50	–	50	*10	–	18	Chopper, CT
	3N108	TI	pnp,EP,si	*12	300	200	1.71	*50	20	–	0.25	*10	–	72	Double emitter chopper
	3N109	TI	pnp,EP,si	*12	300	200	1.71	*50	20	–	0.25	*10	–	72	Double emitter chopper
	3N110	TI	pnp,EP,si	*12	300	200	1.71	*50	20	–	0.5	*10	–	72	Double emitter chopper
	3N111	TI	pnp,EP,si	*12	300	200	1.71	*50	20	–	0.5	*10	–	72	Double emitter chopper
	2N2162	SPR	pnp,SP,si	*14	150	140	1.3	30	50	35	0.001	*6	–	5	Chopper, CT
	2N2163	SPR	pnp,SP,si	*14	150	140	1.3	15	50	30	0.001	*6	–	5	Chopper, CT
	2N337A	GE	npn,DG,si	*15	500	175	3.33	*45	20	*20-55	0.5	*3	1.5	5	TR
	2N522	GI	pnp,AJ,ge	15	100	85	1.67	*15	–	60	2	*14	–	5	TI
	2N522A	GI	pnp,AJ,ge	15	150	100	2.0	*20	–	100	2	*14	–	5	TI, IND
LL 15	2N580		pnp,AJ,ge	15	120	71	–	*20	400	*45	5	–	0.2	9	GI, IND
	2N1276	GE	npn,DG,si	*15	150	150	1.2	*40	25	9-22	1	*5	1	5	TR
	2N1277	GE	npn,DG,si	*15	150	150	1.2	*40	25	18-44	1	*5	1	5	TR
	2N1278	GE	npn,DG,si	*15	150	150	1.2	*40	25	37-90	1	*5.0	1	5	TR
	2N1279	GE	npn,DG,si	*15	150	150	1.2	*40	25	76-333	1	*5	1	5	TR
	2N1309A	GI	pnp,AJ,ge	15	150	85	2.5	*35	300	*80	6	20	0.2	5	TI
	2N2349	GE	npn,DG,si	*15	150	150	1.25	*40	25	*120-250	1	*4	1.5	5	
	2N2944A	TI	pnp EP si	*15	400	200	2.3	*15	100	*100	0 0001	*10	–	46	
	2N3677	CT	EP,si	*15	400	200	2.3	*30	100	–	0.001	*10	–	18	Low Rec (SAT) Chopper
	2N4007	CT	pnp,EP,si	15	400	200	2.3	20	100	150	0.001	6	0.0007	46	
LL 16	2N4008	CT	pnp,EP,si	15	400	200	2.3	35	100	150	0.001	6	0.0008	46	
	2N864	*SPR	pnp,SP,si	*16	150	140	1.3	6	50	65	0.1	*5	0.06	18	*PH orig Reg, CT
	2N941	SSD	AJ	16	250	175	1.67	8	50	*25	0.0025	*14	0.002	18	CT, Chopper Pairs, SPR
	2N1676	*SPR	pnp,SAT,si	*16	100	140	0.87	4.5	50	–	0.001	*7	0.04	5	Chopper, *PH orig Reg
	2N1677	*SPR	pnp,SAT,si	*16	100	140	0.87	4.5	50	50	0.001	*7	0.055	5	Chopper, *PH orig Reg
	2N2167	SPR	pnp,SP,si	*16	150	140	1.3	*12	50	–	0.002	*6	–	5	Chopper, CT
	2N2280	*SPR	pnp,SP,si	*16	150	140	1.3	*10	50	–	0.003	*7	0.05	18	Chopper, *PH orig Reg, CT
	2N2281		pnp,SP,si	*16	150	140	1.3	*10	50	–	0.003	*7	–	18	M Pair 2N2280, SPR, CT
	2N582	RCA	pnp,AJ,ge	18	150	85	–	*25	100	60	2	–	0.2	5	GI, TI, RCA, IND
	2N317	GI	pnp,AJ,ge	20	100	85	2.0	*20	400	*20-60	2	*14	0.20	5	TI, IND

Low-Level Switching *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS						CHARACTERISTICS				Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)		h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ (μA)	C_{oe} $*C_{ob}$ (pF)	$V_{ce(sat)}$ (V)		
LL 17	2N317A	GI	pnp,AJ,ge	20	150	100	2.0	*25	400		*20-60	2	*14	0.20	5	TI, IND
	2N1384	RCA	pnp,DR,ge	*20	240	85	–	*30	500		*20	4	–	–	11	
	2N2350	GE	npn,PL,si	20	400	200	2.3	40	1		*300	–	20	0.35	46	
	2N2351	GE	npn,PL,si	20	400	200	2.3	50	1		*120	–	20	0.35	46	
	2N2352	GE	npn,PL,si	20	400	200	2.3	40	1		*60	–	20	0.35	46	
LL 18	2N2353	GE	npn,PL,si	20	350	200	–	25	1		*20	–	20	0.35	46	
	2N2432A	TI	npn,EP,si	*20	300	175	2	45	100		*50	0.01	*12	0.15	18	
	2N2678	GE	npn,DG,si	*20	250	175	1.66	*45	25		45-150	0.1	*3	1.5	46	
	2N4006	CT	pnp,EP,si	20	400	200	2.3	10	100		250	0.001	6	0.0005	46	
	2N4138	TI	npn EP si	*20	300	175	2	30	100		*50	0 01	*12	0.15	46	
	2N523	GI	pnp,AJ,ge	21	100	85	1.67	*15	–		80	2	*14	–	5	
	2N523A	GI	pnp,AJ,ge	21	150	85	2.0	*15	–		125	2	*14	–	5	IND
	2N865	*SPR	pnp,SP,si	*24	150	140	1.3	*10	50		150	0.1	*5	0.05	18	*PH orig Reg, CT
	2N2164	SPR	pnp,SP,si	*24	150	140	1.3	*12	50		40	0.002	*6	–	5	Chopper, CT
	2N338A	GE	npn,DG,si	25	500	175	3.33	45	25		45-150	0.5	3	1.5	5	TR
LL 19	2N524A	MO	pnp,AJ,ge	25-42	225	100	6.67	*45	500		18-41	10	*40	0.130	5	
	3N74	TI	npn,PL,si	*30	300	175	2	*50	20		–	0.01	*8	–	72	Double emitter chopper
	3N75	TI	npn,PL,si	*30	300	175	2	*50	20		–	0.01	*8	–	72	Double emitter chopper
	3N76	TI	npn,PL,si	*30	300	175	2	*50	20		–	0.01	*8	–	72	Double emitter chopper
	2N842	TR	npn,PE,si	30	300	175	2	45	50		*20-55	1	10	1.2	18	
	3N77	TI	npn,PL,si	*30	300	175	2	*40	20		–	0.01	*8	–	72	Double emitter chopper
	3N78	TI	npn,PL,si	*30	200	175	2	*40	20		–	0.01	*8	–	72	Double emitter chopper
	3N79	TI	npn,PL,si	*30	300	175	2	*40	20		–	0.02	*8	–	72	Double emitter chopper
	2N1060		npn,DM,si	30.0	350	150	2.0	40	50		20	0.1	*10	0.3	18	NA
	2N525A	MO	pnp,AJ,ge	34-65	225	100	6.67	*45	500		30-64	10	*40	0.130	5	
LL 20	2N794		pnp,MS,ge	40	150	85	–	*13	100		*50	13	–	–	18	SPR
	2N843	TR	npn,PE,si	40	300	175	2	45	50		*45-150	1	*10	1.2	18	
	2N1300	RCA	pnp,MS,ge	*40	150	85	–	*13	100		30	3	–	–	5	SPR, TI
	2N1854	RCA	pnp,DM,ge	40	150	85	–	*18	100		40-400	4.2	–	0.25	5	
	2N3547	NA	pnp,DD,EP,si	*45	400	200	2.3	*60	100		*35-300	*0.1025	*8	1	18	
	2N1683	TI	pnp,MS,ge	*50	150	85	–	12	100		*50	3	–	–	5	SPR
	2N3547	NA	pnp,DD,EP,si	*50(min)	500	175	3.3	120	–		*20	1	6	0.2	104	
	2N526A	MO	pnp,AJ,ge	53-90	225	100	6.67	*45	500		44-88	10	*40	0.130	5	
	2N795		pnp,MS,ge	60	150	85	–	*13	100		*75	13	–	–	18	SPR, TI
	2N1301	RCA	pnp,MS,ge	*60	150	85	–	*13	100		30	3	–	–	5	SPR, TI
LL 21	2N3548	NA	pnp,DD,EP,si	*60	400	200	2.3	*60	100		*100-300	*1010	*8	1	18	
	2N3549	NA	pnp,DD,EP,si	*60	400	200	2.3	*60	100		*100-500	*0.010	*8	1	18	
	2N398A	MO	pnp,AJ,ge	65	150	100	2	105	200		*65	12	–	0.11	5	GI, TI, RCA
	2N3107	FA	npn,DPE,si	70	800	200	4.57	100	1000		60	0.01	20	10	5	
	2N3109	FA	npn,DPE,si	70	800	200	4.57	80	1000		60	0.01	25	150	5	
	2N3340	SSD	npn,PL	*70	400	200	2.28	20	30		*60	0.001	*6	0.2	46	
	2N3341	SSD	pnp,EP	*70	400	200	2.28	20	30		*60	0.01	*6	0.25	46	
	2N527A	MO	pnp,AJ,ge	72-121	225	100	6.67	*45	500		60-120	10	*40	0.130	5	
	2N796	SPR	pnp,MS,ge	80	150	85	–	*13	100		*85	13	–	–	18	TI
	2N1131A	HU	pnp	*80	750	175	–	*60	–		*30	–	–	–	5	
LL 22	2N1132A	HU	pnp	*80	750	175	–	*60	–		*60	–	–	–	5	MO
	2N1132B	HU	pnp	*80	750	175	–	*70	–		*60	–	–	–	5	MO
	2N1252	FA	npn,DD,si	*80	2.0	175	13.3	*30	–		*35	0.1	*30	0.6	5	SY, AL, NA, IEC
	2N3108	FA	npn,DPE,si	96	800	200	4.57	100	1000		40	0.01	20	10	5	
	2N3110	FA	npn,DPE,si	96	800	200	4.57	80	1000		40	0.01	25	150	5	
	2N1139	TR	npn,PE,si	100	500	175	6.6	15	100		*20-200	5	12	0.7	5	
	2N1254	HU	pnp	*100	275	175	–	30	–		30	–	8	–	5	IEC
	2N1255	HU	pnp	*100	275	175	–	30	–		*60	–	8	–	5	IEC
	2N1256	HU	pnp	*100	275	175	–	40	–		*30	–	8	–	5	IEC
	2N1257	HU	pnp	*100	275	175	–	40	–		*60	–	8	–	5	IEC
LL 23	2N1258	HU	pnp	*100	275	175	–	30	–		*100	–	8	–	5	IEC
	2N1259	HU	pnp	*100	275	175	–	50	–		*50	–	8	–	5	IEC
	2N1444		npn,DM,si	100	500	150	4	*60	250		*25	0.5	*32	1.5	5	NA
	2N2102	RCA	npn,si	*100	5W	200	28.6	65	1A		*40-120	0.002	*75	0.5	5	CDC, GI, TR, TRWS
	2N2569	AMP	npn,PE,si	100	300	175	2	*20	100		*50	0.01	*10	0.2	18	Chopper – Voffset = 145, AMP
	2N2570	AMP	npn,PE,si	100	300	175	2	*20	100		*50	0.01	*10	0.2	18	Chopper – Voffset = 350, AMP
	2N3883	MO	pnp,EM,ge	*100	750	100	10	15	300		*30	†	*8	0.5	5	Ices = 100, TI
	2N4354	FA	pnp,PE,si	100	800	125	8	*60	600		110	–	15.0	0.25	18	
	2N4355	FA	pnp,PE,si	100	800	125	8	*60	600		170	–	15.0	0.25	18	
	2N4356	FA	pnp,PE,si	100	800	125	8	*80	600		160	–	15.0	0.25	18	
LL 24	3N71	SSD	n,PL	*100	100	200	0.57	*15	10		*40	0.010	*6	50	18	Dual-Emitter Chopper, SOL
	3N72	SSD	n,PL	*100	100	200	0.57	*15	10		*40	0.010	*6	100	18	Dual-Emitter Chopper, SOL
	3N73	SSD	n,PL	*100	100	200	0.57	*15	10		*40	0.010	*6	200	18	Dual-Emitter Chopper, SOL
	2N1204	MO	pnp,EP,ge	*110	750	100	10	15	500		*15	7	*6.5	0.4	5	TI
	2N1204A	MO	pnp,EP,ge	*110	750	100	10	15	500		*25	7	*6.5	0.4	5	
	2N1253	FA	npn,DD,si	*110	2.0	175	13.3	*30	–		*45	0.1	*30	0.6	5	GI, AL, NA, IEC
	2N1494	MO	pnp,EP,ge	*110	750	100	10	15	500		*15	7	*6.5	0.4	31	
	2N1494A	MO	pnp,EP,ge	*110	750	100	10	15	500		*25	7	*6.5	0.4	31	
	2N2800	MO	pnp,AE,si	*120	3W	200	1.73	35	800		*30-90	†0.1	*25	0.4	5	†Icex
	2N2801	MO	pnp,AE,si	*120	3W	200	17.3	35	800		*17-225	†0.1	*25	0.4	5	† Icex

Get detailed spec sheets and application notes: use the reader-service card!

NOW

one source for all your integrated circuit needs

MOTOROLA offers every IC logic complement

DTL ▪ MDTL ▪ MECL ▪ MHTL ▪ MTTL ▪ MRTL ▪ mW MRTL ▪ MVTL

and everything in linear, too!

SEMICONDUCTOR SPECIALISTS stocks 'em all for fast same-day, off-the-shelf delivery!

MDTL, MECL, MHTL, MRTL, MTTL and MVTL are trademarks of Motorola Inc.

Your Franchised Motorola Distributor

Semiconductor Specialists INC.

CHICAGO PO Box 8725, O'Hare Int'l Airport, (312) 279-1000 • **DETROIT** 25127 West 6 Mile Road, (313) 255-0300
MINNEAPOLIS 7742 Morgan Avenue So., (612) UN 6-3434 • **ST. LOUIS** 6154 Jefferson Avenue, (314) JA 1-8866
PITTSBURGH 2011 Waverly Street, (412) 351-3611

ON READER-SERVICE CARD CIRCLE 69

Low-Level Switching *(continued)*

					MAX. RATINGS					CHARACTERISTICS					
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ (μA)	C_{oe} $*C_{ob}$ (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 25	2N1754	*SPR	MADT,ge	*125	50	85	–	*13	100	*75	0.6	*1.5	0.12	9	GI, *PH orig. Reg.
	2N702	TI	npn,si	*150	300	175	2	25	50	*20	0.5	*3	0.5	18	TRWS, GI, NA
	2N703	TI	npn,si	*150	300	175	2	25	50	*40	0.5	*3	0.5	18	TRWS, FA, SY, GI, NA
	2N1495	MO	pnp,EP,ge	*150	750	100	10	25	500	*25	7	*6.5	0.3	5	TI
	2N1496	MO	pnp,EP,ge	*150	750	100	10	25	500	*25	7	*6.5	0.3	31	
LL 26	2N2330	MO	npn,AE,si	*150	3W	175	20	20	–	50/–	0.001	*10	0.001	5	SPR
	2N2331	MO	npn,AE,si	*150	1.8W	175	12	20	–	50 - -	0001	*10	0.001	18	SPR
	2N3554	TI	npn,EP,si	*150	800	200	4.57	30	1200	*25-100	0.5	*25	0.7	5	
	2N4402	MO	pnp,si	*150	310	135	2.81	40	600	*50-150	0.1	–	0.4	92	
	2N1499	PH	pnp,ge	*160	60	100	–	*20	100	*70	0.6	*1.5	0.12	9	
	2N1708	RCA	npn,PE,si	*200	300	175	–	*25	200	*20	12	*6	0.22	46	FA, SY, GI, IEC
	2N2205	SY	npn,PE,si	*200	300	175	–	*25	200	*20	0.025	*6	0.22	18	NEC
	2N2206	RCA	npn,PE,si	200	300	175	–	*25	–	*40	0.025	6	0.22	46	SY
	2N3485	FA	pnp,PE,si	200	360	200	11.4	40	600	40-120	0.020	8	0.4	46	TI, GE
	2N3485A	FA	pnp,PE,si	200	2000	200	11.4	40	600	40-120	0.020	8	0.4	46	TI, GE
LL 27	2N3486	FA	pnp,PE,si	200	2000	200	11.4	40	600	100-300	0.020	8	0.4	46	TI, GE
	2N3486A	FA	pnp,PE,si	200	2000	200	11.4	40	600	100-300	0.020	8	0.4	46	TI, GE
	2N3644	FA	npn,DPE,si	200	700	125	7.0	45	500	200	–	4.5	–	–	IEC
	2N3645	FA	pnp,DPE,si	*200	700	125	7.0	60	500	*200	–	4.5	–	–	IEC
	2N3830	TI	npn EP si	*200	1000	200	5 71	50	1200	*30	0.5	*12	0.3	5	Comp. Dual
	2N3831	TI	npn EP,si	*200	1000	200	5 71	40	1200	*35	0.5	*12	0.3	5	Comp. Dual
	2N3838	TI	npn/pnp,EP,si	*200	350	175	2.34	40	600	*100-300	*0 01	*8	0 4	89	Comp Dual
	2N3905	MO	pnp,AE,si	*200	310	135	2.81	40	200	*50-150	†	*4.5	0.25	92	†0.05 Icex
	2N4125	MO	pnp,AE,si	*200	310	135	2.81	30	200	*50-150	0.05	*4.5	0.4	92	
	2N4400	MO	npn,si	*200	310	135	2.81	40	600	*50-150	0.1	*6.5	0.4	92	
LL 28	2N4403	MO	pnp,si	*200	310	135	2.81	40	600	*100-300	0.1	–	0.4	92	
	2N4854	TI	npn/pnp EP si	*200	600	175	4	40	60	*100-300	0 01	*8	0 4	5	Comp. Dual
	2N4855	TI	npn/pnp EP,si	*200	600	175	4	40	600	*40-120	0 01	*8	0.4	5	Comp. Dual
	2N827	MO	pnp,DM,ge	*250	150	100	2	*20	100	*100	5	9	0.25	18	TI
	2N2048	*SPR	MADT,ge	*250	150	100	–	15	100	*125	1	*1.5	0.13	9	*PH orig. Reg.
	2N2475	RCA	npn,PE,si	250	600	200	–	*60	–	*20	0.2	*10	0.4	5	
	2N2476	RCA	npn,PE,si	250	600	200	–	*60	–	*40	0.2	*10	0.4	5	SPR
	2N3015	FA	npn,EP,si	*250	800	200	4.57	30	–	*30-120	0.2	*8	0.4	5	TI, NA, SPR
	2N3250	FA	pnp,DPE,si	250	360	200	6.9	*50	200	150	–	0.25	0.25	18	TI
	2N3641	FA	npn,PE,si	*250	700	125	7.0	30	–	*75	0.05	*6.0	0.35	–	CDC, IEC, PH
LL 29	2N3642	FA	npn,PE,si	*250	700	125	7.0	45	–	*75	0.5	*6.0	0.35	–	CDC, IEC, PH
	2N3643	FA	npn,PE,si	*250	700	125	7.0	30	–	*220	0.5	*6.0	0.35	–	CDC, IEC, PH
	2N3903	MO	npn,AE,si	*250	310	135	2.81	40	200	*50-150	†	*4	0.2	92	CDC, †0.05 Icex
	2N3906	MO	pnp,AE,si	*250	310	135	2.81	40	200	*100-300	†	*4.5	0.25	92	†0.05 Icex
	2N3946	MO	npn,AE,si	*250	1200	200	6.9	40	200	*50-150	†	*4	0.2	18	†0.01 Icex
	2N4123	MO	npn,AE,si	*250	310	135	2.81	30	200	*50-150	0.05	*4	0.3	92	
	2N4126	MO	pnp,AE,si	*250	310	135	2.81	25	200	*120-360	0.05	*4.5	0.4	92	
	2N4401	MO	npn,si	*250	310	135	2.81	40	600	*100-300	0.1	*6.5	0.4	92	
	2N784A	SY	npn,EP,si	300	360	200	–	*40	200	*25-150	0.025	3.5	0.65	18	
	2N835	MO	npn,EP,si	*300	1W	175	6.67	*25	200	20	0.01	*2.8	30	18	ITT, SPR, IEC
LL 30	2N838	MO	pnp,EM,ge	*300	150	100	2	*30	100	*30	10	4	0.18	18	
	2N914/46	SY	pnp,PL,EP,si	300	400	200	–	*40	–	*30-120	0.025	*6	0.7	46	GI
	2N2381	MO	pnp,EM,ge	*300	750	100	10	15	500	*40	1	*3.5	0.25	5	TI
	2N2382	MO	pnp,EM,ge	*300	750	100	10	20	500	*40	1	*3.5	0.25	5	TI
	2N2717	AMP	pnp,AD,ge	300	275	75	0.50	*20	300	*50	–	–	0.35	18	
	2N3131	NA	npn,si	*300	200	175	–	15	100	*30-120	0.025	*4	0.25	–	
	2N3251	FA	pnp,DPE,si	300	360	200	6.9	*50	200	300	–	0.25	0.25	18	TI
	2N3605	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	0.25	98	CDC, IEC
	2N3606	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	0.25	98	CDC
	2N3607	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	0.25	98	CDC
LL 31	2N3904	MO	npn,AE,si	*300	310	135	2.81	40	200	*100-300	†	*4	0.2	92	CDC, †0.05 Icex
	2N3947	MO	npn,AE,si	*300	1200	200	6.9	40	200	*100-300	†	*4	0.2	18	†0.01 Icex
	2N4124	MO	npn,AE,si	*300	310	135	2.81	25	200	*120-360	0.05	*4	0.3	92	
	2N4264	MO	npn,AE,si	*300	310	135	2.81	15	200	*40-160	†	*4	0.22	92	†0.1 Icex
	2N4265	MO	npn,AE,si	*300	310	135	2.81	12	200	*100-400	†	*4	0.22	92	†0.1 Icex
	2N4421	TI	npn EP si	*300	250	125	2 5	15	200	*25	0.6	*5	0.2	92	
	2N2256	MO	npn,ME,si	*320	1000	175	6.67	7	100	*30	3	*4	–	18	
	2N2257	MO	npn,ME,si	*320	1000	175	6.67	7	100	*50	3	*4	–	18	
	2N2258	MO	pnp,ME,ge	*320	300	100	4	7	100	–	3	*4	–	18	TI
	2N2259	MO	pnp,ME,ge	*320	300	100	4	7	100	–	3	*4	–	18	TI
LL 32	2N834	MO	npn,EM,si	350	1W	175	6.67	*40	200	25	0.01	*2.8	0.25	18	FA, SY, TR, GI, NA, ITT, SPR, CDC, IEC
	2N3009	FA	npn,EP,si	*350	360	200	2.06	15	200	*30-120	0.5	*5	0.18	18	TI, ITT
	2N3647	FA	npn,DPE,si	350	400	200	11.43	10	500	25-150	–	4	0.4	46	
	2N3829	TI	pnp EP,si	*350	360	175	2 4	20	200	*30-120	0.3	*6	0 18	52	Comp. Dual
	2N3973	GE	npn,PEP,si	*350	360	150	2.67	*60	400	*35-100	0.5	*5.2	0.3	98	
	2N3974	GE	npn,PEP,si	*350	360	150	2.67	*60	400	*55-200	0.5	*5.2	0.3	98	
	2N3975	GE	npn,PEP,si	*350	360	150	2.67	*60	400	35-100	0.5	*5.2	0.3	98	
	2N3976	GE	npn,GE,si	*350	360	150	2.67	*60	400	55-200	0.5	*5.2	0.3	98	
	2N4420	TI	npn EP si	*350	250	125	2.5	20	200	*30-120	0.5	*5	0.2	92	

Need a FREE personal copy of this Directory? Circle number **419**.

Low-Level Switching *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS					CHARACTERISTICS				Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)		
LL 33	2N4422	TI	npn,EP,si	*350	250	125	2.5	40	200	*30-120	0.5	*5	0.2	92	
	2N706A	TI	npn,si	400	300	175	2	20	50	*20	10	*5	0.6	18	FA, SY, TR, GI, ITT, GE, MO, RA, CDC
	2N706B	MO	npn,EP,si	*400	300	175	2	*25	500	4	0.005	*5	0.3	18	FA, SY, GI, TR, ITT
	2N707	FA	npn,DD,si	*400	1.0	175	6.7	*56	–	*12	0.005	*5	0.3	18	TRWS, MO, GI
LL 34	2N708	FA	npn,DP,si	*400	1.2	200	6.9	15	–	*50	0.004	*4	0.3	18	SY, MO, TR, GI, AMP, ITT, NA, NUC, IEC, TI, CDC, ITT
	2N742	NA	npn,si	*400	500	200	–	25	100	*25	0.1	*8	0.5	18	
	2N828	MO	pnp,EM,ge	*400	300	100	4	15	200	*40	0.4	3.5	0.18	18	SY, RCA, TI, LAN
	2N2537	MO	npn,AE,si	*400	3W	200	17.2	30	–	*50-150	0.25	*8	0.45	5	SPR, GI, SY, NA, TI, GE
	2N2538	MO	npn ,AE,si	*400	3W	200	17.2	30	–	*100-300	0.25	*8	0.45	5	SPR, GI, SY, NA, TI, GE
	2N2539	MO	npn,AE,si	*400	8W	200	10.3	30	–	50-150	0.25	*8	0.45	18	SPR, GI, NA, TI, GE
	2N2540	MO	npn,AE,si	*400	1.8W	200	10.3	30	–	*100-300	0.25	*8	0.45	18	SPR, GI, NA, TI, GE
	2N2894	TI	pnp,EP,si	*400	360	200	2.06	12	200	*40-150	0.08	*6	0.15	18	
	2N3011	TI	npn,EP,si	*400	360	200	2.06	12	200	*30-120	0.4	*4	0.2	18	IEC
LL 35	2N3012	FA	pnp,EP,si	*400	360	200	2.06	12	200	*30-120	0.08	*6	0.15	18	TI
	2N3493	MO	npn,EA,si	*400	250	200	1.43	8	–	*40-120	† 0.005	*0.7	0.13	18	† Icex
	2N3576	TI	pnp,EP,si	*400	360	175	2.4	15	200	*40-120	0.01	*4.5	0.15	18	
	2N3722	FA	npp,PE,si	400	800	200	22.8	60	500	–	–	9.0	0.75	5	GE
	2N3723	FA	npn,PE,si	400	800	200	22.8	80	500	–	–	9.0	0.75	5	GE
	2N4304	FA	pnp,PE,si	*400	1000	200	5.71	*40	100	*150	–	2.2	0.2	18	
	2N4411	MO	pnp,si	*400	250	200	1.43	12	25	*40-160	5000	–	0.15	72	
	2N4419	TI	npn EP,si	*400	250	125	2.5	12	200	*30	0.4	*4	0.25	92	
	2N4423	TI	pnp EP,si	*400	250	125	2.5	12	200	*40-150	1	*6	0.15	92	Comp. Dual
	2N3648	FA	npn,DPE,si	450	400	200	11.43	15	500	30-120	–	4	0.4	46	
LL 36	2N4035	FA	pnp,PE,si	*450	1000	200	5.71	*40	100	*200	–	2.2	0.2	18	
	2N4046	FA	npn,PE,si	450	0.8	200	20	50	500	*150	–	12	0.75	5	
	2N4047	FA	npn,PE,si	450	0.8	200	20	50	500	*150	–	10	0.95	5	
	2N960	MO	pnp,EM,ge	*460	300	100	4	*15	–	*40	0.4	*2.2	0.13	18	RCA, TI
	2N961	MO	pnp,EM,ge	*460	300	100	4	*12	–	*40	0.4	*2.2	0.13	18	RCA, TI
	2N964	MO	pnp,EM,ge	*460	300	100	4	*15	–	*70	0.4	*2.2	0.11	18	RCA, TI
	2N965	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	0.4	*2.2	0.11	18	RCA, TI
	2N966	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	0.4	*2.2	0.11	18	RCA, TI
	2N3639	IEC	pnp,PE,si	500	200	–	0.50	6.0	80	30	0.01	5.5	0.30	18	
	2N4418	TI	npn,EP,si	*500	250	125	2.5	15	200	*40-120	0.4	*4	0.25	92	
LL 37	2N1195		pnp,DM,ge	*550	250	100	3.33	*30	40.0	13.0	2.0	4.0	0.54	5	TI, MO
	2N2368	FA	npn,PE,si	*550	1200	200	6.85	15	500	*40	0.1	*2.5	0.2	18	TR, AL, MO, SPR, AMP, CDC, ITT, IEC
	2N3646	FA	npn,PE,si	550	500	125	5.0	15	–	*60	0.4	*3.3	0.39	–	IEC, PH
	2N4121	FA	pnp,DPE,si	550	200	125	5	40	100	200	–	4.5	0.3	–	R0110 package
	2N1992		npn,D,si	*600	350	150	2	15	50	*45	0.5	*5	0.25	18	NA
	2N2475	RCA	npn,PE,si	*600	500	200	–	*15	–	–	0.002	*2.1	0.26	18	
	2N3010	FA	npn,EP,si	*600	300	200	1.71	6	50	*25-125	0.1	*3	0.25	52	TI
	2N3640	FA	pnp,PE,si	*600	500	125	5.0	12	–	*63	0.00005	*1.85	0.18	–	IEC, PH
	2N4122	FA	pnp,DPE,si	600	200	125	5	40	100	300	–	4.5	0.3	–	R0110 package
LL 38	2N2369	FA	npn,PE,si	*650	1200	200	6.85	15	500	*80	0.1	*2.5	0.2	18	TR, MO, AL, AMP, CDC, ITT, TI, IEC
	2N4207	FA	pnp,PE,si	*650	700	200	2.3	*6	50	*50	–	3.0	0.15	18	
	2N4257	FA	pnp,PE,si	650	500	125	5	*6	50	*30	–	*2.0	0.2	18	
	2N2369A	FA	npn,PE,si	*675	1200	200	6.85	15	200	*65	0.05	*2.3	0.14	18	TR, AL, TI, AMP, CDC, ITT, SPR
	2N2787	GI	npn,si	*700	800	175	5.33	35	–	*20-60	0.01	*8	0.4	5	STC, SPR
	2N2788	GI	npn,si	*700	800	175	5.33	35	–	*40-120	0.01	*8	0.4	5	STC, SPR
	2N2789	GI	npn,si	*700	800	175	5.33	35	–	*100-300	0.01	*8	0.4	5	STC, SPR
	2N2790	GI	npn,si	*700	500	175	3.33	35	–	*20-60	0.01	*8	0.4	18	STC, SPR
	2N2791	GI	npn,si	*700	500	175	3.33	35	-	*40-120	0.01	*8	0.4	18	STC, SPR
LL 39	2N2792	GI	npn,si	*700	500	175	3.33	35	–	*100-300	0.01	*8	0.4	18	STC, SPR
	2N4208	FA	pnp,PE,si	*700	700	200	2.3	*0.12	50	*30	–	3.0	0.15	18	
	2N4258	FA	pnp,PE,si	700	500	125	5	*12	50	*30	–	*2.0	0.2	18	
	2N4313	FA	pnp,PE,si	*700	500	125	5.0	*12	100	*55	–	3.3	0.25	18	
	2N709	FA	npn,PE,si	*800	0.5	200	5	6	–	*55	0.005	*2.5	0.21	18	SY, AL, TI, TR, VEC, AMP
	2N3832	TI	npn EP,si	*800	200	200	1.14	6	35	*25-125	0.01	*0.85	0.25	72	Comp. Dual
	2N917	FA	npn,DP,si	*800	0.3	200	1.71	15	–	50	0.0005	*1.5	0.4	18	TI, RCA, AL, NA, IEC, TRWS
	2N4209	FA	pnp,PE,si	*850	700	125	2.3	*15	50	*50	–	3.0	0.2	18	
	2N918	FA	npn,PE,si	*900	0.3	200	1.71	15	50	*50	0.0002	*1.4	0.12	18	MO, TI, RCA, AL, TRWS, VEC, NA, TI, IEC
LL 40	2N955A	RCA	npn,DD,ge	*1000	150	100	–	*12	150	*50	0.6	*4	0.22	18	TI
	2N3959	MO	npn,AE,si	*1300	750	200	4.3	12	30	*40-200	0.1	*2.5	0.2	18	
	2N3960	MO	npn,AE,si	*1600	750	200	4.3	12	30	*40-200	0.1	*2.5	0.2	18	
	2N4260	MO	pnp,AE,si	*1600	200	200	1.14	15	30	*30-150	† 0.005	*2.5	0.35	72	†Icex
	2N4261	MO	pnp,AE,si	*2000	200	200	1.14	15	30	*30-150	† 0.005	*2.5	0.35	72	†Icex
	2N284	AMP	pnp,AJ,ge	–	125	75	2.5	32	125	*45	4.5	–	0.4	1	
	2N284A	AMP	pnp,AJ,ge	–	125	75	2.5	60	125	*45	4.5	–	0.4	1	
	2N337	TI	npn,si	–	125	150	1	*45	20	66	1	*1.2	–	5	GE, TR
	2N338	TI	npn,si	–	125	150	1	*45	20	99	1	*1.2	–	5	GE, TR
	2N398		pnp,AJ,ge	–	50	55	–	105	100	*20	14	–	0.35	5	MO, GI, TI, RCA

Circle as many numbers on the reader-service card as you like.

Low-Level Switching *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS					CHARACTERISTICS				Package Outline (TO-)	Remarks
					P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)		
LL 41	2N586	RCA	pnp,AJ,ge	–	250	85	–	*45	250	30	12	–	0.25	7	
	2N705	TI	pnp,ge	–	150	100	2	*15	50	*40	0.3	*5	0.3	18	SY, MO, RCA
	2N707A	TI	npn,si	–	500	175	3.33	40	100	*9	1	*6	0.6	18	MO, GI
	2N710	TI	pnp,ge	–	300	100	4	*15	50	*40	3	–	0.5	18	SY, RCA, MO
	2N711	TI	pnp,ge	–	150	100	2	*12	100	1.5	3	*7.5	0.5	18	SY, MO, AMP, RCA
LL 42	2N711A	TI	pnp,ge	–	150	100	2	7	100	*40	1.5	*6	0.30	18	SY, MO
	2N711B	TI	pnp,ge	–	150	100	2	7	100	*40	1.5	*6	0.25	18	SY, MO
	2N725	TI	pnp,ge	–	150	100	2	*15	50	*20	3	*5	–	18	
	2N744	TI	npn,si	–	300	175	2	12	200	*40	1	*5	0.35	18	FA, SY, MO, TR, GI, ITT, IEC
	2N781	SY	pnp,EP,ge	–	300	100	–	*15	200	*25	3	–	0.2	18	AL, TI
	2N782	SY	pnp,EP,ge	–	300	100	–	*12	200	*20	3	–	0.2	18	TI
	2N797	TI	npn,ge	–	150	100	2	7	150	*40	1	*4	0.14	18	
	2N849/TI430	TI	npn,si	–	300	175	2	15	50	*20	0.5	*5	0.6	50	
	2N850/TI431	TI	npn,si	–	300	175	2	15	50	*40	0.5	*5	0.6	50	
	2N851/TI422	TI	npn,si	–	300	175	2	12	200	*20	–	*5	0.35	50	
LL 43	2N852/TI423	TI	npn,si	–	300	175	2	12	200	*40	–	*5	0.35	50	
	2N985	TI	pnp,ge	–	150	100	2	7	200	*60	3	*6	0.15	18	MO
	2N1228	HU	pnp	–	400	160	–	15	–	20	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N999	FA	npn,DP,si	–	500	200	10.3	60	500	–	0.0001	*15	1.2	8	GE, NA, MO
	2N1229	HU	pnp	–	400	160	–	15	–	40	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N1230	HU	pnp	–	400	160	–	35	–	20	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N1231	HU	pnp	–	400	160	–	35	–	40	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N1232	HU	pnp	–	400	160	–	60	–	20	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N1233	HU	pnp	–	400	160	–	60	–	40	0.1	–	0.2	5	SPR, AMP, CT, NA, SSD
	2N1234	HU	pnp	–	400	160	–	110	–	20	0.1	–	0.2	5	SPR, AMP, CT, SSD
LL 44	2N1302	TI	npn,ge	–	150	85	2.5	*25	300	*20	6	*20	0.2	5	AMP, GE, RCA, NUC, IEC
	2N1303	TI	pnp,ge	–	150	85	2.5	*30	300	*20	6	20	0.2	5	AMP, GI, RCA, NUC, GE, IEC
	2N1304	TI	npn,ge	–	150	85	2.5	*25	300	*40	6	20	0.2	5	AMP, GI, RCA, NUC, IEC
	2N1305	TI	pnp,ge	–	150	85	2.5	*30	300	*40	6	20	0.2	5	AMP, GI, RCA, NUC, GE, IEC
	2N1306	TI	npn,ge	–	150	85	2.5	*25	300	*60	6	20	0.2	5	AMP, GI, RCA, NUC, IEC
	2N1307	TI	pnp,ge	–	150	85	2.5	*30	300	*60	6	20	0.2	5	AMP, GI, RCA, NUC, GE, IEC
	2N1308	TI	npn, ge	–	150	85	2.5	*25	300	*80	6	20	0.2	5	AMP, GI, RCA, NUC, IEC
	2N1309	TI	pnp,ge	–	150	85	2.5	*30	300	*80	6	20	0.2	5	AMP, GI, RCA, NUC, GE, IEC
	2N1404	TI	pnp,ge	–	150	85	2.5	*25	300	–	5	*20	0.15	5	
	2N1404A	TI	pnp,ge	–	150	85	2.5	*25	300	*30	5	*20	0.15	5	
LL 45	2N1507	TI	npn,si	–	600	175	4	*60	1A	*100	1	*35	1,5	5	CDC, AL, TI
	2N1510	GE	npn,GR,ge	–	75	85	1.25	*75	20	*30	0.5	–	0.26	–	
	2N1853	RCA	pnp,DM,ge	–	150	85	–	*18	100	30-400	4.2	–	0.2	5	TI
	2N1917	SSD	AJ	–	250	175	1.67	8	50	*25	0.002	*14	0.002	5	TRWS, CT, Chopper Pairs, SPR
	2N1918	SSD	AJ	–	250	175	1.67	8	50	*25	0.006	*14	0.004	5	Chopper Pairs, CT, SPR
	2N1919	SSD	AJ	–	250	175	1.67	18	50	–	0.002	*14	0.003	5	TRWS, AMP, CT, Chopper Pairs, SPR
	2N1920	SSD	AJ	–	250	175	1.67	18	50	–	0.003	*14	0.004	5	TRWS, AMP, CT, Chopper Pairs, SPR
	2N1921	SSD	AJ	–	250	175	1.67	50	50	–	0.004	*14	0.005	5	TRWS, AMP, CT, Chopper Pairs, SPR
LL 46	2N1922	SSD	AJ	–	250	175	1.67	80	50	–	0.004	*14	0.005	5	CT, Chopper Pairs, SPR
	2N1994	TI	npn,ge	–	150	85	2.5	15	300	*15	6	*20	0.25	5	
	2N1995	TI	npn,ge	–	150	85	2.5	15	300	*25	6	*20	0.25	5	
	2N1996	TI	npn,ge	–	150	85	2.5	15	300	*35	6	*20	0.25	5	
	2N1997	TI	pnp,ge	–	250	100	3.3	15	500	*40	5	*20	0.2	5	ETC
	2N1998	TI	pnp,ge	–	250	100	3.3	15	500	*70	5	*20	0.2	5	ETC
	2N1999	TI	pnp,ge	–	250	100	3.3	15	500	*100	5	*20	0.2	5	ETC
	2N2000	TI	pnp,ge	–	300	100	4	15	1000	*50	10	*35	0.25	5	
	2N2001	TI	pnp,ge	–	300	100	4	15	1000	*100	6	*35	0.2	5	
	2N2188	TI	pnp,ge	–	125	85	2.1	25	30	40	3	*2.5	–	–	
LL 47	2N2189	TI	pnp,ge	–	125	85	2.1	25	30	60	3	*2.5	–	–	
	2N2190	TI	pnp,ge	–	125	85	2.1	25	30	40	3	*2.5	–	–	
	2N2191	TI	pnp,ge	–	125	85	2.1	25	30	60	3	*2.5	–	–	
	2N2551	HU	pnp	–	400	160	–	150	–	20	–	–	–	5	
	2N2692	TI	npn,si	–	300	175	2	30	50	*90	0.01	*5	0.2	18	
	2N2871	HU	pnp	–	400	160	–	60	–	20	–	–	–	5	
	2N2872	HU	pnp	–	400	160	–	110	–	20	–	–	–	5	
	2N3217	CT	pnp,si	–	400	200	2.3	*15	100	10	0.001	*14	–	46	SPR
	2N3218	CT	pnp,si	–	400	200	2.3	*25	100	5	0.001	*14	–	46	SPR
	2N3219	CT	pnp,si	–	400	200	2.3	*40	100	3	0.001	*14	–	46	SPR
LL 48	2N4058	TI	pnp,PE,si	–	250	125	2.5	30	30	100	0.1	–	0.7	92	
	2N4059	TI	pnp,PE,si	–	250	125	2.5	30	30	45	0.1	–	0.7	92	
	2N4060	TI	pnp,PE,si	–	250	125	2.5	30	30	45	0.1	–	0.7	92	
	2N4061	TI	pnp,PE,si	–	250	125	2.5	30	30	90	0.1	–	0.7	92	
	2N4062	TI	pnp,PE,si	–	250	125	2.5	30	30	110	0.1	–	0.7	92	

NEW! ONLY FROM INDUSTRO

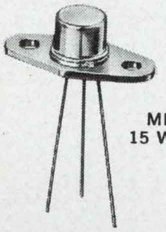
HIGH VOLTAGE

SILICON TRANSISTORS

PNP
200-500V

NPN
200-1000V


TO-5
5 WATTS


MD-14
15 WATTS

Design Your Complementary Circuits with INDUSTRO High Voltage Transistors

PNP		NPN	
V_{CEO} @ I_C = 10mA	200-500V	V_{CEO} @ I_C = 25mA	200-600V
V_{CER} @ I_C = 200μA	200-500V	V_{CER} @ I_C = 200μA	200-1000V
H_{FE} @ V_{CE} = 10V I_C = 20mA	30 min	H_{FE} @ V_{CE} = 4V I_C = 50mA	30 min
GBW @ V_{CE} = 20V f = 5MC; I_C=10mA	6 min	GBW @ V_{CE} = 10V f = 20MC; I_C = 50mA	2.5 min

Write today for complete specifications.

watch for... it CORP.

INDUSTRO TRANSISTOR CORPORATION
35-10 36th AVENUE/LONG ISLAND CITY, NEW YORK 11106/(212) EX 2-8000

ON READER-SERVICE CARD CIRCLE 70

And Now...

HIGHER CURRENT

1/2 AMP & 1 AMP HIGH VOLTAGE SILICON TRANSISTORS

TO-5 and MD-14

PNP
200-500V

TO-5 and MD-14

NPN
200-700V

PNP	
V_{CEO} @ I_C = 10mA	200-500V
V_{CER} @ I_C = 200μA	200-500V
H_{FE} @ V_{CE} = 10V I_C = .25A	25 min
H_{FE} @ V_{CE} = 10V I_C = .1A	40 min
GBW @ V_{CE} = 10V I_C = 50mA f = 5MC	4 min

NPN	
V_{CEO} @ I_C = 25mA	200-500V
V_{CER} @ I_C = 200μA	200-700V
H_{FE} @ V_{CE} = 10V I_C = 1A	10 min
H_{FE} @ V_{CE} = 10V I_C = .25A	40 min
GBW @ V_{CE} = 10V I_C = 50mA f = 5MC	4 min

watch for... it CORP.

High-Level Switching one watt and above

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (kHz)	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
					P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $^{\dagger}I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)		
HL 1	2N1518	DE	pnp,AJ,ge	4	150	100	0.5	40	25	*15-60	4	0.7	36	ETC
	2N1519	DE	pnp,AJ,ge	4	150	100	0.5	60	25	*15-60	4	0.7	36	ETC
	2N1520	DE	pnp,AJ,ge	4	150	100	0.5	40	35	*17-68	4	0.7	36	ETC
	2N1521	DE	pnp,AJ,ge	4	150	100	0.5	60	35	*17-68	4	0.7	36	ETC
	2N1522	DE	pnp,AJ,ge	4	150	100	0.5	40	50	*25-100	4	0.7	36	ETC
HL 2	2N1523	DE	pnp,AJ,ge	4	150	100	0.5	60	50	*25-100	4	0.7	36	ETC
	2N2230	WH	npn,AJ,si	7	150	150	2	50	10	*400	10	2.2	–	
	2N2231	WH	npn,AJ,si	7	150	150	2	100	10	*400	10	2.2	–	
	2N2232	WH	npn,AJ,si	7	150	150	2	150	10	*400	10	2.2	–	
	2N2233	WH	npn,AJ,si	7	150	150	2	200	10	*400	10	2.2	–	
	2N2560	TI	pnp,ge	8	20	100	0.5	*40	3	*20-60	0.65	–	–	NA, KSC, BE
	2N2564	KSC	pnp,ge	8	20	100	0.5	*40	3	*20-60	0.65	–	–	TI
	2N2565	KSC	pnp,ge	8	20	100	0.5	*60	3	*20-60	0.65	–	–	TI
	2N618	MO	pnp,AJ,ge	8.5	90	100	1.25	*80	3	*90	0.8	0.3	3	KSC
	2N1907	TI	pnp,ge	*10	60	100	2	*100	20	*20	0.5	1.0	3	
HL 3	2N1908	TI	pnp,ge	*10	60	100	2	*130	20	*20	0.5	1.0	3	
	2N2226	WH	npn,AJ,si	10	150	150	2	50	10	*100	10	2.2	–	
	2N2227	WH	npn,AJ,si	10	150	150	2	100	10	*100	10	2.2	–	
	2N2228	WH	npn,AJ,si	10	150	150	2	150	10	*100	10	2.2	–	
	2N2229	WH	npn,AJ,si	10	150	150	2	200	10	*100	10	2.2	–	
	2N1809	WH	npn,AJ,si	14	250	175	2.22	50	30	*10	15	0.4	–	
	2N1810	WH	npn,AJ,si	14	250	175	2.22	100	30	*10	15	0.4	–	
	2N1811	WH	npn,AJ,si	14	250	175	2.22	150	30	*10	15	0.4	–	
	2N1812	WH	npn,AJ,si	14	250	175	2.22	200	30	*10	15	0.4	–	
	2N1813	WH	npn,AJ,si	14	250	175	2.22	250	30	*10	15	0.4	–	
HL 4	2N1814	WH	npn,AJ,si	14	250	175	2.22	300	30	*10	15	0.4	–	
	2N1830	WH	npn,AJ,si	14	250	175	2.22	50	30	*10	15	0.875	–	
	2N1831	WH	npn,AJ,si	14	250	175	2.22	100	30	*10	15	0.875	–	
	2N1832	WH	npn,AJ,si	14	250	175	2.22	150	30	*10	15	0.875	–	
	2N1833	WH	npn,AJ,si	14	250	175	2.22	200	30	*10	15	0.875	–	
	2N2109	WH	npn,AJ,si	14	250	0.75	2.22	50	30	*10	15	0.4	–	
	2N2110	WH	npn,AJ,si	14	250	175	2.22	100	30	*10	15	0.4	–	
	2N2111	WH	npn,AJ,si	14	250	175	2.22	150	30	*10	15	0.4	–	
	2N2112	WH	npn,AJ,si	14	250	175	2.22	200	30	*10	15	0.4	–	
	2N2113	WH	npn,AJ,si	14	250	175	2.22	250	30	*10	15	0.4	–	
HL 5	2N2114	WH	npn,AJ,si	14	250	175	2.22	300	30	*10	15	0.4	–	
	2N2130	WH	npn,AJ,si	14	250	175	2.22	50	30	*10	15	0.875	–	
	2N2131	WH	npn,AJ,si	14	250	175	2.22	100	30	*10	15	0.875	–	
	2N2132	WH	npn,AJ,si	14	250	175	2.22	150	30	*10	15	0.875	–	
	2N2133	WH	npn,AJ,si	14	250	175	2.22	200	30	*10	15	0.875	–	
	2N2739	WH	npn,AJ,si	14	200	175	2	50	20	*10	15	0.4	–	
	2N2740	WH	npn,AJ,si	14	200	175	2	100	20	*10	15	0.4	–	
	2N2741	WH	npn,AJ,si	14	200	175	2	150	20	*10	15	0.4	–	
	2N2742	WH	npn,AJ,si	14	200	175	2	200	20	*10	15	0.4	–	
	2N2757	WH	npn,AJ,si	14	200	175	2	50	30	*10	15	0.4	–	TI
HL 6	2N2758	WH	npn,AJ,si	14	200	175	2	100	30	*10	15	0.4	–	TI
	2N2759	WH	npn,AJ,si	14	200	175	2	150	30	*10	15	0.4	–	TI
	2N2760	WH	npn,AJ,si	14	200	175	2	200	30	*10	15	0.4	–	TI
	2N2761	WH	npn,AJ,si	14	200	175	2	250	30	*10	15	0.4	–	TI
	2N1816	WH	npn,AJ,si	14.5	250	175	2.22	50	30	*10	15	0.63	–	
	2N1817	WH	npn,AJ,si	14.5	250	175	2.22	100	30	*10	15	0.63	–	
	2N1818	WH	npn,AJ,si	14.5	250	175	2.22	150	30	*10	15	0.63	–	
	2N1819	WH	npn,AJ,si	14.5	250	175	2.22	200	30	*10	15	0.63	–	
	2N2116	WH	npn,AJ,si	14.5	250	175	2.22	50	30	*10	15	0.63	–	
	2N2117	WH	npn,AJ,si	14.5	250	175	2.22	100	30	*10	15	0.63	–	
HL 7	2N2118	WH	npn,AJ,si	14.5	250	175	2.22	150	30	*10	15	0.63	–	
	2N2119	WH	npn,AJ,si	14.5	250	175	2.22	200	30	*10	15	0.63	–	
	2N2745	WH	npn,AJ,si	14.5	200	175	2	50	20	*10	15	0.63	–	
	2N2746	WH	npn,AJ,si	14.5	200	175	2	100	20	*10	15	0.63	–	
	2N2747	WH	npn,AJ,si	14.5	200	175	2	150	20	*10	15	0.63	–	
	2N2748	WH	npn,AJ,si	14.5	200	175	2	200	20	*10	15	0.63	–	
	2N2763	WH	npn,AJ,si	14.5	200	175	2	50	30	*10	15	0.63	–	TI
	2N2764	WH	npn,AJ,si	14.5	200	175	2	100	30	*10	15	0.63	–	TI
	2N2765	WH	npn,AJ,si	14.5	200	175	2	150	30	*10	15	0.63	–	TI
	2N2766	WH	npn,AJ,si	14.5	200	175	2	200	30	*10	15	0.63	–	TI
HL 8	2N1823	WH	npn,AJ,si	16	250	175	2.22	50	30	*10	15	0.74	–	
	2N1824	WH	npn,AJ,si	16	250	175	2.22	100	30	*10	15	0.74	–	
	2N1825	WH	npn,AJ,si	16	250	175	2.22	150	30	*10	15	0.74	–	
	2N1826	WH	npn,AJ,si	16	250	175	2.22	200	30	*10	15	0.74	–	
	2N2123	WH	npn,AJ,si	16	250	175	2.22	50	30	*10	15	0.74	–	
	2N2124	WH	npn,AJ,si	16	250	175	2.22	100	30	*10	15	0.74	–	
	2N2125	WH	npn,AJ,si	16	250	175	2.22	150	30	*10	15	0.74	–	
	2N2126	WH	npn,AJ,si	16	250	175	2.22	200	30	*10	15	0.74	–	
	2N2751	WH	npn,AJ,si	16	200	175	2	50	20	*10	15	0.74	–	
	2N2752	WH	npn,AJ,si	16	200	175	20	100	2	*10	15	0.74	–	

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (kHz)	P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 9	2N2753	WH	npn,AJ,si	16	200	175	2	150	20	*10	15	0.74	–	
	2N2754	WH	npn,AJ,si	16	200	175	2	200	20	*10	15	0.74	–	
	2N2769	WH	npn,AJ,si	16	200	175	2	50	30	*10	15	0.74	–	
	2N2770	WH	npn,AJ,si	16	200	175	2	100	30	*10	15	0.74	–	
	2N2771	WH	npn,AJ,si	16	200	175	2	150	30	*10	15	0.74	–	
HL 10	2N2772	WH	npn,AJ,si	16	200	175	2	200	30	*10	1.5	0.74	–	
	2N1015	WH	npn,AJ,si	25	150	150	1.43	30	7.5	*10	10	0.5	–	STC
	2N1015A	WH	npn,AJ,si	25	150	150	1.43	60	7.5	*10	10	0.5	–	STC
	2N1015B	WH	npn,AJ,si	25	150	150	1.43	100	7.5	*10	10	0.5	–	STC
	2N1015C	WH	npn,AJ,si	25	150	150	1.43	150	7.5	*10	10	0.5	–	STC
	2N1015D	WH	npn,AJ,si	25	150	150	1.43	200	7.5	*10	10	0.5	–	STC
	2N1015E	WH	npn,AJ,si	25	150	150	1.43	250	7.5	*10	10	0.5	–	STC
	2N1702	RCA	npn,si	25	75	200	0.429	40	5	*15-60	0.2	–	3	STC
	2N1016	WH	npn,AJ,si	30	150	150	1.43	30	7.5	*8	10	0.6	–	STC
	2N1016A	WH	npn,AJ,si	30	150	150	1.43	60	7.5	*10	10	0.6	–	STC
HL 11	2N1016B	WH	npn,AJ,si	30	150	150	1.43	100	7.5	*10	10	0.6	–	STC
	2N1016C	WH	npn,AJ,si	30	150	150	1.43	150	7.5	*10	10	0.6	–	STC
	2N1016D	WH	npn,AJ,si	30	150	150	1.43	200	7.5	*10	10	0.6	–	STC
	2N1016E	WH	npn,FJ,si	30	150	150	1.43	250	7.5	*10	10	0.6	–	STC
	2N1701	RCA	npn,si	30	25	200	0.143	40	2.5	*20-80	0.1	–	8	STC
	2N3851	SSP	npn,TDP	*30	30	200	0.4	*100	5	*90	0.0001	0.25	59	
	2N3853	SSP	npn,TDP	*30	30	200	0.4	*60	5	*90	0.0001	0.25	59	
	2N1409	RA	npn,si	*40	2.8	150	0.22	*30	0.5	*30	0.010	0.5	5	GI
	2N1410	RA	npn,si	*40	2,8	150	0.22	*30	0.5	*60	0.010	0.5	5	GI
	2N1768	–	npn,si	40	40	200	0.229	40	3	*35-100	0.015	–	–	STC, TI
HL 12	2N1769	–	npn,si	40	40	200	0.229	55	3	*35-100	0.015	–	–	STC, TI
	2N3850	SSP	npn,TDP	*40	30	200	0.4	*100	5	*150	0.0001	0.25	59	TI
	2N3852	SSP	npn,TDP	*40	30	200	0.4	*60	5	*150	0.0001	0.25	59	TI
	2N2310	RA	npn,si	*50	3	300	0.017	60	0.5	*12	10	5	46	
	2N2311	RA	npn,si	*50	3	300	0.017	100	0.5	*12	10	5	46	
	2N2312	RA	npn,si	*50	3	300	0.017	60	0.5	*30	10	1.5	46	
	2N2313	RA	npn,si	*50	3	300	0.017	100	0.5	*30	10	5	46	
	2N2314	RA	npn,si	*50	3	300	0.017	35	0.5	*15	10	1.5	46	
	2N2315	RA	npn,si	*50	3	300	0.017	35	0.5	*40	10	1.5	46	
	2N2316	RA	npn,si	*50	3	300	0.17	60	0.5	*40	10	5	46	
HL 13	2N2317	RA	npn,si	*50	3	300	0.17	40	0.5	*40	10	1.5	46	
	2N3506	MO	npn,EA,si	*60	5	200	0.029	40	3	*40-200	†0.001	1.0	5	
	2N3507	MO	npn,EA,si	*60	5	200	0.029	50	3	*30-150	†0.001	1.0	5	
	2N2270	RCA	npn,si	*100	5	200	0.0286	45	1	*50-200	5	–	5	TRWS, GI, CDC, TR, NA
	2N3468	MO	pnp,EA,si	*150	5	200	0.0057	50	1	*25-75	0.0001	0.6	5	TI
	2N3495	MO	pnp,EA,si	*150	3	200	0.0172	120	100	*40	0.0001	0.35	5	
	2N3497	MO	pnp,EA,si	*150	1.8	200	0.0103	120	100	*40	0.0001	0.35	18	
	2N3498	MO	npn,EA,si	*150	5	200	0.0057	100	0.5	*40-120	0.00005	0.4	5	TRWS
	2N3499	MO	npn,EA,si	*150	5	200	0.0057	100	0.50	*100-300	0.00005	0.4	5	TRWS
	2N3500	MO	npn,EA,si	*150	5	200	0.0057	150	0.30	*40-120	0.00005	0.4	5	
HL 14	2N3501	MO	npn,EA,si	*150	5	200	0.0057	150	0.300	*100-300	0.00005	0.4	5	
	2N3634	MO	pnp,EA,si	*150	5	200	0.029	140	1	*50-150	0.00010	0.5	5	
	2N3636	MO	pnp,EA,si	*150	5	200	0.029	175	1	*50-150	0.00010	0.5	5	
	2N3253	MO	npn,AE,si	*175	5	200	0.029	40	–	*25-75	0.0005	0.6	5	TI, AL
	2N3444	MO	npn,AE,si	*175	5	200	0.029	50	–	*20-60	0.0005	0.6	5	TI
	2N3467	MO	pnp,EA,si	*175	5	200	0.0057	40	1	*40-120	0.0001	0.5	5	TI
	2N456B	TI	pnp,ge	*200	150	100	2.0	30	7	*40	0.5	–	3	DE, KSC, ITT
	2N457B	TI	pnp,ge	*200	150	100	2.0	40	7	*40	0.5	–	3	DE, KSC, ITT
	2N458B	TI	pnp,ge	200	150	100	2	45	7	*40	7.0	–	3	TI, DE
	2N1666	AMP	pnp,PADT,ge	200	30	90	–	60	6	*55	<100	–	3	
HL 15	2N1667	AMP	pnp,PADT,ge	200	30	90	–	48	6	140	<100	–	3	
	2N1668	AMP	pnp,PADT,ge	200	30	90	–	48	6	75	<100	–	3	
	2N1669	AMP	pnp,PADT,ge	200	30	90	–	60	6	110	<100	–	3	
	2N2397	SY	npn,PE,si	*200	300	200	–	*35	200	*25-120	0.1	0.3	51	
	2N3252	MO	npn,AE,si	*200	5	200	0.029	30	–	*30-90	0.0005	0.5	5	TI, AMP
	2N3426	FA	npn,PE,si	*200	3.0	200	0.017	12	1.0	*50	0.0000015	0.18	–	
	2N3429	WH	npn,AJ,si	*200	150	175	1.33	*50	7.5	*10	10	0.9	–	
	2N3430	WH	npn,AJ,si	*200	150	175	1.33	*100	7.5	*10	10	0.9	–	
	2N3431	WH	npn,AJ,si	*200	150	175	1.33	150	7.5	*10	10	0.9	–	
	2N3432	WH	npn,AJ,si	*200	150	175	1.33	*200	7.5	*10	10	0.9	–	
HL 16	2N3433	WH	npn,AJ,si	*200	150	175	1.33	*250	7.5	*10	10	0.9	–	
	2N3434	WH	npn,AJ,si	*200	150	175	1.33	*300	7.5	*10	10	0.9	–	
	2N3485	MO	pnp,AE,si	*200	2	200	0.011	40	0.6	*40-120	0.00002	0.4	46	TI, GE
	2N3485A	MO	pnp,AE,si	*200	2	200	0.011	60	0.6	*40-120	0.00001	0.4	46	TI, GE
	2N3486	MO	pnp,AE,si	*200	2	200	0.011	40	0.6	*100-300	0.00002	0.4	46	TI, GE
	2N3486A	MO	pnp,AE,si	*200	2	200	0.011	60	0.6	*100-300	0.00001	0.4	46	TI, GE
	2N3494	MO	pnp,EA,si	*200	3	200	0.0172	80	100	*40	0.0001	0.3	5	
	2N3496	MO	pnp,EA,si	*200	1.8	200	0.0103	80	100	*40	0.0001	0.3	18	
	2N3635	MO	pnp,EA,si	*200	5	200	0.029	140	1	*100-300	0.00010	0.5	5	

High-Level Switching *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (kHz)	P_c (W)	T_j (°C)	W/°C	V_{CEO} *V_{CBO} (V)	I_C (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 17	2N3637	MO	pnp,EA,si	*200	5	200	0.029	175	1	*100-300	0.00010	0.5	5	
	2N2217	MO	npn,EA,si	250	3	175	0.02	30	0.8	20-160	0.00001	0.4	5	GI, SY, SPR, TR, AMP. TI, ITT, IEC, TRWS. AL
	2N2218	MO	npn,AE,si	*250	3	175	0.02	30	0.8	*40-120	0.00001	–	5	GI, SY, SPR, TR, AMP, TRWS, AL, TI, ITT, IEC
HL 18	2N2219	MO	npn,AE,si	250	3	175	0.02	30	0.8	100-300	0.00001	0.4	5	GI, SY, SFR, TR, AMP, TI, AL, ITT, IEC
	2N2219A	MO	npn,AE,si	250	3	175	0.02	30	0.8	100-300	0.00001	0.4	5	GI, SY, SPR, TR, AMP, ITT, NA
	2N2220	MO	npn,AE,si	250	1.8	175	0.012	30	0.8	20-60	0.00001	0.4	18	GI, SPR, TR, AMP, AL, ITT, IEC
	2N2221	MO	npn, AE, si	250	1.8	175	0.012	30	0.8	40-120	0.00001	0.4	18	GI, SPR, TR, AMP, AL, ITT, IEC
	2N2222	MO	npn,AE,si	250	1.8	175	0.012	30	0.8	100-300	0.00001	0.4	18	TRWS, GI, SPR, TR AMP, AL, TI, ITT, IEC
HL 19	2N3250A	MO	pnp,AE,si	*250	1.2	200	0.0069	60	0.2	*50-150	† 0.00002	0.25	18	
	2N3734	MO	npn,AE,si	*250	4	200	0.023	30	1.5	*30-120	† 0.0002	0.2	5	
	2N3504	FA	pnp,PE,si	*250	1.3	200	0.0022	45	0.6	*70	0.050	0.5	18	TI, GE, NA
	2N3735	MO	npn,AE,si	*250	4	200	0.023	50	1.5	*20-80	† 0.0002	0.2	5	
	2N3736	MO	npn,AE,si	*250	2	200	0.011	30	1.5	*30-120	† 0.0002	0.2	46	
	2N3737	MO	npn,AE,si	*250	2	200	0.011	50	1.5	*20-80	† 0.0002	0.2	46	
	2N914/46	SY	npn,PL,EP,si	*300	400	200	–	*40	–	*30-120	0.025	0.7	46	GI
	2N2481	MO	npn,AE,si	*300	1.2	200	0.0069	15	–	*40-120	0.00005	0.25	18	TI, AL
	2N3251A	MO	pnp,AE,si	*300	1.2	200	0.0069	60	0.2	*100-300	† 0.00002	0.25	18	
	2N3647	MO	npn,EA,si	*350	2.0	200	0.011	10	0.50	*25-150	† 0.000025	0.4	46	
HL 20	2N3510	MO	npn,EA,si	*350	1.2	200	0.0069	10	0.50	*25-150	† 0.000025	0.4	52	
	2N3714	MO	npn,si	*400	150	200	0.857	80	10	*25-90	† 1.0	1.0	3	
	2N3511	MO	npn,EA,si	*450	1.2	200	0.0069	15	0.50	*30-120	† 0.000025	0.4	52	
	2N3648	MO	npn,EA,si	*450	2.0	200	0.011	15	0.50	*30-120	† 0.000025	0.4	46	
	2N3227	MO	npn,AE,si	*500	1.2	200	0.0069	20	–	*100-300	0.0002	0.25	18	IEC
	2N3055	RCA	npn,si	*500	115	200	0.657	60	15	*20-70	† 5	1.1	3	† Icev, MO, SOL
	2N3470	WH	npn,AJ,si	*500	150	150	2	*50	10	*100	10	2.2	–	
	2N3471	WH	npn,AJ,si	*500	150	150	2	*100	10	*100	10	2.2	–	
	2N3472	WH	npn,AJ,si	*500	150	150	2	*150	10	*100	10	2.2	–	
	2N3473	WH	npn,AJ,si	*500	150	150	2	*200	10	*100	10	2.2	–	
HL 21	2N3474	WH	npn,AJ,si	*500	150	150	2	*50	10	*400	10	2.2	–	
	2N3475	WH	npn,AJ,si	*500	150	150	2	*100	10	*400	10	2.2	–	
	2N3476	WH	npn,AJ,si	*500	150	150	2	*150	10	*400	10	2.2	–	
	2N3477	WH	npn,AJ,si	*500	150	150	2	*200	10	*400	10	2.2	–	
	2N3508	MO	npn,EA,si	*500	2.0	200	0.011	20	–	*40-120	0.0002	0.25	46	
	2N3509	MO	npn,EA,si	*500	2.0	200	0.011	20	–	*100-300	0.0002	0.25	46	
	2N3013	FA	npn,PE,si	*550	1.2	200	0.00685	15	–	*60	40	0.16	52	TI, ITT, IEC
	2N3014	FA	npn,PE,si	*550	1.2	200	0.00685	20	–	*60	40	–	52	TI, ITT
	2N3424	FA	npn,PE,si	*600	1.2	200	0.29	15	.050	*20-200	0.000010	0.4	–	AL, MO
	2N3546	MO	pnp,EA,si	*700	1.2	200	0.0069	12	–	*30-120	0.000010	0.15	18	
HL 22	2N3054	RCA	npn,si	*1000	25	200	0.143	55	4	*25-100	1.0	1.0	66	
	2N551	TR	npn,PL,si	3000	3	175	.025	60	.2	*20-80	.015	–	5	CDC, STC, SSP
	2N552	TR	npn,PL,si	3000	3	175	.025	30	.2	*20-80	.015	–	5	CDC, STC
	2N1055	TR	npn,PL,si	3000	3	175	.025	100	.2	*20-80	.015	2	5	SSP
	2N1212	TR	npn,PL,si	3000	85	175	.485	60	5	*12-36	–	5	–	STC, TI
	2N1620	TR	npn,PL,si	3000	60	175	.40	*100	5	*15-75	10	–	53	TI
	2N4234	MO	pnp,si	*3000	6	200	0.034	40	3.0	*30-150	*1.0	0.6	5	
	2N4235	MO	pnp,si	3000	6	200	0.034	60	3.0	*30-150	*1.0	0.6	5	
	2N4236	MO	pnp,si	*3000	6	200	0.034	80	3.0	*30-150	*1.0	0.6	5	
	2N545	TR	npn,PL,si	4000	5	175	.045	60	.8	*15-80	.015	–	5	SSP, TI
HL 23	2N546	TR	npn,PL,si	4000	5	175	.045	30	.8	*15-80	.015	–	5	SSP, TI
	2N547	TR	pnp,PL,si	4000	5	175	.045	60	.8	*20-80	.015	–	5	CDC, STC, SSP, TI
	2N548	TR	npn,PL,si	4000	5	175	.045	30	.8	*20-80	.015	–	5	CDC, STC, SSP, TI
	2N549	TR	npn,PL,si	4000	5	175	.045	60	.8	*20-80	.015	–	5	CDC, STC, SSP, TI
	2N550	TR	npn,PL,si	4000	5	175	.045	30	.8	*20-80	.015	–	–	CDC, STC, TI
	2N1117	TR	npn,PL,si	4000	5	175	.045	60	.8	*40-150	.015	4	5	STC, CDC, SSP, TI
	2N3713	MO	npn,si	*4000	150	200	.857	60	10	*25-90	† 1.0	1.0	3	
	2N3715	MO	npn,si	*4000	150	200	.857	60	10	*50-150	† 1.0	1.0	3	
	2N3716	MO	npn,si	*4000	150	200	.857	80	10	*50-150	† 1.0	1.0	3	
	2N3740	MO	pnp,si	*4000	25	200	.143	60	1	*30-100	0.1	0.6	66	
HL 24	2N3741	MO	pnp,si	*4000	25	200	.143	80	1	*30-100	0.1	0.6	66	
	2N1116	TR	npn,PL,si	6000	5	175	.045	60	.8	*40-150	.015	5	5	STC, CDC, SSP, TI
	2N1173	IEC	npn,PE,si	6000	3	150	0.0172	25	–	50	25	1.0	18	
	2N1711	FA	npn,DP,si	*10000	3	200	0.0172	*75	–	*130	.00003	0.5	5	TRWS, CDC, MO, AMP, GI, AL, TR, NA, RCA, TI, IEC
	2N1886	STC	npn,si	10,000	40	175	0.265	60	3.0	20-80	0.35	2.5	59	
	2N3738	MO	npn,si	*15,000	20	175	.133	225	.250	*40-200	0.1	2.5	66	
	2N3739	MO	npn,si	*15,000	20	175	.133	300	.250	*40-200	0.1	2.5	66	
	2N3766	MO	npn,si	*15,000	20	175	.133	60	1	*40-160	0.1	2.5	66	

Need a FREE personal copy of this Directory? Circle number **419.**

ON READER-SERVICE CARD CIRCLE 71 ➤

Now the industry-accepted TTL has a double, pin for pin...

Westinghouse TTL. Available now.

The new direct replacement for industry-accepted SUHL II is here. Westinghouse TTL is a true mechanical and electrical replacement, pin for pin. Here's a second source TTL that can help keep your products competitive into the 1970's. □ Circuits now available in industry standard dual-in-line and flat packages include: 6G241 Dual NAND/NOR Gate; 6G221 Quadruple NAND/NOR Gate; 6F251 JK Flip-Flop, AND input; 6F261 JK Flip-Flop, OR input. □ For evaluation quantities, contact your Westinghouse Electronic salesman. Or phone Westinghouse at (301) 796-3666. Or write Westinghouse, Molecular Electronics Division, Box 7377, Elkridge, Maryland 21227.

You can be sure if it's Westinghouse

J-09141

High-Level Switching *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (kHz)	P_c (W)	T_j (°C)	W/°C	V_{CEO} *V_{CBO} (V)	I_C (A)	h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 25	2N3767	MO	npn,si	*15,000	20	175	.133	80	1	*40-160	0.1	2.5	66	
	2N1983	FA	npn,DD,si	*30000	2	150	0.016	25	–	100	0.001	0.25	5	TRWS, CDC, AL
	2N1984	FA	npn,DD,si	*30000	2	150	0.016	25	–	80	0.001	0.25	5	TRWS, CDC, AL
	2N1985	FA	npn,DP,si	*30000	2	150	0.016	25	–	60	0.001	0.25	5	TRWS, CDC, AL
	2N4300	TI	npn,PE,si	*30,000	15	200	0.15	80	2	*30-120	0.01	0.3	5	
HL 26	2N698	FA	npn,DP,si	*40000	3	200	0.0172	60	–	*40	–	–	5	TRWS, TR, GI CDC
	2N2852	SSP	npn,PE,si	*40000	5	200	0.005	*100	5	*45	0.001	0.2	5	TI
	2N2856	SSP	npn,PE,si	*40000	5	200	0.005	*60	5	45	0.001	0.2	5	TI
	2N4301	TI	npn,PE,si	*40,000	50	200	0.5	80	10	*30-120	0.01	0.4	61	
	2N1899	TRWS	npn,PL,si	*50000	125	150	1	*140	10	*10-30	10	1.0	–	
	2N1901	TRWS	npn,PL,si	*50000	125	150	1	*140	10	*20-60	10	1.0	–	
	2N1902	TRWS	npn,PL,si	*50000	125	150	1	*140	10	*10-30	10	1.0	–	
	2N1904	TRWS	npn,PL,si	*50000	125	150	1	*140	10	*20-60	10	1.0	–	
	2N1978	FA	npn,DP,si	*50000	30	200	0.172	*60	–	*30	0.001	1.0	–	
HL 27	2N1986	FA	npn,DD,si	*50000	2	150	0.016	25	–	150	0.001	0.4	5	TRWS, CDC, GI, AMP, AL
	2N1987	FA	npn,DD,si	*50000	2	150	0.016	25	–	50	0.001	0.4	5	TRWS, CDC, GI, AMP, AL
	2N1988	FA	npn,DD,si	*50000	2	150	0.016	45	–	*75	0.001	1.5	5	TRWS, CDC, GI, AL
	2N1989	FA	npn,DD,si	*50000	2	150	0.016	45	–	*40	0.001	1.5	5	TRWS, CDC, GI, AL
	2N1991	FA	pnp,DD,si	*50000	2	150	0.016	*30	–	*30	0.001	1.2	5	TRWS, CDC, TR, MO
	2N3076	TRWS	npn,PL,si	*50000	125	150	1	*140	10	*30-90	25	1.0	*	Single Ended *MT-38 Case
	2N717	FA	npn,DD,si	*60000	1.5	175	0.010	*60	–	*40	.00001	0.7	18	TRWS, CDC, TR, GI, AMP, NA TI, IEC
HL 28	2N719	FA	npn,DD,si	*60000	1.5	175	0.010	*120	–	*40	0.001	2.5	18	TRWS, CDC, TR, GI
	2N719A	FA	npn,DP,si	*60000	1.8	200	0.0103	*120	–	*40	.000005	0.8	18	TRWS, CDC, AMP AL, GI, TR, TI
	2N720A	FA	npn,DP,si	*60000	1.8	200	0.0103	*120	–	*80	.000005	0.9	18	TRWS, CDC, GI, TI AMP, AL, NA, TR, RCA
	2N721	FA	pnp,DD,si	*60000	1.5	175	0.010	35	–	*60	0.001	1.0	18	KSC, TR, CDC, NA,IEC
	2N909	FA	npn,DD,si	*60000	1.5	175	0.010	*60	–	*250	.00001	0.3	18	TRWS, AMP, CDC
	2N912	FA	npn,DP,si	*60000	1.8	200	0.0103	60	–	45	.000005	0.16	18	TRWS, AMP, AL, TI, CDC
	2N978	FA	pnp,DD,si	*60000	1.25	150	0.010	20	–	*30	.001	1.3	18	TR, IEC
	2N2850	SSP	npn,PE,si	*60000	5	200	0.005	*100	5	*85	–	0.15	5	TI
HL 29	2N2851	SSP	npn,PE,si	*60000	5	200	0.005	*100	5	*85	–	0.2	5	TI
	2N2853	SSP	npn,PE,si	*60000	5	200	0.005	*60	5	*85	0.001	1.0	5	TI
	2N2855	SSP	npn,PE,si	*60000	5	200	0.005	60	5	85	0.001	0.2	5	TI
	2N1972	FA	npn,DD,si	*60000	2	175	0.010	*60	–	*250	.0001	0.4	5	AMP, TR, TRWS, CDC
	2N1975	FA	npn,DP,si	*60000	3	200	0.0172	60	–	45	.00005	0.16	5	TRWS, CDC, AMP
	2N3117	FA	npn,DP,si	*60000	1.2	200	0.00685	60	–	*300	.00001	0.3	18	UC, TI, AL, NA, SSD
	2N3719	MO	pnp,AE,si	*60,000	6	200	.034	40	3	*25-180	.01	0.75	5	TI
	2N3720	MO	pnp,AE,si	*60,000	6	200	.034	60	3	*25-180	.01	0.75	5	TI
	2N3879	RCA	npn,si	*60,000	35	200	0.2	75	10(peak)	*20-80	*5	1.2	66	
	2N4036	RCA	pnp,si	*60,000	7	200	0.04	–65	–1	*40-140	*–0.5μA	–0.65	5	
HL 30	2N4037	RCA	pnp,si	*60,000	7	200	0.04	–40	–1	*50-250	*–5μA	–1.4	5	
	2N4296	RCA	npn,TDP,si	*60,000	20	175	0.13	250	1	*80	0.1	0.9	66	
	2N4297	RCA	npn,TDP,si	*60,000	20	175	0.13	250	1	*100	0.1	0.75	66	
	2N4298	RCA	npn,TDP,si	*60,000	20	175	0.13	350	1	*30	0.1	0.9	66	
	2N4299	RCA	npn,TDP,si	*60,000	20	175	0.13	350	1	*80	0.1	0.75	66	
	2N4314	RCA	pnp,si	*60,000	7	200	0.04	–65	–1	*50-250	*–5μA	–1.4	5	
	2N911	FA	npn,DP,si	*70000	1.8	200	0.0103	60	–	70	.00005	0.13	18	TRWS, AMP, AL, TI, CDC
	2N1131	FA	pnp,DD,si	*70000	2	175	0.0133	35	600	*30	0.001	1.0	5	TR, MO, TI, NA, IEC
	2N1974	FA	npn,DP,si	*70000	3	200	0.0172	60	–	70	.000005	0.13	5	TRWS, CDC, AMP
	2N696	FA	npn,DD,si	*80000	2	175	0.0133	*60	–	*40	.00001	–	5	TRWS, TR, GI, AMP CDC, NA, TI, ITT, IEC
HL 31	2N699	FA	npn,DD,si	*80000	2	175	0.0133	*120	–	*80	.00001	–	5	TRWS, SY, TR, CDC AMP, NA, RCA, TI
	2N718	FA	npn,DD,si	*80000	1.5	175	0.010	*60	–	*75	.00001	0.7	18	TRWS, CDC, SY, TR GI, AMP, AL, NA, MO, ITT, IEC
	2N718A	FA	npn,DP,si	*80000	1.8	200	0.0103	*75	–	*80	.000003	0.6	18	CDC, MO, TR, GI, AMP, AL, NA, RCA, MO, TRWS, TI
	2N720	FA	npn,DD,si	*80000	1.5	175	0.010	*120	–	*80	.001	2.5	18	TRWS, CDC, TR, GI AMP, AL, NA, TI
HL 32	2N870	FA	npn,DP,si	*80000	1.8	200	0.0103	60	–	*75	.00004	0.6	18	GI, AMP, AL, TI, CDC, IEC
	2N910	FA	npn,DP,si	*80000	1.8	200	0.0103	60	–	140	.00005	0.13	18	TRWS, AMP, AL, TI, CDC, NA
	2N1252	FA	npn,DD,si	*80000	2	175	0.0133	*30	–	*35	.0001	0.6	5	SY, AL, NA, IEC
	2N1613	FA	npn,DP,si	*80000	3	200	0.0172	*75	–	*80	.00003	0.6	5	TRWS, CDC, MO, TR AMP, RCA, TI, AL, IEC
	2N1973	FA	npn,DP,si	*80000	3	200	0.00456	60	–	140	.0005	0.13	5	TRWS, CDC, AMP
	2N2849	SSP	npn,PE,si	*80000	5	200	0.005.	*100	5	*150	–	0.2	5	TI
	2N2854	SSP	npn,PE,si	*80000	5	200	0.005	*60	5	*150	0.001	0.2	5	TI

Complete listing of semiconductor manufacturers starts on page 86.

High-Level Switching *(continued)*

					MAX. RATINGS					CHARACTERISTICS				
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (kHz)	P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 33	2N2894A	FA	pnp,PE,si	80,000	1.2	200	0.0068	*12	0.200	*55	–	0.28	18	
	2N3919	FA	npn,DPE,si	80000	15	150	.200	60	2	*40	–	.6	3	
	2N3920	FA	npn,DPE,si	80000	15	150	.200	60	2	*100	–	.6	3	
	2N4074	RCA	npn,DPE,si	*80,000	2	175	0.02	40	0.3	*150	0.00001	0.22	104	
HL 34	2N3108	FA	npn,DP,si	*86000	5	200	0.0286	60	–	*70	.0004	0.16	5	
	2N3110	FA	npn,DP,si	*86000	5	200	0.0286	40	–	*70	.0004	0.16	5	
	2N722	FA	pnp,DD,si	*90000	1.5	175	0.010	35	.00001	*50	.001	1.0	18	KSC, MO, TR, CDC, NA, IEC
	2N1132	FA	pnp,DD,si	*90000	2	175	0.0133	35	0.6	*45	.00001	1.0	5	TR, MO, TI, NA, IEC
	2N1838	TRWS	npn,PL,si	*90000	2	175	.013	*45	0.50	*40-150	.0015	1.4	5	CDC
	2N1839	TRWS	npn,PL,si	*90000	2	175	.013	*45	0.50	*12-50	.0015	1.4	5	CDC
	2N1840	TRWS	npn,PL,si	*90000	2	175	.013	*25	0.50	*10-100	0.30	1.4	5	CDC
	2N871	FA	npn,DP,si	*100000	1.8	200	0.0103	60	–	*130	.0004	0.35	18	CDC, GI, AMP, AL, TI, IEC
HL 35	2N1420	FA	npn,DD,si	*100000	2	175	0.0133	*60	–	*200	.00001	0.7	5	TRWS, CDC, MO, TR, GI, NA, AMP, CDC, IEC. TI
	2N1893A	TRWS	npn,PL,si	*100000	3	200	.017	80	0.50	*40-120	.0001	2.0	5	GI, TR, NA
	2N3053	RCA	npn,si	*100,000	5	200	0.0286	40	0.7	*50-250	0.00025	1.4	5	CDC, MO
	2N4026	FA	pnp,PE,si	100,000	2.0	200	0.0114	*60	1.0	*60	–	0.25	18	
	2N4027	FA	pnp,PE,si	100,000	2.0	200	0.0114	*80	1.0	*60	–	0.25	18	
	2N4028	FA	pnp,PE,si	100,000	2.0	200	0.0114	*60	1.0	*110	–	0.25	18	
	2N4029	FA	pnp,PE,si	100,000	2.0	200	0.0114	*80	1.0	*110	–	0.25	18	
	2N4068	RCA	npn,si	*100,000	0.5	175	0.003	150	0.2	80	0.00005	0.68	104	
HL 36	2N4069	RCA	npn,si	*100,000	1	175	0.006	150	0.2	80	0.00005	0.68	104	With heat radiator
	2N1253	FA	npn,DD,si	*110000	2	175	0.0133	*30	–	*45	.0001	0.6	5	AL, NA, IEC
	2N219A	GE	npn,PE,si	*130000	2.8	200	.016	40	1	*100-300	1	.25	5	GI, NA, CDC, FA, MO, AL
	2N2193A	GE	npn,PE,si	*130000	2.8	200	.016	50	1	*40-120	10	.25	5	CDC, GI, NA, MO, AL, TI
	2N2194A	GE	npn,PE,si	*130000	2.8	200	.016	40	1	*20-60	1	.25	5	CDC, GI, NA, FA, MO, AL, TI
	2N2195A	GE	npn,PE,si	*130000	2.8	200	.016	25	1	*20	10	.25	5	CDC, GI, MO, AL, TI
	2N2243A	GE	npn,PE,si	*130000	2.8	200	0.16	80	1	*40-120	1	.25	5	GI, NA, TI, AL, CDC
	2N2350A	GE	npn,PE,si	*130000	5	200	.0285	25	1	*20	1	.25	46	
HL 37	2N2351A	GE	npn,PE,si	*130000	5	200	.0285	50	1	*40-120	1	.25	46	NA
	2N2352A	GE	npn,PE,si	*130000	5	200	.0285	40	1	*20-60	1	.25	46	NA
	2N2353A	GE	npn,PE,si	*130000	5	200	.0285	25	1	*20	1	.25	46	NA
	2N2364A	GE	npn,PE,si	*130000	5	200	.0285	80	1	*40-125	1	.25	46	NA, CDC
	2N1837	TRWS	npn,PL,si	*140000	2	175	.013	*80	0.50	*40-120	.0005	0.8	5	CDC
	2N3638A	IEC	pnp,PE,si	150,000	0.3	150	–	60	–	30-300	–	0.3	18	
	2N3763	MO	pnp,AE,si	*150,000	4	200	.023	60	1.5	*20-80	†.0001	0.1	5	
	2N3765	MO	pnp,AE,si	*150,000	2	200	.011	60	1.5	*20-80	†.0001	0.1	46	
	2N3241A	RCA	npn,DPE,si	*175,000	2	175	0.02	40	–	*150	0.0001	0.22	104	
	2N3242A	RCA	npn,DPE,si	*175,000	2	175	0.02	40	–	*200	0.00001	0.24	104	
HL 38	2N3762	MO	pnp,AE,si	*180,000	4	200	.023	40	1.5	*30-120	†.0001	0.1	5	
	2N3764	MO	pnp,AE,si	*180,000	2	200	.011	40	1.5	*30-120	†.0001	0.1	46	
	2N947	FA	npn,DP,si	*250000	1.2	200	0.0069	*20	0.1	*40	.0001	0.3	18	GE
	2N3502	FA	pnp,PE,si	*250,000	3.0	200	0.017	60	.600	*70	0.05	0.5	5	TI, GE, NA
	2N3503	FA	pnp,PE,si	*250,000	3.0	200	0.017	60	0.6	*70	0.00000007	0.5	5	TI, GE, NA
	2N3505	FA	pnp,PE,si	*250,00	1.3	200	0.0023	45	0.6	*70	0.00000007	0.5	18	TI, GE, NA
	2N4960	FA	npn,PE,si	250,000	3.5	200	0.02	60	0.5	100-3000	0.000001	0.18	39	
	2N4961	FA	npn,PE,si	250,000	3.5	200	0.02	80	0.5	100-300	0.000001	0.18	39	
	2N4962	FA	npn,PE,si	250,000	1.2	200	0.0685	80	0.5	100-300	0.000001	0.18	18	
	2N4963	FA	npn,PE,si	250,000	1.2	200	0.0685	80	0.5	100-300	0.000001	0.18	18	
HL 39	2N915	FA	npn,DP,si	*300000	1.2	200	0.0069	50	–	*100	.0005	0.8	18	TRWS, AMP, NA, MO, AL, IEC
	2N3724	ITT	npn,PE,si	300,000	3.5	200	0.02	30	1	60-150	0.0017	0.25	5	
	2N3725	ITT	npn,PE,si	300,000	3.5	200	0.02	50	1	60-150	0.0017	0.25	5	
	2N4014	FA	npn,PE,si	300,000	1.2	200	0.00685	30	1	60-150	0.0017	0.2	18	ITT
	2N4013	FA	npn,PE,si	300,000	1.2	200	0.00685	30	1	60-150	0.0017	0.2	18	ITT
	2N3512	RCA	npn,EP,si	375,000	4	200	–	*60	–.	80	0.5	0.28	5	
	2N708	FA	npn,DP,si	*400000	1.2	200	0.0069	15	–	*50	.0004	0.3	18	SY, TR, GI, AMP, RCA, MO, FA, NA, TI, ITT, CDC, IEC
HL 40	2N916	FA	npn,DP,si	*400000	1.2	200	0.0069	25	–	*100	.0005	0.4	18	TRWS, AMP, NA, MO, TI, AL, IEC
	2N3299	FA	npn,PE,si	*400,000	3.0	200	0.017	*30	–	*75	0.0000002	0.4	5	ITT
	2N3300	FA	npn,PE,si	*400,000	3.00	200	0.017	*30	–	*220	0.0000002	0.4	5	ITT
	2N3301	FA	npn,PE,si	*400,000	1.8	200	0.010	*30	–	*75	0.0002	0.4	18	ITT
	2N3302	FA	npn,PE,si	*400,000	1.8	200	0.010	*30	–	*220	0.0002	0.4	18	ITT
	2N2369A	RCA	npn,PE,si	*500,000	1.2	200	0.0068	*40	0.2	*40	30	0.2	18	
	2N4137	FA	npn,PE,si	500,000	1.2	200	0.00685	20	0.5	40-120	0.0004	0.18	18	
	2N2368	FA	npn,PE,si	*550000	1.2	200	0.0685	15	0.5	*40	.0001	0.2	18	TR, AL, SPR, TI, AMP. CDC, ITT, IEC

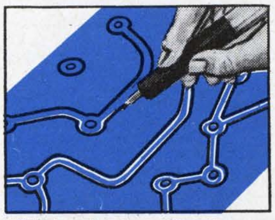
Reader-Service cards are good all year.

High-Level Switching *(continued)*

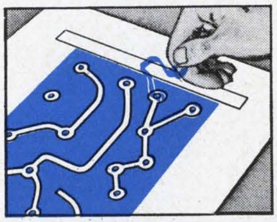
Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (kHz)	MAX. RATINGS					CHARACTERISTICS			Package Outline (TO-)	Remarks
					P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)		
HL 41	2N3209	FA	npn,PE,si	*550000	1.2	200	0.00685	20	0.0002	*75	.00002	0.07	18	
	2N2455	SY	npn,EP,ge	600,000	150	100	–	*15	200	*20-100	2.0	.19	18	
	2N3423	FA	npn,PE,si	*600,000	1.2	200	0.29	15	.050	*20-200	0.000010	0.4	–	AL, MO
	2N2369	FA	npn,PE,si	*650000	1.2	200	0.00685	15	0.5	*80	.0001	0.2	18	AL, NUC, SPR, TI, AMP, CDC, ITT, IEC
HL 42	2N3303	FA	npn,PE,si	*650000	3.0	200	0.017	12	1.0	*60	0.1	0.18	–	MO, TI
	2N917	FA	npn,DP,si	*800000	0.3	200	0.00171	15	–	50	.00005	0.4	18	AL, TI, RCA, TRWS, NA, IEC
	2N4251	FA	npn,PE,si	1,300,000	1.3	200	0.00743	10	0.1	100-300	0.001	0.25	46	
	2N418	BE	pnp,ge	–	25	100	0.5	–	5	*40	1.0	–	3	KSC, ITT
	2N420	BE	pnp,ge	–	25	100	0.5	–	5	*40	–	–	3	ITT, KSC
	2N420A	BE	pnp,ge	–	25	100	0.5	–	5	*40	–	–	3	ITT, KSC
	2N424A	STC	npn	–	85	200	.483	80	3	*12-60	–	–	53	STC, TR, BE, TI
	2N637	BE	pnp,ge	–	25	100	0.5	*25	5	*30-60	0.5	.8-1.5	3	KSC, TI
	2N637A	BE	pnp,ge	–	25	100	0.5	*60	5	30-60	2-5	.5	3	KSC, TI
HL 43	2N637B	BE	pnp,ge	–	25	100	0.5	*60	5	*30-60	2-5	.5	3	KSC, TI
	2N638	BE	–	–	–	–	–	–	–	–	–	–	–	KSC, TI
	2N638A	BE	–	–	–	–	–	–	–	–	–	–	–	KSC, TI
	2N638B	BE	–	–	–	–	–	–	–	–	–	–	–	KSC, TI
	2N656	TI	npn,si	–	4	200	0.0228	60	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, GE, NA
	2N657	TI	npn,si	–	4	200	0.0228	100	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, STC, SSP, GE, NA
	2N730	TI	npn,si	–	0.5	175	3.33	*60	1	*20	1	1.5	18	TR, TI, CDC, NA
	2N731	TI	npn,si	–	0.5	175	3.33	*60	1	*40	1	1.5	18	TR, TI, CDC, NA
HL 44	2N1011	BE	pnp,ge	–	35	95	0.5	*80	5	*35-75	5	1.5	3	MO, ITT, DE
	2N1038	TI	pnp,ge	–	20	100	0.267	*40	3	*20	0.125	0.25	–	SY, KSC
	2N1039	TI	pnp,ge	–	20	100	0.267	*60	3	*20	0.125	0.25	–	SY, KSC
	2N1040	TI	pnp,ge	–	20	100	0.267	*80	3	*20	0.125	0.25	–	SY, KSC
	2N1041	TI	pnp,ge	–	20	100	0.267	*100	3	*20	0.125	0.25	–	SY, KSC
	2N1046	TI	pnp,ge	–	30	100	0.400	50	12	*40	2.0	0.4	3	
	2N1046A	TI	pnp,ge	–	50	100	1.0	50	12	*40	2.0	0.4	3	
	2N1046B	TI	pnp,ge	–	50	100	1.0	50	12	*40	2.0	0.9	3	
	2N1073	BE	pnp,ge	–	60	110	0.833	*25	10	*20-60	15	1	41	DE, MO
	2N1073A	BE	pnp,ge	–	60	110	0.833	*60	10	*20-60	20	1	41	DE, MO
HL 45	2N1073B	BE	pnp,ge	–	60	110	0.833	*100	10	*20-60	20	1	41	DE, MO
	2N1208	TR	npn,PL,si	–	85	175	.485	60	5	*15	10	5	–	STC, TI
	2N1209	TR	npn,PL,si	–	85	175	.485	45	5	*20-80	20	5	–	STC, TI
	2N1238	HU	pnp	–	1	160	–	15	–	20	–	–	–	
	2N1239	HU	pnp	–	1	160	–	15	–	40	–	–	–	
	2N1240	HU	pnp	–	1	160	–	35	–	20	–	–	–	
	2N1241	HU	pnp	–	1	160	–	35	–	40	–	–	–	
	2N1242	HU	pnp	–	1	160	–	60	–	20	–	–	–	
	2N1243	HU	pnp	–	1	160	–	60	–	40	–	–	–	
	2N1244	HU	pnp	–	1	160	–	110	–	20	–	–	–	
HL 46	2N1990	FA	npn,DD,si	–	2	150	0.016	*100	1	*30	0.001	0.4	5	TRWS, CDC, GI, AMP, AL, NUC, IEC
	2N2285	BE	pnp,ge	–	100	110	1.25	30	25	*35-140	5	–	3	
	2N2286	BE	pnp,ge	–	100	110	1.25	60	25	*35-140	5	–	3	
	2N2287	BE	pnp,ge	–	100	110	1.25	80	25	*35-140	5	–	3	
	2N2288	BE	pnp,ge	–	60	110	0.833	*40	10	*20-60	5	–	3	
	2N2289	BE	pnp,ge	–	60	110	0.833	*80	10	*20-60	5	–	3	
	2N2290	BE	pnp,ge	–	60	110	0.833	*120	10	*20-60	5	–	3	
	2N2291	BE	pnp,ge	–	60	110	0.833	30	30	50-200	5	–	3	
	2N2292	BE	pnp,ge	–	60	110	0.833	50	10	50-200	5	–	3	
HL 47	2N2293	BE	npn,ge	–	60	110	0.833	70	10	50-200	5	–	3	
	2N2294	BE	pnp,ge	–	60	110	0.833	30	10	50-200	1	–	41	
	2N2295	BE	pnp,ge	–	60	110	0.833	50	10	50-200	1	–	41	
	2N2296	BE	pnp,ge	–	60	110	0.833	70	10	50-200	2	–	41	
	2N2359	BE	pnp,ge	–	170	110	2	30	50	*30-90	50	–	41	
	2N2358	BE	pnp,ge	–	170	110	2	60	50	*30-90	50	–	41	
	2N2357	BE	pnp,ge	–	170	110	2	80	50	30-90	50	–	–	
	2N2389	TI	npn,si	–	0.45	200	0.00257	*75	500	35	10	1.5	50	
	2N2390	TI	npn,si	–	0.45	200	0.00257	*75	0.5	*100	10	1.5	50	
	2N2394	TI	pnp,si	–	0.45	175	0.003	35	0.3	30	1	1.5	50	
HL 48	2N2395	TI	npn,si	–	0.45	200	0.00257	40	0.3	*20	10	1.0	50	
	2N2410	TI	npn,si	–	0.8	200	0.00457	30	0.8	*30	0.3	0.45	5	SY, NA
	2N2411	TI	pnp,si	–	0.3	200	0.00172	20	0.1	*20	10	0.2	18	IEC
	2N2526	MO	pnp,AD,ge	–	85	110	1.25	80	10	20-50	3	0.8	3	
	2N2527	MO	pnp,AD,ge	–	85	110	1.25	120	10	20-50	3	0.8	3	
	2N2528	MO	pnp,AD,ge	–	85	110	1.25	160	10	20-50	3	0.8	3	DE

Circle as many numbers on the reader-service card as you like.

In Making Masks for Electronic Components...
...there's no Margin for Error!

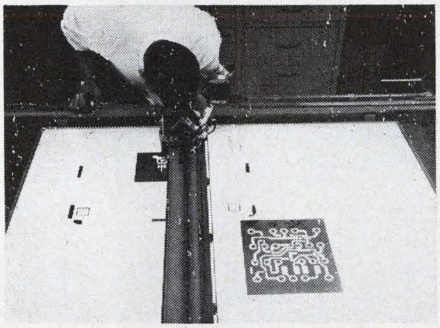


With sharp blade, outline the areas to be masked. **Do not cut through the backing sheet.** The Ulano Swivel Knife does the job quickly, easily.



Now carefully peel off the film as outlined leaving a completed photo mask, positive or negative, that corresponds exactly to the desired pattern.

THAT'S WHY EXPERIENCED DESIGNERS AND ENGINEERS ALWAYS INSIST ON...



RUBYLITH T.M.

HAND-CUT MASKING FILM FOR THE GRAPHIC ARTS

by

Ulano T.M.

THE KNIFE-CUT, LIGHT-SAFE MASKING FILM LAMINATED TO A STABLE POLYESTER BASE

The most versatile line of hand-cut masking films, including

.0075—RUBYLITH 75 DR* **.005 RUBYLITH 5 DR**
.005 AMBERLITH 5 DA

These new, thick Ulano films provide the positive answers where exact register assumes a critical importance.

**Available in sheets only, cut to your specifications.*

ulano T.M.

610 DEAN STREET, BROOKLYN, N.Y. 11238

NEW YORK • CALIFORNIA • CHICAGO • ZURICH
In Europe: ULANO A. G., Untere Heslibachstrasse 22, Kusnacht 8700, Switzerland

Write on your letterhead for special electronic test kit** (no charge) **No. 4127

ON READER-SERVICE CARD CIRCLE 72

Unijunction

Type 1. Pulse Generation (e.g., SCR Triggering)

	Type Number	Orig. Reg.	Type	V_{OB1} [min] (volts)	I_V [min] (mA)	V_{EB2} [max] (volts)	η [min–max]	R_{BBO} [min] (kΩ)	I_P [max] (μA)	I_{EO} [max] (μA)	$V_{E(SAT)}$ [max] (volts)	Alternate Sources and Remarks
UJT 1	2N489A	GE	pn,si	3.0	8.0	60	0.51–0.62	4.7	12.0	2.0	4.0	TI, TO-5
	2N490A	GE	pn,si	3.0	8.0	60	0.51–0.62	6.2	12.0	2.0	4.0	TI, TO-5
	2N491A	GE	pn,si	3.0	8.0	60	0.56–0.68	4.7	12.0	2.0	4.3	TI, TO-5
	2N492A	GE	pn,si	3.0	8.0	60	0.56–0.68	6.2	12.0	2.0	4.3	TI, TO-5
	2N493A	GE	pn,si	3.0	8.0	60	0.62–0.75	4.7	12.0	2.0	4.6	TI, TO-5
	2N494A	GE	pn,si	3.0	8.0	60	0.62–0.75	6.2	12.0	2.0	4.6	TI, TO-5
	2N1671A	GE	pn,si	3.0	8.0	30	0.47–0.62	4.7	25.0	2.0	5.0	TI
	2N1671B	GE	n, si	3.0	8.0	30	0.47–0.62	4.7	6.0	0.2	5.0	TI
	2N2160	GE	pn,si	3.0	8.0	30	0.47–0.80	4.0	25.0	2.0	–	TI, TO-5
	2N2646	GE	pn,AE,si	3.0	4.0	30	0.56–0.75	4.7	5.0	12.0	2.0(typ)	MO, TI
	2N4893	TI	pn,si	3.0	2.0	30	0.55–0.82	4.0	5.0	1.0	4.0	Plastic (218) TO-92
	SJ1034	TI	pn,si	3.0	–	30	0.50–0.80	4.0	–	15.0	–	TO-5
	SJ5898	TI	pn,si	3.0	2.0	30	0.55–0.80	4.0	5.0	0.01	4.0	T-69 (Plastic Planar)
	2N2647	GE	pn,si	6.0	8.0	30	0.68–0.82	4.7	2.0	0.20	2.0(typ)	
	SJ1158	TI	pn,si	6.0	3.0	30	0.56–0.85	4.0	5.0	0.01	4.0	TO-18 (Planar)
	SJ1159	TI	pn,si	6.0	4.0	30	0.65–0.85	4.7	2.0	0.01	4.0	TO-18 (Planar)

Type 2. High-Frequency Control, Voltage-Sensing, Frequency Dividing and Short Timing Periods

	Type Number	Orig. Reg.	Type	I_V [min] (mA)	η [min–max]	R_{BBO} [min] (kΩ)	I_{EO} [max] (μA)	I_P [max] (μA)	$V_{E(SAT)}$ [max] (volts)	V_{EB2} [max] (volts)	V_{OB1} [min] (volts)	Alternate Sources and Remarks
UJT 2	2N3980	TI	pn,AE,si	1.0	0.68–0.82	4.0	0.01	2.0	3.0	30	6.0	MO
	2N4891	TI	pn,si	2.0	0.55–0.82	4.0	1.0	5.0	4.0	30	3.0	TO-92
	2N4892	TI	pn,si	2.0	0.55–0.82	4.0	1.0	5.0	4.0	30	3.0	TO-92
	SJ993	TI	pn,si	4.0	0.56–0.75	4.7	0.01	5.0	4.0	30	3.0	TO-18 (Planar)
	2N4947	TI	pn,si	4.0	0.51–0.069	4.0	2.0	2.0	3.0	30	3.0	TO-18
	SJ1127	TI	pn,si	8.0	0.68–0.82	4.7	0.01	2.0	4.0	60	6.0	TO-18 (Planar)
	2N489	GE	pn,si	8.0	0.51–0.62	4.7	2.0	12.0	5.0	60	–	TI, TO-5
	2N490	GE	pn,si	8.0	0.51–0.62	6.2	2.0	12.0	5.0	60	–	TI, TO-5
	2N491	GE	pn,si	8.0	0.56–0.68	4.7	2.0	12.0	5.0	60	–	TI, TO-5
	2N492	GE	pn,si	8.0	0.56–0.68	6.2	2.0	12.0	5.0	60	–	TI, TO-5
	2N493	GE	pn,si	8.0	0.62–0.75	4.7	2.0	12.0	5.0	60	–	TI, TO-5
	2N494	GE	pn,si	8.0	0.62–0.75	6.2	2.0	12.0	5.0	60	–	TI, TO-5
	2N1671	TI	pn,si	8.0	0.47–0.62	4.7	12.0	25.0	5.0	30	–	GE, TO-5

Type 3. Low-Frequency Control, Long Timing-Periods and Current-Sensing

	Type Number	Orig. Reg.	Type	I_P [max] (μA)	I_{EO} [max] (μA)	η [min–max]	V_{OB1} [min] (volts)	R_{BBO} [min] (kΩ)	I_V [min] (mA)	$V_{E(SAT)}$ [max] (volts)	V_{EB2} [max] (volts)	Alternate Sources and Remarks
UJT 3	2N489B	GE	pn,si	6.0	2.0	0.51–0.62	3.0	4.7	8.0	4.0	60	TI, TO-5
	2N490B	GE	pn,si	6.0	2.0	0.51–0.62	3.0	6.2	8.0	4.0	60	TI, TO-5
	2N491B	GE	pn,si	6.0	2.0	0.56–0.68	3.0	4.7	8.0	4.3	60	TI, TO-5
	2N492B	GE	pn,si	6.0	2.0	0.56–0.68	6.2	6.2	8.0	4.3	60	TI, TO-5
	2N494B	GE	pn,si	6.0	2.0	0.62–0.75	3.0	6.2	8.0	4.6	60	TI, TO-5
	2N495B	GE	pn,si	6.0	2.0	0.62–0.75	3.0	4.7	8.0	4.6	60	TI, TO-5
	2N1671B	TI	pn,si	6.0	0.20	0.47–0.62	3.0	4.7	8.0	5.0	30	GE, TO-5
	2N4894	TI	pn,si	5.0	1.0	0.55–0.82	3.0	4.0	2.0	4.0	30	TO-92
	2N490C	GE	n,si	2.0	0.02	0.62–0.91	3.0	6.2	8.0	4.0	60	
	2N492C	GE	n,si	2.0	0.02	0.62–0.91	3.0	6.2	8.0	4.3	60	
	2N494C	GE	pn,si	2.0	0.02	0.62–0.75	3.0	6.2	8.0	4.6	60	TI, TO-5
	2N1671C	GE	pn,si	2.0	0.02	0.47–0.62	3.0	4.7	8.0	5.0	60	
	2N2647	GE	pn,si	2.0	0.20	0.68–0.82	6.0	4.7	8.0	2.0(typ)	30	MO, TO-18 (Planar)
	2N3980	TI	pn,si	2.0	0.01	0.68–0.82	6.0	4.0	1.0	3.0	30	TO-18 (Planar)
	2N4948	TI	pn,si	2.0	2.0	0.55–0.82	6.0	4.0	2.0	3.0	30	TO-18
	2N4949	TI	pn,si	1.0	2.0	0.74–0.86	3.0	4.0	2.0	3.0	30	TO-18

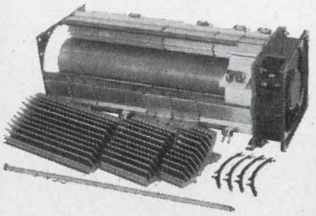
make or buy?

Your answer for
SEMICONDUCTOR
COOLING PACKAGES
could very well be . . .

Wakefield Customized Standards

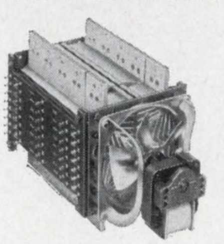
Confined Airflow Packages are custom engineered with modular "building block" sections combined in a variety of ways for the desired cooling system.

4 Confined Airflow Series:
FCA-700, 800, 820 and 900.



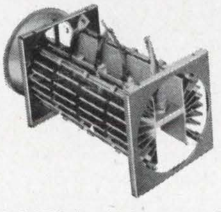
Modular assembly of an FCA-800.

Terminal board assemblies

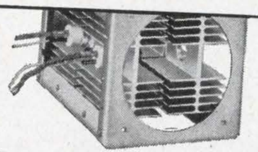


on a standard FCA-820 Package.

4 Open Airflow Series:
FCA-1000, 1100,
1122 and 1200.

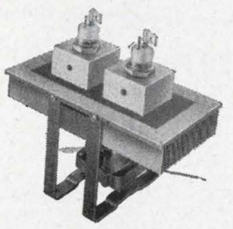


FCA-1000 for high power devices.



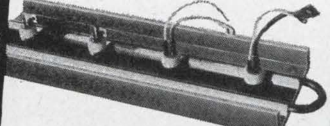
FCA-1122 utilizes 2 heat sinks.

Mounting blocks bonded on an FCA-1200



with thermally conductive adhesive.

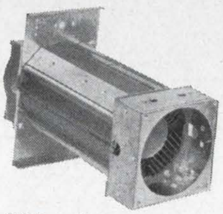
3 LIQUID COOLED PLATES:
LCP-10, 11 (below) and 20



with custom mounting accommodations.

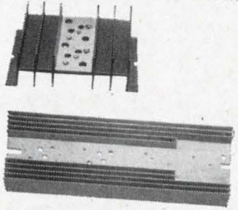
Wakefield Special Coolers or Assemblies

Engineered Cooling Package . . .



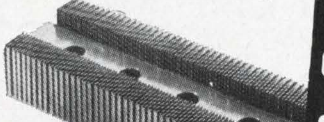
even outlet air cools semiconductors.

Unique hole and fin patterns on

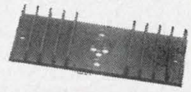


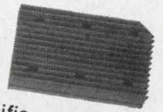
standard Series FSE Extrusions.

Special copper heat sinks.



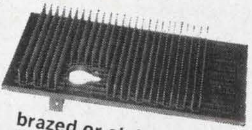
Extrusions designed for





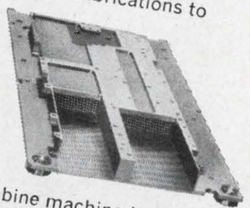
specific requirements.

Fins bonded, soldered,



brazed or staked.

Special fabrications to



combine machined parts with the heat sink extrusion.

**CATALOG
No. 17**

24 pages
of complete
technical
information

DELTA
DIVISION

WAKEFIELD
ENGINEERING, INC.
Wakefield, Massachusetts 01880
(617) 245-5900 • TWX 617-245-9213

ON READER-SERVICE CARD CIRCLE 73

Field-Effect

Type 1(a). Analog-switching

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	$r_{ds(on)}$ [Max.] (ohms)	$I_{D(off)}$ [Max.] (μA)	C_{dgs} or $*C_{sgs}$ or $\dagger C_{iss}$ [Max.] (pF)	BV_{GSS} or $*BV_{DSS}$ [Min.] (volts)	$V_{GS\,(off)}$ or $*V_{GS(TH)}$ [Max.] (volts)	g_{fs} [Min.-Max.] (μmhos)	I_{GSS} or $*I_{DGO}$ [max.] (nA)	I_{DSS} [Min.-Max.] (mA)	TO-	Alternate Sources and Remarks
FET 1	K1504	KMC	p,M,4	10000	10	4.5	25	–8	800	0.05	.05	18	
	2N3610	PH	p,M,4	3000	–	0.6	*–20	*–7	150 (min)	0.0002	0.00001	18	
	2N3376	SI	p,DP,F,3	1500	–.0004	3	30	5	800-2300	3	–(0.6–6.0)	72	
	2N3377	SI	p,DP,F,3	1500	–.0004	2	30	5	800-2300	3	–(0.6–6.0)	–	Flat pack
	C6692	CT	n,EP,F,3	1500	0.001	5	25	6	–	1.0	–	18	
FET 2	2N2497	TI	p,DP,F,3	1000	0.01	–	–	15	1000-2000	10	1-3	5	UC, SI
	2N3329	TI	p,DP,F,3	1000	–	–	–	5	1000-2000	10	1-3	72	UC, SI
	2N3460	AL	n,DPE,F,3	1000	–	6	50	2	1000-4500	–	0.2-1	18	DIC, SI, UC
	D1303	DIC	n,DPE,F,3	1000	–	6	25	2	1000-4500	–	0.2-1	18	
	DNX9	DIC	n,DPE,F,3	1000	–	6	50	2	1000-4500	–	0.2-1	18	
	TIXS11	TI	p,PL,M,3	1000	0.01	–	30	*3-6	800 (min)	0.003	–	72	
	2N2498	TI	p,DP,F,3	800	0.01	–	–	15	1500-3000	10	2-6	5	SI, UC
	2N3330	TI	p,DP,F,3	800	–	–	–	6	1500-3000	10	2-6	72	SI
	2N3378	SI	p,DP,F,3	750	–.0004	3	30	5	1500-2300	3	–(3–6)	72	
	2N3379	SI	p,DP,F,3	750	–.0004	2	30	5	1500-2300	3	–(3–6)	–	Flat pack
FET 3	2N3437	DIC	n,DPE,F,3	700	–	6	50	4	1500-6000	–	0.8-4	18	AL, SI
	2N3459	SI	n,DPE,F,3	700	–	6	50	4	1500-6000	–	0.8-4	18	AL
	2N4360	FA	p,DP,F,3	700	1	†5	20	10	2000-8000	10	3-30	18	
	C6690	CT	n,EP,F,3	700	0.001	5	30	10	–	1.0	–	18	
	C6691	CT	n,EP,F,3	700	0.001	5	25	10	–	1.0	–	18	
	D1184	DIC	n,DPE,F,3	700	–	6	40	4	1500-6000	–	0.8-4	18	
	D1302	DIC	n,DPE,F,3	700	–	6	25	4	1500-6000	–	0.8-4	18	
	DNX8	DIC	n,DPE,F,3	700	–	6	50	4	1500-6000	–	0.8-4	18	
	2N2499	TI	p,DP,F,3	600	–	–	–	15	2000-4000	10	0.5-15	5	SI
	2N3331	TI	p,DP,F,3	600	–	–	–	8	2000-4000	10	5-15	72	
FET 4	2N3380	SI	p,DP,F,3	600	–.0005	3	30	9.5	1500-2300	3	–(3–20)	72	
	2N3381	SI	p,DP,F,3	600	–.0005	2	30	9.5	1500-2300	3	–(3–20)	–	Flat pack
	2N3631	SI	n,M,3	550	–.0001	1.6	20	–6	1400-2800	–	2-10	18	
	2N4343	FA	p,DP,F,3	500	1	†5	25	10	4000-8000	10	10-30	18	
	2N3436	DIC	n,DPE,F,3	450	–	6	50	8	2500-10,000	–	3-15	18	AL, SI
	2N3458	SI	n,DPE,F,3	450	–	6	50	8	2500-10,000	0.25	3-15	18	AL
	D1183	DIC	n,DPE,F,3	450	–	6	40	8	2500-10,000	–	3-15	18	
	D1301	DIC	n,DPE,F,3	450	–	6	25	8	2500-10,000	–	3-15	18	
	DNX7	DIC	n,DPE,F,3	450	–	6	50	8	2500-10,000	–	3-15	18	
	2N4342	FA	p,DP,F,3	350	1	†5	25	5.5	2000-6000	10	4-12	18	
FET 5	2N4381	FA	p,DP,F,3	350	1	†5	25	1-5	2000-6000	1	10-30	18	
	2N4382	FA	p,DP,F,3	350	1	†5	25	2.5-9.0	4000-8000	1	10-30	18	
	2N3382	SI	p,DP,F,3	300	–.002	6	30	5	4500-12,500	15	–(3–30)	72	
	2N3383	SI	p,DP,F,3	300	–.002	5	30	5	4500-12,500	15	–(3–30)	–	Flat pack
	2N3608	PH	p,M,4	300	–	3	*–30	*–6	800 (min)	0.002	0.00003 (max)	5	
	2N3994	TI	p,DP,F,3	300	1.2	–	25	1-5.5	4000-10,000	1.2	2 (min)	72	
	DE1004	PH	p,M,4	300	–	3.5	*–20	*–8	600 (min)	1000	0.0001	18	
	F10049	FA	p,DP,M,6	270	0.001	0.7	30	–6	2000 (min)	–	1000	–	
	2N3824	TI	n,EP,F,3	250	0.1	–	30	8	–	0.1	–	72	UC, SI
	CM640	CT	n,EP,F,3	250	0.001	5	20	1.5	–	0.4	0.5 (min)	18	
FET 6	UC401	UC	p,F,3	250	.0001	4	30	8	–	0.1	8 (min)	72	
	2N3966	AL	n,DP,F 3	220	0.001	1.5	30	6.0	–	0.1	2 (min)	18	
	M103	SI	p,M,4	200	–0.0002	4	–30	–6	–	–0.1	–	72	
	HA2010	HU	p,M,4	200	1000	1	*–35	*5	1000-2000	0	–	72	
	U139D	SI	p,DP,F,6	200	–.002	6	20	10	5000 (min)	10	–(4–50)	5	Dual
	2N3384	SI	p,DP,F,3	180	–.002	6	30	5	7500-12,500	15	–(15–30)	72	
	2N3385	SI	p,DP,F,3	180	–.002	5	30	5	7500-12,500	15	–(15–30)	–	Flat pack
	2N3386	SI	p,DP,F,3	150	–.0025	6	30	9.5	7500-15,000	15	–(15–50)	72	
	2N3387	SI	p,DP,F,3	150	–.0025	5	30	9.5	7500-15,000	15	–(15–50)	–	Flat pack
	2N3993	TI	p,DP,F,3	150	1.2	–	25	4-9.5	6000-12,000	1.2	10 (min)	72	
FET 7	TIS05	TI	p,DP,F,3	150	2	5	25	10	6000-12,000	2	10-45	72	
	U139	SI	p,DP,F,6	150	–.0025	6	30	7	7000 (min)	10	–(9–35)	5	Dual
	UC451	UC	p,F,3	150	.00025	6	25	6	–	0.25	3.75-37.5	18	
	M511	SI	p,M,4	150 (typ)	–0.01	4	–30	–6	–	–1	–	72	
	2N3972	SI	p,DPE,F,3	100	0.25	†25	40	–3	–	*0.25	5-30	18	AL
	2N4393	UC	n,EP,F,3	100	0.0001	14	–40	–3	–	–0.1	5-30	18	
	UC201	UC	n,F,3	100	.00025	6	50	8	–	0.25	15 (min)	72	
	2N4093	AL	n,DP,F,3	80	.00002	5.0	40	5.0	–	0.2	8 (min)	18	
	CM600	CT	n,EP,F,3	75	0.003	15	10	7	10-30000	3	–	18	
	UC251	UC	n,F,3	75	.001	6	30	6	–	1	7.5-75	18	
FET 8	TIS42	TI	n,EP,F,3	70	0.005	†18	25	10	–	5	10 (min)	92	
	TIXS42	TI	n,EP,F,3	70	5	–	25	10	–	–	10 (min)	92	
	2N3971	SI	n,DPE,F,3	60	.00025	†25	40	–5	–	*0.25	25-75	18	AL
	2N4392	UC	n,EP,F,3	60	0.0001	14	–40	–5	–	–0.1	25-75	18	
	2N4858	TI	n,EP,F,3	60	0.00025	†18	40	4	–	0.25	8-80	18	
	2N4861	TI	n,EP,F,3	60	0.00025	†18	30	4	–	0.25	8-80	18	
	MFE2133	MO	n,DP,F,3	60	0.001	†20	30	–	12,000	*1	25 (min)	39	
	TIXS33	TI	n,EP,F,3	60	1	–	30	10	12000 (min)	–	25 (min)	72	
	UC450	UC	p,F,3	60	.00025	6	25	10	–	0.25	25-75	18	
	2N4092	AL	n,DP,F,3	50	.00002	5.0	40	7.0	–	0.2	15 (min)	18	

Field-Effect *(continued)*

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	$r_{ds(on)}$ [Max.] (ohms)	$I_{D(off)}$ [Max.] (μA)	C_{dgs} or $*C_{sgs}$ or $\dagger C_{iss}$ [Max.] (pF)	BV_{GSS} or $*BV_{DSS}$ [Min.] (volts)	$V_{GS\,(off)}$ or $*V_{GS(TH)}$ [Max.] (volts)	g_{fs} [Min.-Max.] (μmhos)	I_{GSS} or $*I_{DGO}$ [max.] (nA)	I_{DSS} [Min.-Max.] (mA)	TO-	Alternate Sources and Remarks
FET 9	CM601	CT	n,EP,F,3	50	0.003	15	15	10	10-30000	3	–	18	
	CM602	CT	n,EP,F,3	50	0.003	15	30	10	10-30000	10	–	18	
	CM642	CT	n,EP,F,3	50	0.001	5	20	3.0	–	0.4	10 (min)	18	
FET 10	TIXS36	TI	n,EP,F,4	50	–	–	30	10	10,000-20,000	10	10,000	18	
	2N4857	TI	n,EP,F,3	40	0.00025	†18	40	6	–	0.25	20-100	18	
	2N4860	TI	n,EP,F,3	40	0.00025	†18	30	6	–	0.25	20-100	18	
	U182	SI	n,DPE,F,3	40	.00025	†25(Ciss)	40	–10	–	*0.25	50-150	18	
	CM603	CT	n,EP,F,3	35	0.003	15	15	10	20-60000	3	–	18	
	CM643	CT	n,EP,F,3	35	0.001	5	20	5.0	–	0.4	50 (min)	18	
	2N4091	AL	n,DP,F,3	30	.00002	5.0	40	10	–	0.2	30 (min)	18	
	2N4391	UC	n,EP,F,3	30	0.0001	14	–40	–10	–	–0.1	50-150	18	
	CM646	CT	n,EP,F,3	30	0.001	5	25	7.0	–	0.4	30 (min)	18	
	UC250	UC	n,F,3	30	.001	6	30	10	–	0.1	50-150	18	
FET 11	TIXS41	TI	n,EP,F,3	25	0.5	–	30	10	–	0.2	50 (min)	18	
	2N4856	TI	n,EP,F,3	25	0.00025	†18	40	10	–	0.25	50 (min)	18	
	2N4859	TI	n,EP,F,3	25	0.00025	†18	30	10	–	0.25	50 (min)	18	
	CM647	CT	n,EP,F,3	25	0.001	5	25	10	–	0.4	50 (min)	18	
	TIS41	TI	n,EP,F,3	25	0.0005	†18	30	10	–	0.2	50 (min)	18	
	2N4448	CT	n,ED,F,3	12	0.003	20	20	10	100,000	3.0	100 (min)	46	
	2N4446	CT	n,EP,F,3	10	0.003	20	25	10	100,000	3.0	100 (min)	46	
	2N4447	CT	n,EP,F,3	6	3.0	20	20	10	150,000	3.0	150 (min)	46	
	2N4445	CT	n,EP,F,3	5	0.003	20	25	10	150,000	3.0	150 (min)	46	
	2N2386	TI	p,DP,F,3	–	0.01	–	–	8	1000 (min)	10	–	5	DIC, SI
FET 12	2N2500	Ti	p,DP,F,3	–	–	–	–	15	1000-2200	10	1-6	5	
	2N3277	FA	p,DP,F,3	–	1	4.5	25	5	100	0.4	0.15-0.50	33	
	2N3278	FA	p,DP,F,3	–	1	4.5	25	8	200	0.4	0.40-0.90	33	
	2N3332	TI	p,DP,F,3	–	–	–	–	6	1000-2200	10	1-6	72	
	2N3796	MO	n,DP,M,3	–	–	0.8	*25	–4	900-1800	–0.001	0.5-3	18	
	2N3797	MO	n,DP,M,3	–	–	0.8	*25	–4	1500-3000	–0.001	4-6	18	
	2N3819	TI	n,EP,F,3	–	–	–	25	8	2000-6500	2	2-20	92	
	2N3820	TI	p,PL,F,3	–	–	–	20	8	800-5000	20	0.3-15	92	
	2N3821	TI	n,EP,F,3	–	–	–	50	4	1500-4500	0.1	0.5-2.5	72	MO, SI
	2N3822	TI	n,EP,F,3	–	–	–	50	6	3000-6500	0.1	2-10	72	MO, SI
FET 13	2N3823	TI	n,EP,F,3	–	–	–	30	8	3500-6500	0.5	1-7.5	72	SI
	2N3909	TI	p,PL,F,3	–	–	–	20	0.3-7.9	1000-5000	10	0.3-15	72	SI
	2N4220	SI	n,DP,F,3	–	–	2	–30	–4	1000-4000	–0.1	0.5-3	72	
	2N4221	SI	n,DP,F,3	–	–	2	–30	–6	2000-5000	–0.1	2-6	72	
	2N4222	SI	n,DP,F,3	–	–	2	–30	–8	2500-6000	–0.1	5-15	72	
	3N124	MO	n,DP,F,3	–	–	2	–50	–2.5	500-2000	–0.25	0.2-2	72	
	3N125	MO	n,DP,F,4	–	–	2	–50	–4.0	800-2400	–0.25	1.5-4.5	72	
	3N126	MO	n,DP,F,4	–	–	2	–50	–6.5	1200-3600	–0.25	3.0-9.0	72	
	MFE2093	MO	n,DP,F,3	–	–	2	–50	–2.5	250-500	–0.1	0.1–0.7	72	
	MFE2094	MO	n,DP,F,3	–	–	2	–50	–4.5	350-700	–0.1	0.4-1.4	72	
FET 14	MFE2095	MO	n,DP,F,3	–	–	2	–50	–5.5	400-800	–0.1	1-3	72	
	TIS14	TI	n,EP,F,3	–	–	–	30	6.5	1000-7500	1	0.5-15	72	
	TIS34	TI	n,EP,F,3	–	–	–	30	1-8	3500-6500	5	4-20	92	
	TIXS35	TI	n,EP,F,4	–	–	–	30	1-5	10,000-20,000	10	10-50	72	

Field-Effect *(continued)*

Type 1(b). Digital-switching

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	$V_{GS(TH)}$ or $*V_P$ [Min.-Max.] (volts)	$r_{ds\,(on)}$ [Max.] ohms	I_{DSS} [Min.-Max.] (mA)	I_{GSS} or $*I_{DGO}$ [Max.] (nA)	BV_{GSS} or $*BV_{DSS}$ or $\dagger BV_{DSX}$ [Min.] (volts)	C_{rss} [Max.] (pF)	C_{iss} [Max.] (pF)	$t_{on} + t_{off}$ [Max.] (μs)	TO-	Alternate Sources and Remarks
FET 15	2N2497	TI	p,DP,F,3	15 (max)	1000	1-3	10	–	–	32	–	5	SI
	2N2498	TI	p,DP,F,3	15 (max)	800	2-6	10	–	–	32	–	5	SI
	2N2499	TI	p,DP,F,3	15 (max)	600	5-15	10	–	–	32	–	5	SI
	2N2500	TI	p,DP,F,3	15 (max)	–	1-6	10	–	–	32	–	5	
FET 16	2N3970	UC	n,F,3	10 (max)	30	50-150	0.25	40	6	25	50	18	AL, SI
	2N4343	FA	p,DP,F,3	*10	350	10-30	10	25	5	20	–	18	
	2N4360	FA	p,DP,F,3	*10	700	3-30	10	20	5	20	–	18	
	TIS05	TI	p,DP,F,3	10 (max)	150	10-45	2	25	–	12	–	72	
	TIS41	TI	n,EP,F,3	*10 (max)	25	50 (min)	0.2	30	8	18	–	18	
	TIS42	TI	n,EP,F,3	*10 (max)	70	10 (min)	5	25	9	18	–	92	
	TIXS33	TI	n,EP,F,3	10 (max)	60	25 (min)	–	30	5	20	–	72	
	TIXS41	TI	n,EP,F,3	10 (max)	25	50 (min)	0.2	8	18	–	18		
	TIXS42	TI	n,EP,F,3	10 (max)	70	10 (min)	–	25	9	18	–	92	
FET 17	2N2386	TI	p,DP,F,3	8 (max)	–	–	10	–	–	50	–	5	DIC, SI
	2N3331	TI	p,DP,F,3	8 (max)	600	5-15	10	–	–	20	–	72	SI
	2N3819	TI	n,EP,F,3	8 (max)	–	2-20	2	25	4	8	–	92	
	2N3820	TI	p,PL,F,3	8 (max)	–	0.3-15	20	20	16	32	–	92	
	2N3823	TI	n,EP,F,3	8 (max)	–	1-7.5	0.5	30	2	6	–	72	SI, MO
	2N3824	TI	n,EP,F,3	8 (max)	250	–	0-1	50	3	6	–	72	SI
	M101	SI	n,M,4	*–8 (max)	300 (typ)	4-12	–	†20	–	7.5	–	18	
	TIS14	TI	n,EP,F,3	6.5 (max)	–	0.5-15	1	30	4	8	–	72	
FET 18	2N3330	TI	p,DP,F,3	6 (max)	800	2-6	10	–	–	20	–	72	SI
	2N3332	TI	p,DP,F,3	6 (max)	–	1-6	10	–	–	20	–	72	
	2N3631	SI	n,M,4	*–6 (max)	550	2-10	–	†20	1.6	7.5	–	18	
	2N4342	FA	p,DP,F,3	*5.5	700	4-12	10	25	5	20	–	18	
	2N3329	TI	p,DP,F,3	5 (max)	1000	1-3	10	–	–	20	–	72	SI
	2N3971	UC	n,F,3	5 (max)	60	25-75	0.25	40	6	25	90	18	AL, SI
	MI00	SI	n,M,4	*–5 (max)	350 (typ)	1.5-4.5	–	†20	–	7.5	–	18	
	2N4856	TI	n,EP,F,3	*4-10	25	50 (min)	0.25	40	8	18	0.031	18	
	2N4859	TI	n,EP,F,3	*4-10	25	50 (min)	0.25	30	8	18	0.031	18	
FET 19	U182	SI	n,DPE,F,3	*– (4-10)	40	50-150	*0.25	40	6	25	50	18	
	2N3993	TI	p,DP,F,3	4-9.5	150	10 (min)	1.2	25	4.5	16	–	72	
	2N3608	PH	p,M,4	– (4-6)	300	0.00003	0.002	–30	–	–	–	5	
	HA2000	HU	p,M,4	4-5	200	–	–	*–35	1	8	0.003	72	
	2N3821	TI	n,EP,F,3	4 (max)	–	0.5-2.5	0.1	50	3	6	–	72	SI
	TIXS36	TI	n,EP,F,4,4	3-10	50	40-200	10	30	5	12	–	72	
	DE1004	PH	p,M,4	– (3-8)	300	0.0001	1000	*–20	3	10	–	18	
	2N4066	FA	p,EP,M,6	3-6	500	0.001	0.0025	30	1.5	7	0.01	76	
	2N4067	FA	p,EP,M,6	3-6	250	0.001	0.0025	30	1.5	7	0.01	76	
	2N4267	FA	p,EP,M,4	3-6	250	0.001 (max)	0.005	30	3	15	–	72	
FET 20	2N4268	FA	p,EP,M,4	3-6	125	0.001 (max)	0.005	30	3	15	–	72	
	FI-0049	FA	p,EP,M,6	3-6	500	0.001 (max)	0.0025	30	0.7 (typ)	0.5 (typ)	–	–	
	TIXS11	TI	p,PL,M,4	3-6	250-1000	–	0.003	30	3	8	–	72	
	2N3972	UC	n,F,3	3 (max)	100	5-30	0.25	40	6	25	180	18	AL, SI
	2N4382	FA	p,DP,F,3	*2.5-9.0	350	10-30	1	25	5	20	–	18	
	FI-100	FA	p,EP,M,4	2.5-6.0	1000	–	0.0025	30	1.0	3.5	–	72	
	2N4857	TI	n,EP,F,3	*2-6	40	20-100	0.25	40	8	18	0.056	18	
	2N4860	TI	n,EP,F,3	*2-6	40	20-100	0.25	30	8	18	0.056	18	
	2N3971	SI	n,DPE,F,3	*–(2-5)	60	25-75	*0.25	40	6	25	90	18	AL
FET 21	2N3994	TI	p,DP,F,3	1-5.5	300	2 (min)	1.2	25	5	16	–	72	
	2N4352	MO	p,DP,M,4	1.5-6	600	0-0.005	0.010	*–25	2.5	6.5	0.35	72	
	2N4351	MO	n,DP,M,3	1.5	300	0-0.01	0.01	*25	2.5	5.5	0.22	72	
	2N4381	FA	p,DP,F,3	*1-5	350	10-30	1	25	5	20	–	18	
	TIXS35	TI	n,EP,F,4	1-5	–	10-50	10	30	5	12	–	72	
	TIS34	TI	n,EP,F,3	1-8	–	4-20	5	30	2	6	–	92	
	2N4858	TI	n,EP,F,3	*0.8-4	60	8-80	0.25	40	8	18	0.110	18	
	2N4861	TI	n,EP,F,3	*0.8-4	60	8-80	0.25	30	8	18	0.110	18	
	2N3972	SI	n,DPE,F,3	*– (0.5-3)	100	5-30	*0.25	40	6	25	180	18	
	2N3909	TI	p,PL,F,3	0.3-7.9	–	0.3-15	10	20	16	32	–	72	SI
	2N3824	MO	n,DP,F,3	–	250	–	–0.1	–50	3	6	–	72	SI
FET 22	2N4065	FA	p,EP,M,4	–	1500	0.0005 (max)	0.0025	30	0.7	4.5	0.65	72	
	2N4120	FA	p,EP,M,4	–	1000	0.0005 (max)	0.0025	30	0.7	4.5	0.65	72	
	2N4220	MO	n,DP,F,3	–	–	0.5-3	–0.1	–30	2	6	–	72	SI
	2N4221	MO	n,DP,F,3	–	–	2-6	–0.1	–30	2	6	–	72	SI
	2N4222	MO	n,DP,F,3	–	–	5-15	–0.1	–30	2	6	–	72	SI
	3N124	MO	n,DP,F,4	–	–	0.2-2.0	–0.25	–50	2.0	14	–	72	
	3N125	MO	n,DP,F,4	–	–	1.5-4.5	–0.25	–50	2.0	14	–	72	
	3N126	MO	n,DP,F,4	–	–	3.0-9.0	–0.25	–50	2.0	14	–	72	
	MFE2093	MO	n,DP,F,3	–	–	0.1-0.7	–0.1	–50	2	6	–	72	
	MFE2094	MO	n,DP,F,3	–	–	0.4-1.4	–0.1	–50	2	6	–	72	
	MFE2095	MO	n,DP,F,3	–	–	1.0-3.0	–0.1	–50	2	6	–	72	

Complete listing of semiconductor manufacturers starts on page 86.
Circle as many numbers on the reader-service card as you like.

Design Data from Schweber

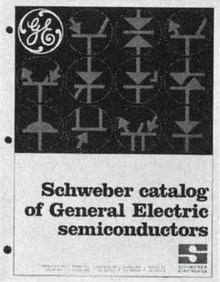
Fairchild Semiconductors

This condensed catalog presents the most complete line of advanced silicon planar and planar epitaxial devices in the industry. High performance transistors, dual transistors, differential amplifiers, and microminiature devices for the full range of military commercial-industrial and consumer product applications.

Schweber Electronics
Westbury, New York 11591
516-334-7474

171

General Electric Semiconductors

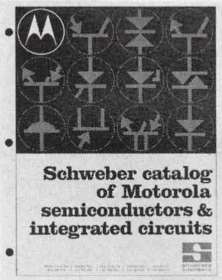


The Schweber catalog of G.E. semiconductors lists the major specifications of a broad product range. Also special products to meet individual needs include tunnel diodes, light emitting diodes, light activated SCR's, unijunction transistors, etc. Fifty-five pages of G.E. product innovation.

Schweber Electronics
Westbury, New York 11591
516-334-7474

172

Motorola Semiconductors



New 1967 condensed catalog of Motorola Semiconductors and Integrated Circuits just off the press. There are 20 sections in this 36-page catalog — from Integrated Circuits to Photo-sensitive Detectors, and between these the famous Motorola Zener diodes, and others. One of the industry's deepest and broadest line of semiconductors condensed in this single catalog.

Schweber Electronics
Westbury, New York 11591
516-334-7474

173

Union Carbide FET'S & OP Amps

10-page catalog featuring Union Carbide's complete line of Field Effect Transistors. 150 different types are listed emphasizing the best in FET characteristics. Also included are a wide range of modular solid state operational amplifiers.

Schweber Electronics
Westbury, New York 11591
516-334-7474

174

Westinghouse Semiconductors

20-page catalog of silicon high-power transistors, high voltage and high-power thyristor assemblies, SCR's up to 300 amps at 1200 volts low and high-power rectifiers, also fast switching type and the famous "OEM" low cost rectifiers up to 400 amps at 600 volts.

Schweber Electronics
Westbury, New York 11591
516-334-7474

175

Microwave Diodes By Micro Optics

Data sheets listing silicon point contact diodes with higher power ratings. Included are stripline mixer and video detectors, varactors for parametric amplifiers, gallium arsenide diodes, PIN microwave switching diodes, step recovery diodes and others.

Schweber Electronics
Westbury, New York 11591
516-334-7474

176

Field-Effect *(continued)*

Type 2(a). Low-drift, single-ended dc amplifiers

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I_{DX} [Min.-Max.] (mA)	g_{fsx} [Min.-Max.] (μmhos)	I_{GX} or $^*I_{GSS}$ [Max.] (nA)	BV_{GSS} or $^*BV_{DSS}$ [Min.] (volts)	V_{GSX} or $^*V_P$ [Min.-Max.] (volts)	g_{osx} [Max.] (μmhos)	C_{iss} [Max.] (pF)	NF [Max.] dB at (f in KHz / R_{gen} in KΩ)	TO-	Alternate Sources and Remarks
FET 23	2N3112	SI	p,DP,F,3	.008 (typ)	20	*0.05	20	0.4-3.5	–	2	–	–	
	2N3113	SI	p,DP,F,3	.008 (typ)	20 (typ)	*0.05	20	0.4-3.5	–	3.5	–	18	
	2N2606	SI	p,DP,F,3	.01 (typ)	40 (typ)	*1	30	0.4-3.5	–	6	–	18	AL, DIC
	2N2841	SI	p,DP,F,3	.014 (typ)	50 (typ)	–	30	1.2 (max)	–	6	3 (1/10000)	18	
FET 24	2N2607	SI	p,DP,F,3	.03 (typ)	120 (typ)	*3	30	0.4-3.5	–	10	–	18	AL, DIC
	2N2842	SI	p,DP,F,3	.04 (typ)	150 (typ)	–	3	1.2 (max)	–	10	3 (1/10000)	18	
	2N2608	SI	p,DP,F,3	.1 (typ)	370 (typ)	*10	30	0.4-3.5	–	17	–	18	AL
	MFE2093	MO	n,DP,F,3	0.1-0.7	250-500	–0.1	–50	–2.5	1.5	6	–	72	
	2N2843	SI	p,DP,F,3	0.12 (typ)	450 (typ)	–	30	1.2 (max)	–	17	3 (1/1000)	18	
	3N124	MO	n,DP,F,4	0.2-2	500-2000	–0.25	–50	–2.5	2	14	–	72	
	2N2609	SI	p,DP,F,3	0.27 (typ)	1200 (typ)	*30	30	0.4-3.5	–	30	–	18	AL
	2N3820	TI	p,PL,F,3	0.3-15	800-5000	20	20	8 (max)	–	32	–	92	
	2N3909	TI	p,PL,F,3	0.3-15	1000-5000	10	20	0.3-7.9	–	32	–	72	SI
FET 25	2N2844	SI	p,DP,F,3	0.4 (typ)	1400 (typ)	–	30	1.2 (max)	–	30	3 (1/1000)	18	
	MFE2094	MO	n,DP,F,3	0.4-1.4	350-700	–0.1	–50	–4.5	3.0	6	–	72	
	2N3969	AL	n,DP,F,3	0.4-2.0	1300 (min)	0.1	30	*1.7 (typ)	5.0	5.0	1.5 (0.1/1000)	18	
	2N3821	TI	n,EP,F,3	0.5-2.5	1500-4500	0.1	50	4 (max)	–	6	5 (0.01/1000)	72	SI
	2N3796	MO	n,DP,M,3	0.5-3	900-1800	–0.001	*25	–4	25	7	–	18	
	2N4220	MO	n,DP,F,3	0.5-3	1000-4000	–0.1	–30	–4	10	6	–	72	SI
	TIS14	TI	n,EP,F,3	0.5-15	1000-7500	1	30	65 (max)	–	8	–	72	
	2N2497	TI	p,DP,F,3	1-3	1000-2000	10	–	15 (max)	–	32	–	5	SI
	2N3329	TI	p,DP,F,3	1-3	1000-2000	10	–	5 (max)	–	20	3 (1/1000)	72	SI
	MFE2095	MO	n,DP,F,3	1.0-3.0	400-800	–0.1	–50	–5.5	10	6	–	72	
FET 26	2N3968	AL	n,DP,F,3	1.0-5.0	2000 (min)	0.1	30	*3 (typ)	15	5.0	1.5 (0.1/1000)	18	
	2N2500	TI	p,DP,F,3	1-6	1000-2200	10	–	15 (max)	–	32	–	5	
	2N3332	TI	p,DP,F,3	1-6	1000-2200	10	–	6 (max)	–	20	1 (1/1000)	72	
	2N3823	TI	n,EP,F,3	1-7.5	3500-6500	0.5	30	8 (max)	–	6	2.5 (100000/1)	72	
	3N125	MO	n,DP,F,4	1.5-4.5	800-2400	–0.25	–50	–4.0	10	14	–	72	
	2N3994	TI	p,DP,F,3	2 (min)	4000-10,000	1.2	25	1-5.5	–	16	–	72	
	2N2498	TI	p,DP,F,3	2-6	1500-3000	10	–	15 (max)	–	32	–	5	SI
	2N3330	TI	p,DP,F,3	2-6	1500-3000	10	–	6 (max)	–	20	3-1-1000	72	SI
	2N3797	MO	n,DP,M,3	2-6	1500-3000	–0.001	*25	–4	60	8	–	18	
	2N4221	MO	n,DP,F,3	2-6	2000-5000	–0.1	–30	–6	20	6	–	72	SI
FET 27	2N3822	TI	n,EP,F,3	2-10	3000-6500	0.1	50	6 (max)	–	6	5(0.01/1000)	72	MO, SI
	2N3819	TI	n,EP,F,3	2-20	2000-6500	2	25	8 (max)	–	8	–	92	
	2N3967	AL	n,DP,F,3	2.5-10	2500 (min)	0.1	30	*2.0-5.0	35	5.0	1.5 (0.1/1000)	18	
	3N126	MO	n,DP,F,4	3-9	1200-3600	–0.25	–50	–6.5	20	14	–	72	
	2N4360	FA	p,DP,F,3	3-30	2000-8000	*10	20	*10	–	5	1.5(0.1/10)	18	
	2N4342	FA	p,DP,F,3	4-12	2000-6000	*10	25	*5.5	–	5	1.5(0.1/10)	18	
	TIS34	TI	n,EP,F,3	4-20	3500-6500	5	30	1-8	–	6	–	92	
	2N2499	TI	p,DP,F,3	5-15	2000-4000	10	–	15 (max)	–	32	–	5	SI
	2N3331	TI	p,DP,F,3	5-15	2000-4000	10	–	8 (max)	–	20	4 (1/1000)	72	SI
FET 28	2N4222	MO	n,DP,F,3	5-15	2500-6500	–0.1	–30	–8	40	6	–	72	SI
	2N4343	FA	p,DP,F,3	10-30	4000-8000	*10	25	*10	–	5	1.5(0.1/10)	18	
	2N4381	FA	p,DP,F,3	10-30	2000-6000	*1	25	*1-5	–	5	3(10/0.4)	18	
	2N4382	FA	p,DP,F,3	10-30	4000-8000	*1	25	*2.5-9.0	–	5	3(10/0.4)	18	
	TIXS35	TI	n,EP,F,4	10-50	10,000-20,000	10	30	1-5	–	12	–	72	
	TIXS36	TI	n,EP,F,4	40-200	10,000-20,000	10	30	3-10	–	12	–	72	
	2N2386	TI	p,DP,F,3	–	1000 (min)	10	–	8 (max)	–	50	–	5	DIC SI
	HA2020	HU	p,M,4	–	1000-2000	0	*–35	80 (min)	–	8.0	2(5000/.05)	72	
	TIXS11	TI	p,PL,m,3	–	800 (min)	0.003	30	3-6	–	8	–	72	

Circle as many numbers on the reader-service card as you like.

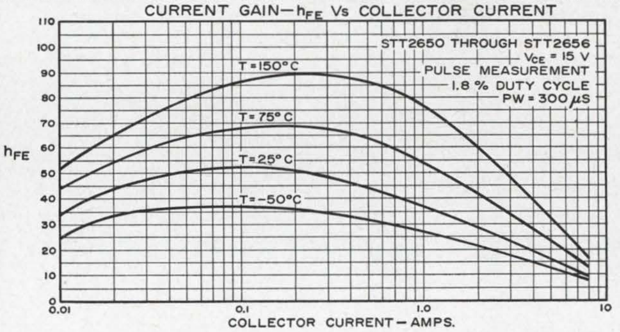
Valuable reprints are FREE if you circle them on the reader-service card.

Get detailed spec sheets and application notes: use the reader-service card!

Reader-Service cards are good all year.

NEW TRIPLE DIFFUSED PLANAR

Silicon Transistor Corporation is now a major source for triple diffused planar NPN silicon power transistors. The new STT2650—STT2656 25 MHz series is immediately available from stock at low prices. They have a voltage range of 30V—150V, maximum T_j is 175°C, C_{ob} is 200pf and they are packaged in a T0-61 case. Prices for this series range from $12 to $36 per unit on orders of 100. High power high frequency inverters and converters, switching type regulated power supplies and power linear amplifiers are just a few applications. For further information, call or write today.



TRIPLE DIFFUSED PLANAR—NPN

	V_{CEO}	V_{CBO}	V_{EBO}	$I_C$max.	Pmax. (100°C)	V_{BE}(sat)	V_{CE}(sat)	h_{FE}	$f_{t(typ)}$	I_{CES}	
	Volts	Volts	Volts	Amps	Watts	Volts	Volts	—	MHz	Volts	μA
STT 2650	150	150	12	7.5	75	1.3	0.6	30-90	25	60	1
STT 2651	120	140	12	7.5	75	1.3	0.6	30-90	25	60	1
STT 2652	120	140	12	7.5	75	1.3	0.6	50-150	25	60	1
STT 2653	100	120	12	7.5	75	1.3	0.6	30-90	25	60	1
STT 2654	80	100	12	7.5	75	1.3	0.6	30-90	25	60	1
STT 2655	60	75	10	7.5	75	1.3	0.6	30-90	25	40	1
STT 2656	30	40	10	7.5	75	2.0	1.0	25	25	20	500
CONDITIONS I_C	200mA	5mA	10mA			2A	2A	2A	0.15A		
I_B						0.2A	0.2A				
V_{CE}								15V	15V		

Silicon Transistor Corporation produces the broadest line of silicon power transistors in the Industry.

SILICON TRANSISTOR CORPORATION

Executive offices and main plant: EAST GATE BLVD., GARDEN CITY, N. Y. 11530 (516) Pioneer 2-4100, TWX 510-222-8258

ON READER-SERVICE CARD CIRCLE 75

Field-Effect *(continued)*

Type 2(b). Differential dc amplifiers

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	$\frac{\Delta V_{GS}}{\Delta T}$ [Max.] (μvolts/°C)	$V_{GS1}-V_{GS2}$ [Max.] (volts)	BV_{gss} or $*BV_{DSS}$ [Min.] (volts)	V_P or $*V_{GS\,(off)}$ [Min. - Max.] (volts)	I_{GSS} or $*I_{GX}$ [Max.] (nA)	I_{DSS} [Min. - Max.] (mA)	I_{G1} - I_{G2} [Max.] (nA)	g_{fsx} [Min. - Max.] (μmhos)	TO-	Alternate Sources and Remarks
FET 29	2N3336	TI	p,DP,F,6	520	0.050	20	0.3-1.6	10	0.3-1	200	600-1800	89	UC
	2N3335	TI	p,DP,F,6	280	0.040	20	0.3-1.6	10	0.3-1	100	600-1800	89	UC
	TIS27	TI	n,EP,F,6	210	0.015	50	6 (max)	0.25	0.5-8	10	1500-6000	5	
	2N3334	TI	p,DP,F,6	200	0.020	20	0.3-1.6	10	0.3-1	50	600-1800	89	UC
	TIS26	TI	n,EP,F,6	140	0.010	50	6 (max)	0.25	0.5-8	10	1500-6000	5	
FET 30	3N97	SI	p,DP,F,6	106	0.2	30	3.3	5	−0.5-2.5	3	250-500	5	
	2N3958	UC	n,PL,F,6	100	0.025	50	1.0-4.5	0.0001	0.5-5.0	10	1000-3000	71	
	MEM551	GI	p,MOS,C,7	100	0.200	*30	3-6	0.004	10nA	–	500 (min)	77	
	2N3333	TI	p,DP,F,6	80	0.015	20	0.3-1.6	10	0.3-1	50	600-1800	89	
	2N3957	UC	n,PL,F,6	75	0.020	50	1.0-4.5	0.1	0.5-5.0	10	1000-3000	71	
	TIS25	TI	n,EP,F,6	70	0.005	50	6 (max)	0.25	0.5-8	10	1500-6000	5	
	SU2079	AL	n,F,6	60	0.015	50	4 (max)	0.25	0.25-2	–	300 (min)	18	
	SU2081	AL	n,DP,F,6	60	0.015	50	4 (typ)	0.5	1.0-10	–	1500 (min)	18	
	2N3935	AL	n,DP,F,6	50	0.005	50	3 (typ)	0.1	0.25-1.3	–	300 (min)	18	UC
	2N3956	UC	n,PL,F,6	50	0.015	50	1.0-4.5	0.1	0.5-5.0	10	1000-3000	71	
FET 31	SU2078	AL	n,F,6	35	0.015	50	4 (max)	0.25	0.25-2	–	300 (min)	18	
	SU2080	AL	n,DP,F,6	35	0.015	50	4 (typ)	0.5	1.0-10	–	1500 (min)	18	
	2N3922	AL	n,DP,F,6	25	0.005	50	3 (typ)	0.25	1.0-10	–	1500 (min)	18	
	2N3955	UC	n,PL,F,6	25	0.010	50	1.0-4.5	0.0001	0.5-5.0	10	1000-3000	71	
	2N4083	AL	n,DP,F,6	25	0.015	50	3 (typ)	0.1	0.25-1.3	–	300 (min)	18	
	2N4085	AL	n,DP,F,6	25	0.015	50	3 (typ)	0.25	1.0-10	–	1500 (min)	18	
	3N96	SI	p,DP,F,6	13	0.1	30	3.3 (typ)	5	−0.5-2.5	1.0	250-500	5	
	2N3921	AL	n,DP,F,6	10	0.005	50	3 (typ)	0.25	1.0-10	–	1500 (min)	18	UC
	2N3934	AL	n,DP,F,6	10	0.005	50	3 (typ)	0.1	0.25-1.3	–	300 (min)	18	UC
	2N3954	UC	n,PL,F.6	10	0.005	50	1.0-4.5	0.0001	0.5-5.0	10	1000-3000	71	
FET 32	2N4082	AL	n,DP,F,6	10	0.015	50	3 (typ)	0.1	0.25-1.3	–	300 (min)	18	
	2N4084	AL	n,DP,F,6	10	0.015	50	3 (typ)	0.25	1.0-10	–	1500 (min)	18	

Need a FREE personal copy of this Directory? Circle number **419.**

Complete listing of semiconductor manufacturers starts on page 86.

Valuable reprints are FREE if you circle them on the reader-service card.

Type 3(a). General-purpose ac amplifiers

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I_{DSS} [Min.-Max.] (mA)	g_{fs} [Min.-Max.] (μmhos)	V_P or $*V_{GS\,(off)}$ [Min.-Max.] (volts)	I_{GSS} [Max.] (nA)	BV_{GSS} or $*BV_{DSS}$ or $\dagger BV_{DGO}$ [Min.] (volts)	C_{iss} [Max.] (pF)	C_{rss} [Max.] (pF)	g_{oss} [Max.] (μmhos)	TO-	Alternate Sources and Remarks
FET 33	2N4353	GI	p,MOS,C,4	5nA	1000-4000	3-5	1.0	*30	12	4	350	72	
	MEM511	GI	p,MOS,C,4	10nA	1000 (min)	3-6	1.0	*30	8	3	350	72	
	MEM520	GI	p,MOS,C,4	10nA	1000 (min)	3-6	0.003	*30	8	3	350	72	
	517	GI	p,MOS,C,4	50nA	10,000 (min)	2.5-5.0	1.0	*30	25	10	–	33	
	UC852	UC	p,F,3	0.025 (min)	60	6 (max)	2	25	6	–	–	18	
FET 34	2N2841	SI	p,DP,F,3	– (.025-.12)	60 (min)	1.7 (max)	1	–	6	–	–	18	UC
	DNX3	DIC	n,DPE,F,3	0.025-0.25	200-700	−2 (max)	−1.0	50	–	–	–	18	
	2N4117	SI	p,DPE,F,3	0.03-0.09	70-210	−0.6-1.8	−0.01	40	3	1.5	3	72	
	2N4117A	SI	n,DPE,F,3	0.03-0.09	70-210	−(0.6-1.8)	−0.001	−40	3	1.5	3	72	
	2N3112	SI	p,DP,F,3	−(.035-.175)	50-115	1-4	0.05	20	3.5	–	–	72	
	2N3113	SI	p,DP,F,3	−(.035-.175)	50-115	1-4	0.05	–	2.0	–	–	–	Flatpack
	UC750	UC	n,F,3	0.05 (min)	120	6 (max)	2	30	6	–	–	18	
	2N3068	AL	n,DP,F,3	0.05-0.25	200-1000	2.5 (max)	1.0	†50	10	–	–	18	DIC,UC,SI
	2N3367	AL	n,DP,F,3	0.05-0.25	100-1000	2.5 (max)	5		–	–	–	18	DIC, UC, SI
	2N3454	AL	n,DP,F,3	0.05-0.25	100-600	2.5	0.1	†50	6	–	–	18	UC, SI

Reader-Service cards are good all year.

Circle as many numbers on the reader-service card as you like.

Field-Effect *(continued)*

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I_{DSS} [Min.-Max.] (mA)	g_{fs} [Min.-Max.] (μmhos)	V_P or *V_{GS} (off) [Min.-Max.] (volts)	I_{GSS} [Max.] (nA)	BV_{GSS} or *BV_{DSS} or †BV_{DGO} [Min.] (volts)	C_{iss} [Max.] (pF)	C_{rss} [Max.] (pF)	g_{oss} [Max.] (μmhos)	TO-	Alternate Sources and Remarks
FET 35	2N3457	AL	n,DP,F,3	0.05-0.25	150-600	2.5	0.04	†50	5	1.5	–	18	UC, SI
	2N3698	UC	p,F,3	0.05-0.25	250-750	0.3-1.2	0.1	30	5	1.2	–	72	
	DN3068A	DIC	n,DPE,F,3	0.05-0.25	200-1000	–2.5 (max)	–1.0	50	10	1.5	5	18	
	UC801	UC	p,F,3	0.05-1.5	75-750	6 (max)	0.2	25	3	–	–	72	
	UC803	UC	p,F,3	0.05-5.0	250-2500	6 (max)	0.5	25	6	–	–	72	
FET 36	UC-41	UC	p,F,3	0.06-0.3	100 (min)	1-2.5	0.01	30	1.4	–	–	72	
	UC-43	UC	p,F,3	0.06-0.3	100 (min)	1-2.5	0.01	30	1.4	–	–	–	
	UC853	UC	p,F,3	0.065 (min)	180	6 (max)	4	25	10	–	–	18	
	2N2842	SI	p,DP,F,3	– (.065-.325)	180 (min)	1.7 (max)	3	30	10	–	–	18	UC
	2N4118	SI	p,DPE,F,3	0.08-0.24	80-250	–(1-3)	–0.01	40	3	1.5	5	72	
	2N4118A	SI	n,DPE,F,3	0.08-0.24	80-250	–(1-3)	–0.001	–40	3	1.5	5	72	
	C680	CT	n,F,3	0.08-0.4	200-500	0.5-2.5	1.0	30	5	2	–	5	
	C681	CT	n,F,3	0.08-0.4	200-500	0.5-2.5	1.0	30	5	2	–	18	
	U197	SI	n,DPE,3	0.1-1.0	200	–(0.2-1)	–0.5	–30	7	–	–	18	
	UC751	UC	n,F,3	0.1 (min)	350	6 (max)	2	30	10	–	–	18	
FET 37	U1285	AL	n,DP,F,3	0.1 (min)	200-1200	8.0 (max)	5.0	†30	–	–	–	18	
	2N2606	SI	p,DPE,F,3	– (0.1-0.5)	110-500	4 (max)	1.0	–40	6	–	–	18	AL, DIC, UC
	2N3687	UC	n,F,3	0.1-0.5	500-1500	0.3-1.2	0.1	50	4.0	1.2	–	72	
	U114	SI	p,DP,F,3	– (0.10-0.50)	110 (min)	1-4	1	30	6	–	–	46	
	2N3071	AL	n,F,3	0.1-0.6	500-2500	2.5 (max)	1.0	†50	15	1.5	–	18	DIC, UC, SI
	2N3370	AL	n,DP,F,3	0.1-0.6	300-2500	3.5 (max)	5.0	†40	–	–	–	18	DIC,UC,SSD
	D1182	DIC	n,DPE,F,3	0.1-0.6	500-2500	2.5 (max)	5	50	–	–	–	18	
	D1203	DIC	n,DPE,F,3	0.1-0.6	300-1500	–2.5 (max)	10	25	–	–	–	18	
	DN3071A	DIC	n,DPE,F,3	0.1-0.6	500-2500	–2.5 (max)	–1.0	50	15	–	7	18	
	DNX6	DIC	n,DPE,F,3	0.1-0.6	500-2500	2 (max)	–	50	–	–	–	18	
FET 38	MFE2093	MO	n,DP,F,3	0.1-0.7	250-500	*–2.5	–0.1	–50	6	2	1.5	72	
	DNX2	DIC	n,DPE,F,3	0.1-1.0	300-1000	–4 (max)	–1.0	50	–	–	–	18	
	U110	SI	p,DP,F,3	– (0.1-1.0)	110 (min)	1-6	4	20	6	–	–	18	
	UC850	UC	p,F,3	0.1-1	110	6 (max)	2	*20	6	–	–	18	
	UC701	UC	n,F,3	0.1-3.0	150-1500	6 (max)	0.2	40	3	–	–	72	
	U1280	AL	n,DP	0.1-10	250 (min)	10 (max)	0.1	†50	–	–	–	18	
	UC703	UC	n,F,3	0.1-10	500-5000	6 (max)	0.5	40	6	–	–	72	
	UC804	UC	p,F,3	0.1-12	500-5000	8 (max)	0.5	25	8	–	–	72	
	UC21	UC	n,F,3	0.12-0.6	200 (min)	1-2.5	0.1	30	2	–	–	72	
	UC23	UC	n,F,3	0.12-0.6	200 (min)	1.0-2.5	0.01	30	1.3	–	–	–	
FET 39	U1286	AL	n,DP	0.2 (min)	1000-10,000	8 – (max)	10	†30	–	–	–	18	
	UC854	UC	p,F,3	0.2 (min)	540	6 (max)	15	25	17	–	–	18	
	2N3697	UC	p,F,3	0.2-0.6	500-1000	0.6-2.0	0.1	30	5	1.2	–	72	
	2N4119	SI	p,DPE,F,3	0.20-0.60	100-330	–(2-6)	–0.01	40	3	1.5	10	72	
	2N4119A	SI	n,DPE,F,3	0.2-0.6	100-330	–(2-6)	–0.001	–40	3	1.5	10	–	
	2N4338	SI	n,DPE,3	0.2-0.6	600-1800	0.3-1	–0.1	–50	6	2	5	18	
	2N2843	SI	p,DPE,F,3	– (0.2-1.0)	540 (min)	1.7 (max)	10	30	17	–	–	18	UC
	2N3067	AL	n,DP,F,3	0.2-1.0	300-1000	5 (max)	1.0	†50	10	–	–	18	DIC,UC,SI
	2N3366	AL	n,DP,F,3	0.2-1.0	250-1000	7 (max)	5.0	†40	–	–	–	18	DIC, UC, SI
	2N3438	AL	n,DP,F,3	0.2-1.0	800-4500	2.5 (max)	0.5	†50	18	–	–	18	UC, SI, DIC
FET 40	2N3453	AL	n,DP,F,3	0.2-1.0	150-900	5 (max)	0.1	†50	6	–	–	18	UC, SI
	2N3456	AL	n,DP,F,3	0.2-1.0	300-900	5 (max)	0.04	†50	5	1.5	–	18	UC, SI
	2N3460	AL	n,DP,F,3	0.2-1.0	800-4500	2 (max)	0.25	†50	18	–	–	18	UC, DIC, SI
	D1102	DIC	n,DPE,F,3	0.2 -1.0	300-1000	– (max)	–10	25	–	–	–	18	
	D1178	DIC	n,DPE,F,3	0.2-1	300-1000	–5 (max)	–5.0	50	–	–	–	18	
	D1185	DIC	n,DPE,F,3	0.2-1.0	800-4500	–2 (max)	–5	50	–	–	–	18	
	D1303	DIC	n,DPE,F,3	0.2-1.0	800-4500	–2 (max)	–10	25	–	–	–	18	
	DN3067A	DIC	n,DPE,F,3	0.2-1.0	300-1000	–5 (max)	–1.0	50	10	1.5	20	18	
	UC-40	UC	p,F,3	0.2-1.0	150 (min)	2-5	0.01	30	2.5	–	–	72	
	UC-42	UC	p,F,3	0.2-1.0	150 (min)	1.0-2.5	0.01	30	1.4	–	–	–	
FET 41	U1279	AL	n,DP	0.2-1.5	250 (min)	2.5 (max)	0.1	†50	–	–	–	18	
	3N124	MO	n,DP,F,4	0.2-2.0	500-2000	*–2.5	–0.25	–50	14	2	2	72	
	UC704	UC	n,F,3	0.2-24	1000-10,000	8 (max)	0.5	40	8	–	–	72	
	U1284	AL	n,DP	0.2-40	1000 (min)	10 (max)	0.5	†50	18	–	–	–	
	2N3277	FA	p,EP,F,3	0.25 (typ)	150 (min)	5 (typ)	0.1	25	–	–	–	72	
	UC752	UC	n,F,3	0.3 (min)	1000	6 (max)	6	30	17	–	–	18	
	2N2607	SI	p,DP,F,3	– (.30-1.5)	330 (min)	1-4	3	30	10	–	–	18	DIC, UC, AL
	U133	SI	p,DP,F,3	– (0.30-1.5)	330 (min)	1-4	3	50	10	–	–	18	
	2N3820	TI	p,PL,F,3	0.3-15	800-5000	*8 (max)	20	20	32	16	–	92	
	2N3909	TI	p,PL,F,3	0.3-15	1000-5000	*0.3-7.9	10	20	32	16	–	72	SI,UC
FET 42	UC814	UC	p,F,3	0.3-15	800-5000	8 (max)	2	25	16	8	–	72	
	UC805	UC	p,F,3	0.3-25	1000-10,000	8 (max)	1	25	12	–	–	72	
	2N3686	UC	n,F,3	0.4-1.2	1000-2000	0.6-2.0	0.1	50	4	1.2	–	72	
	2N4867	SI	n,DPE,3	0.4-1.2	700-2000	–(0.7-2)	–0.25	–40	25	5	1.5	72	
	MFE2094	MO	n,DP,F,3	0.4-1.4	350-700	*–4.5	–0.1	–50	6	2	3.0	72	
	C682	CT	n,F,3	0.4-1.6	400-1000	1.0-5.0	1.0	30	5	2	–	5	
	C683	CT	n,F,3	0.4-1.6	400-1000	1.0-5.0	1.0	30	5	2	–	18	
	UC20	UC	n,F,3	0.4-2.0	300 (min)	2.0-5.0	0.01	30	2	–	–	72	
	UC22	UC	n,F,3	0.4-2.0	300 (min)	2.0-5.0	0.01	30	1.3	–	–	–	
	UC855	UC	p,F,3	0.44 (min)	1400	6 (max)	50	25	25	–	–	18	

Field-Effect *(continued)*

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I_{DSS} [Min.-Max.] (mA)	g_{fs} [Min.-Max.] (μmhos)	V_P or $^*V_{GS\,(off)}$ [Min.-Max.] (volts)	I_{GSS} [Max.] (nA)	BV_{GSS} or $^*BV_{DSS}$ or $^{\dagger}BV_{DGO}$ [Min.] (volts)	C_{iss} [Max.] (pF)	C_{rss} [Max.] (pF)	g_{oss} [Max.] (μmhos)	TO-	Alternate Sources and Remarks
FET 43	2N2844	SI	p,DP,F,3	– (0.44-2.2)	1400 (min)	1.7 (max)	30	30	30	–	–	18	UC
	FP4339	SI	p,n,DPE,6	0.5	800	0.6	3	40	7	3	–	72	
	U1325	AL	n,F,3	0.5 (typ)	500 (min)	1.2 (max)	0.1	–	–	–	–	18	
	2N3696	UC	p,F,3	0.5-1.5	250-1250	1-3.5	0.1	30	5	1.2	–	72	
	2N4339	SI	n,DPE,3	0.5-1.5	800-2400	0.6-1.8	–0.1	–50	6	2	15	18	
FET 44	U203	SI	n,DPE,3	0.5-2	300-2000	–(1-5)	–1	–30	6	1.5	50	72	
	U204	SI	n,DPE,3	0.5-2	300-2000	–(1-5)	–1	–30	6	1.5	50	72	
	2N3070	AL	n,F,3	0.5-2.5	750-2500	5 (max)	1.0	†50	15	1.5	–	18	DIC,UC,SI
	2N3369	AL	n,DP,F,3	0.5-2.5	600-2500	7 (max)	5.0	†40	–	–	–	18	DIC,UC,SI
	2N3821	TI	n,DP,F,3	0.5-2.5	1500-4500	*–4	–0.1	–50	6	3	10	72	MO, UC
	3N89	SI	p,DP,F,4	– (0.5-2.5)	450-1300	3.3 (typ)	5	30	3	–	–	72	
	D1181	DIC	n,DPE,F,3	0.5-2.5	750-2500	5 (max)	5	50	–	–	–	18	
	D1202	DIC	n,DPE,F,3	0.5-2.5	600-2000	–5 (max)	10	25	–	–	–	18	
	DN3070A	DIC	n,DPE,F,3	0.5-2.5	750-2500	–5 (max)	–1.0	50	15	–	30	18	
	DNX5	DIC	n,DPE,F,3	0.5-2.5	750-2500	4 (max)	–	50	–	–	–	18	
FET 45	UC420	UC	p,F,3	0.5-2.5	1500 (min)	2.5 (max)	0.1	30	8	–	–	72	
	2N3796	MO	n,DP,M,3	0.5-3.0	900-1800	*–4	–0.01	–25	7	0.8	25	18	
	2N4220	MO	n,DP,F,3	0.5-3.0	1000-4000	1-4	–0.1	–30	6	2	10	72	SI
	U1278	AL	n,DP	0.5-3.0	350 (min)	4.5 (max)	0.1	†50	–	–	–	18	
	U89	SI	p,DP,F,4	– (0.5-5.0)	450-1300	3.3 (typ)	10	20	3	–	–	72	
	MFE3001	MO	n,DP,M,4	0.5-6	700-3500	*8	0.01	*20	5	1.5	–	72	
	K1004	KMC	n,M,4	0.5-7.0	800 (min)	12 (max)	0.05	15	4.5	0.7	1000	18	
	2N3822	UC	n,F,3	0.5-10	3000-6500	6 (max)	0.1	50	6	3	–	72	SI
	TIS14	TI	n,EP,F,3	0.5-15	1000-7500	*6.5 (max)	1	30	8	4	–	72	
	UC705	UC	n,F,3	0.5-50	2000-20,000	8 (max)	1	40	12	–	–	72	
FET 46	P1003	AL	p,PL,F,3	0.6-6.0	1000-3500	3 (max)	3	–50	20	–	–	18	
	U168	SI	p,DP,F,3	– (0.6-6)	800 (min)	5 (max)	30	20	65	–	–	18	
	U198	SI	n,DPE,3	0.6-6.0	600	–(0.8-4)	–0.5	–30	7	–	–	18	
	2N3278	FA	p,EP,F,3	0.67(typ)	200 (min)	8 (typ)	0.1	25	–	–	–	72	
	2N3084	CT	n,F,3	0.8-3.0	400-1200	–10	0.1	30	5	2	–	5	
	2N3085	CT	n,F,3	0.8-3.0	400-1200	–10	0.1	30	5	2	–	18	DIC
	2N3086	CT	n,F,3	0.8-3.0	400-1200	–10	1.0	40	5	2	–	5	
	2N3087	CT	n,F,3	0.8-3.0	400-1200	–10	1.0	40	5	2	–	18	DIC
	2N3066	AL	n,DP,F,3	0.8-4.0	400-1000	10 (max)	1.0	†50	10	1.5	–	18	DIC, UC, SI
	2N3365	AL	n,DP,F,3	0.8-4.0	400-2000	12 (max)	5.0	†40	–	–	–	18	DIC, UC, SI
FET 47	2N3437	AL	n,DP,F,3	0.8-4.0	1500-6000	5.0	0.5	†50	18	–	–	18	UC, SI
	2N3452	AL	n,DP,F,3	0.8-4.0	200-1200	10 (max)	0.1	†50	6	–	–	18	UC, SI
	2N3455	AL	n,DP,F,3	0.8-4.0	400-1700	10 (max)	0.04	†50	5	1.5	–	18	UC, SI
	2N3459	AL	n,DP,F,3	0.8-4.0	1500-6000	4 (max)	0.25	†50	18	5	–	18	UC, SI, DIC
	D1101	DIC	n,DPE,F,3	0.8-4.0	400-2000	–10 (max)	–10	25	–	–	–	18	
	D1177	DIC	n,DPE,F,3	0.8-4.0	400-2000	–10 (max)	–5	50	–	–	–	18	
	D1184	DIC	n,DPE,F,3	0.8-4.0	1500-6000	–4 (max)	–5	50	–	–	–	18	
	D1302	DIC	n,DPE,F,3	0.8-4.0	1500-6000	–4 (max)	–10	25	–	–	–	18	
	DN3066A	DIC	n,DPE,F,3	0.8-4.0	400-1000	–10 (max)	–1.0	50	10	1.5	50	18	
	DNXI	DIC	n,DPE,F,3	0.8-6	400-1500	–8 (max)	–1.0	50	–	–	–	18	
FET 48	UC753	UC	n,F,3	0.9 (min)	2500	6 (max)	10	30	25	–	–	18	
	2N2608	SI	p,DP,F,3	– (0.90-4.5)	1000 (min)	1-4	10	30	17	–	–	18	AL, UC
	2N3578	SI	p,DP,F,3	– (0.9-4.5)	1200-3500	1.5-4	15	20	65	–	–	18	
	2N2386	TI	p,DP,F,3	– (0.9-9.0)	1000 (min)	8 (max)	10	20	50	–	–	5	SI,UC
	U112	SI	p,DP,F,3	– (0.9-9.0)	1000 (min)	16	4	20	17	–	–	18	
	UC851	UC	p,F,3	0.9-9	1000	6 (max)	4	*20	17	–	–	18	
	2N3328	SI	p,DP,F,3	–1 (max)	100 (min)	6 (max)	1	20	4	–	–	72	
	UC807	UC	p,F,3	1 (min)	2500-25,000	12 (max)	2	20	30	–	–	18	
	2N3821	SI	n,F,3	1-2.5	1500-4500	4 (max)	0.1	50	6	3	–	72	
	2N2497	TI	p,DP,F,3	1-3	1000-2000	15 (max)	10	–	32	–	–	5	SI, UC
FET 49	2N3329	SI	p,DP,F,3	– (1-3)	1000-2000	*5 (max)	0.01	–20	20	–	–	72	TI, UC
	2N4868	SI	n,DPE,3	1-3	1000-3000	–(1-3)	–0.25	–40	25	5	4	72	
	MFE2095	MO	n,DP,F,3	1.0-3.0	400-800	*–5.5	–0.1	–50	6	2	10	72	
	2N3685	UC	n,F,3	1.0-3.5	1500-2500	1.0-3.5	0.1	50	4.0	1.2	–	72	
	MPF103	MO	n,DP,F,3	1-5	1000-5000	*6	1.0	25	7	3	50	92	
	UC220	UC	n,F,3	1.0-5.0	3000 (min)	2.5 (max)	0.1	50	7.0	–	–	72	
	2N2500	TI	p,DP,F,3	1-6	1000-2200	15 (max)	10	–	32	–	–	5	UC
	2N3332	TI	p,DP,F,3	1-6	1000-2200	6 (max)	10	–	20	–	–	72	UC
	2N3823	TI	n,EP,F,3	1-7.5	3500-6500	*8 (max)	0.5	30	6	2	–	72	UC, SI, MO
	U1283	AL	n,DP	1.0-10	1500 (min)	2.5 (max)	0.5	†50	18	–	–	18	
FET 50	UC240	UC	n,F,3	1.0-10	1200 (min)	5.0 (max)	0.1	50	18	–	–	18	
	FP4340	SI	p,n,DPE,6	1.2	1300	1	3	40	7	3	–	72	
	2N4340	SI	n,DPE,3	1.2-3.6	1300-3000	1-3	–0.1	–50	6	2	30	18	
	2N3695	UC	p,F,3	1.25-3.75	1000-1750	2-5	0.1	30	5	1.2	–	72	
	2N4339	SI	p,n,DPE,6	1.5	2400	1.8	0.1	50	6	2	–	18	
	3N125	MO	n,DP,F,4	1.5-4.5	800-2400	*–4.0	–0.25	–50	14	2	10	72	
	M100	SI	n,M,3	1.5-4.5	1000-2200	*–5	–	20	–	–	–	18	
	C684	CT	n,F,3	1.5-6.0	600-1500	2.0-10	1.0	30	5	2	–	5	
	C685	CT	n,F,3	1.5-6.0	600-1500	2.0-1.0	1.0	30	5	2	–	18	
	U1277	AL	n,DP	1.5-8.0	450 (min)	8.0 (max)	0.1	†50	–	–	–	18	

Complete listing of semiconductor manufacturers starts on page 86.

Field-Effect *(continued)*

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	I_{DSS} [Min.-Max.] (mA)	g_{fs} [Min.-Max.] (μmhos)	V_P or $*V_{GS\,(off)}$ [Min.-Max.] (volts)	I_{GSS} [Max.] (nA)	BV_{GSS} or $*BV_{DSS}$ or $†BV_{DGO}$ [Min.] (volts)	C_{iss} [Max.] (pF)	C_{rss} [Max.] (pF)	g_{oss} [Max.] (μmhos)	TO-	Alternate Sources and Remarks
FET 51	2N4881	AL	n	2.0	350	*15	2.0	100	15	1.5	2.5	5	
	2N4883	AL	n	2.0	350	*10	1.0	100	15	1.5	2.5	5	
	2N4885	AL	n	2.0	350	*10	1.0	75	15	1.5	2.5	5	
	2N2498	TI	p,DP,F,3	2-6	1500-3000	15 (max)	10	–	32	–	–	5	SI, UC
	2N3330	SI	p,DP,F,3	– (2-6)	1500-3000	6 (max)	0.01	–20	20	–	–	72	TI, UC
FET 52	2N4221	MO	n,DP,F,3	2-6	2000-5000	* –6	–0.1	–30	6	2	20	72	SI
	UC410	UC	p,F,3	2-6	2250 (min)	4 (max)	0.1	30	8	–	–	72	
	MPF104	MO	n,DP,F,3	2-9	1500-5500	*7	1.0	25	7	3	50	92	
	2N2609	SI	p,DP,F,3	– (2-10)	2500 (min)	1-4	30	30	30	–	–	18	AL, UC
	2N3069	AL	n,F,3	2-10	1000-2500	10 (max)	1.0	†50	15	1.5	–	18	DIC,UC,SI
	2N3822	TI	n,EP,F,3	2-10	3000-6500	*6 (max)	0.1	50	6	3	–	72	MO, SI
	D1180	DIC	n,DPE,F,3	2-10	1000-2500	10 (max)	5	50	–	–	–	18	
	D1201	DIC	n,DPE,F,3	2-10	1000-2500	–10 (max)	10	25	–	–	–	18	
	DN3069A	DIC	n,DPE,F,3	2-10	1000-2500	–10 (max)	–1.0	50	15	–	80	18	
	DNX4	DIC	n,DPE,F,3	2-10	1000-2500	8 (max)	–	50	–	–	–	18	
FET 53	2N3368	AL	n,DP,F,3	2-12	1000-4000	12 (max)	5.0	†40	–	–	–	18	DIC, UC, SI
	2N3819	TI	n,EP,F,3	2-20	2000-6500	*8 (max)	2	25	8	4	–	92	
	P1004	AL	p,PL,F,3	2-20	2500-6000	5 (max)	3	–50	20	–	–	18	
	U183	SI	n,DPE,F,3	2-20	2000-6500	–8 (max)	–2	–25	8	4	50	72	
	UC714	UC	n,F,3	2-20	2000-6500	3 (max)	1	30	8	4	–	72	
	2N3684	UC	n,F,3	2.5-7.5	2000-3000	2-5	0.1	50	4.0	1.2	–	72	
	2N4869	SI	n,DPE,3	2.5-7.5	1300-4000	–(1.8-5)	–0.25	–40	25	5	10	72	
	TIS58	TI	n,EP,F,3	2.5-8	1300-4000	*0.5-5	4	25	6	3	–	92	
	UC707	UC	n,F,3	2.5-250	5000-50,000	12 (max)	2	20	30	–	–	18	
	2N2386	TI	p,F,3	3 (typ)	1000-3000	8 (max)	10	20	–	–	–	5	SI, UC
FET 54	2N3378	SI	p,DP,F,3	– (3-6)	1500-2300	4-5	3	30	5	3	–	72	
	2N3379	SI	p,DP,F,3	– (3-6)	1500-2300	4-5	3	30	4	2	–	–	
	2N4341	SI	n,DPE,3	3-9	2000-4000	2-6	–0.1	–50	6	2	60	18	
	3N126	MO	n,DP,F,4	3-9	1200-3600	*–6.5	–0.25	–50	14	2	20	72	
	2N4381	FA	p,DP,F,3	3-10	2000-6000	*1-5	0.1	*25	20	5	–	18	
	2N3436	AL	n,DP,F,3	3.0-15	2500-10,000	10 (max)	0.5	†50	18	–	–	18	UC, SI
	2N3458	AL	n,DP	3.0-15	2500-10,000	8 (max)	0.25	†50	18	–	–	18	UC, SI, DIC
	D1183	DIC	n,DPE,F,3	3-15	2500-10,000	–8 (max)	–5	50	–	–	–	18	
	D1301	DIC	n,DPE,F,3	3.0-15	2500-10,000	–8 (max)	–10	25	–	–	–	18	
	U199	SI	n,DPE,3	3-20	1500	–(3-10)	–0.5	–30	7	–	–	18	
FET 55	2N4340	SI	p,n,DPE,6	3.6	3000	3	0.1	50	6	2	–	18	
	2N3797	MO	n,DP,M,3	4-6	1500-3000	*–4	–0.001	–25	8	0.8	60	18	
	M101	SI	n,M,3	4-12	1500-3300	*–8	–	20	–	–	–	18	
	UC210	UC	n,F,3	4-12	4500 (min)	4.0 (max)	0.1	50	7.0	–	–	72	
	40461	RCA	n,DP,MOS,4	4-14	3500 (typ)	–	0.01	±25	1.2	5	–	–	
	MPP105	MO	n,DP,F,3	4-16	2000-6000	*8	1.0	25	7	3	50	92	
	TIS34	TI	n,EP,F,3	4-20	3500-6500	1-8	5	30	6	2	–	92	
	U1282	AL	n,DP	4.0-20	2500 (min)	4.5 (max)	0.5	50	–	–	–	18	
	2N2499	TI	p,DP,F,3	5-15	2000-4000	15 (max)	10	–	32	–	–	5	SI
	2N3331	TI	p,DP,F,3	5-15	2000-4000	8 (max)	10	–	20	–	–	72	SI, UC
FET 56	2N4222	MO	n,DP,F,3	5-15	2500-6000	*–8	–0.1	–30	6	2	40	72	SI
	UC400	UC	p,F,3	5-15	3000 (min)	6 (max)	0.1	30	8	–	–	72	
	P1005	AL	p,PL,F,3	5-25	3500-7000	8 (max)	3	–50	20	–	–	18	
	3N128	RCA	n,DP,MOS,4	5-30	5000-12,000	–	0.05	20	5.8 (typ)	0.2	–	104	
	TIS59	TI	n,EP,F,3	6-25	2300-5000	*1-9	4	25	6	3	–	92	
	2N4882	AL	n	7.5	600	*15	2.0	100	15	1.5	5.0	5	
	2N4884	AL	n	7.5	600	*10	1.0	100	15	1.5	5.0	5	
	2N4886	AL	n	7.5	600	*10	1.0	75	15	1.5	5.0	5	
	U1281	AL	n,DP	8 (max)	250 (min)	10 (max)	0.1	†50	–	–	–	18	
	2N4382	FA	p,DP,F,3	10-30	4000-8000	*2.5-9.0	0.1	*25	20	5	–	18	
FET 57	UC200	UC	n,F,3	10-30	6000 (min)	6.0 (max)	0.1	50	7.0	–	–	72	
	TIXS35	TI	n,EP,F,4	10-50	10,000-20,000	*1-5	10	30	12	5	–	72	
	2N4139	AL	n	11.0	3500	8.0	1.0	†50	18	5	35	18	
	MFE2097	MO	n,DP,F,3	15-50	10,000-20,000	7	1.0	50	2	5	200	39	
	U146	SI	p,DP,F,3	–25 (min)	60 (min)	6 (max)	10	20	–	–	–	18	
	2N2841	DIC	n,DPE,F,3	25-125	60-300	1.7 (max)	1.0	–40	6	–	–	18	
	MFE2098	MO	n,DPE,3	40-100	13,000-25,000	10	1.0	50	20	5	400	39	
	TIXS36	TI	n,EP,F,4	40-200	10,000-20,000	*3-10	10	30	12	5	–	72	
	U147	SI	p,DP,F,3	–65 (min)	180 (min)	6 (max)	20	20	–	–	–	18	
	2N2842	DIC	p,DPE,F,3	– (65-325)	180-500	1.7 (max)	3	–40	6	–	–	18	UC
FET 58	U1287	AL	n,DP,F,3	100 (typ)	20,000	15 (max)	2.0	30	–	–	–	4	†MT25 package
	U148	SI	p,DP,F,3	*	540 (min)	6 (max)	60	20	–	–	–	18	* loss (min)=0.2
	U149	SI	p,DP,F,3	*	1400 (min)	6 (max)	200	20	–	–	–	18	* loss (min)=0.44
	2N3608	PH	p,M,4	–	800 (min)	*4 (typ)	0.002	*–30	8.0	2.5	–	5	
	DE1004	PH	p,M,4	–	600 (min)	*3	1000	*20	10	3	–	18	
	HA2001	HU	p,M,4	–	1000-2000	–	0	*35	8.0		–	72	
	TIXS11	TI	p,PL,M,3	–	800 (min)	3-6	0.003	30	8	3	–	72	
	2N3376	SI	–	–	800-2300	1-5	3	30	5	3	–	72	
	2N3377	SI	–	–	800-2300	1-5	3	30	4	2	–		

Need a FREE personal copy of this Directory? Circle number **419.**

Field-Effect *(continued)*

Type 3(b). Low-noise ac amplifiers

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	NF [Max.] dB at (f in KHz / R_{gen} in KΩ)	g_{fs} [Min.-Max.] (μmhos)	I_{DSS} [Min.-Max.] (mA)	BV_{GSS} or $*BV_{DSS}$ [Min.] (volts)	I_{GSS} [Max.] (nA)	C_{iss} [Max.] (pF)	V_P or $*V_{GS}$ (off) [Min.-Max.] (volts)	TO-	Alternate Sources and Remarks
FET 59	2N3458	SI	n,DPE,F,3	6 (.02/1000)	2500-10,000	3-15	–	0.25	18	7.8 (max)	18	AL, DIC
	2N3796	MO	n,DP,F,3	5 (200000/–)	900-1800	0.5-3	–25	–0.001	7	–4 (typ)	72	
	2N3797	MO	n,DP,M,3	5 (200000/–)	1500-3000	4-6	–25	–0.001	8	–4 (typ)	72	
	2N3821	TI	n,EP,F,3	5 (0.01/1000)	1500-4500	0.5-2.5	50	0.1	6	*4 (max)	72	SI
	2N3822	TI	n,EP,F,3	5 (0.01/1000)	3000-6500	2-10	50	0.1	6	*6 (max)	72	SI
FET 60	2N4220	MO	n,DP,F,3	5 (200000/–)	1000-4000	0.5-3	–30	–0.1	6	–4 (typ)	72	SI
	2N4221	MO	n,DP,F,3	5(200000/–)	2000-5000	2-6	–30	–0.1	6	–6 (typ)	72	SI
	2N4222	MO	n,DP,F,3	5 (200000/–)	2500-6000	5-15	–30	–0.1	6	–8 (typ)	72	
	2N4223	MO	n,DP,F,3	5 (200000/–)	3000-7000	3-18	–30	–0.25	6	*–1-7	72	SI
	2N3331	TI	p,DP,F,3	4 (1/1000)	2000-4000	5-15	–	10	20	*8 (max)	72	SI
	2N3455	SI	n,DPE,F,3	4 (.02/1000)	400-1200	0.8-4.0	50	–0.04	5	–9.8 (max)	72	AL
	2N3457	SI	n,DPE,F,3	4 (.02/1000)	150-600	0.05-0.25	50	–0.04	5	–2.3 (max)	72	AL
	2N3456	SI	n,DPE,F,3	4 (.02/1000)	300-900	0.2-1.0	50	–0.04	5	–4.8 (max)	72	AL
	2N3460	SI	n,DPE,F,3	4 (.02/1000)	800-4500	0.2-1.0	50	0.25	18	1.8 (max)	18	AL, DIC
	2N3459	SI	n,DPE,F,3	4 (.02/1000)	1500-6000	0.8-4.0	50	0.25	18	3.4 (max)	18	AL, DIC
FET 61	2N3088	CT	n,F,3	3 (.01/1000)	300-900	0.5-2.0	15	1.0	5	5 (typ)	5	
	2N3089	CT	n,F,3	3 (.01/1000)	300-900	0.5-2.0	15	1.0	5	5 (typ)	18	DIC
	2N3329	TI	p,DP,F,3	3 (1/1000)	1000-2000	1-3	–	10	20	*5 (max)	72	SI
	2N3330	TI	p,DP,F,3	3 (1/1000)	1500-3000	2-6	–	10	20	*6 (max)	72	SI
	P-102	SI	p,DP,F,3	3 (1/1000)	1600 (typ)	0.90-4.5	30	10	17	1-4	18	
	2N4381	FA	p,PP,F,3	3(10/0.4)	2000-6000	10-30	25	1	5	1-5	18	
	2N4382	FA	p,PP,F,3	3(10/0.4)	4000-8000	10-30	25	1	5	2.5-9.0	18	
	U203	SI	n,DPE,3	3(15/1000)	300-2000	0.5-2	–30	–1	6	–(1-5)	72	
	2N3823	TI	n,EP,F,3	2.5 (100000/1)	3500-6500	1-7.5	30	0.5	6	*8 (max)	72	AL
	2N3823	SI	n,DPE,F,3	2.5 (.1/1000)	3200 (min)	4-20	30	–0.5	6	–8 (max)	72	
FET 62	2N4220A	MO	n,DP,F,3	2.5(0.1/1000)	1000-4000	0.5-3	30	0.1	6	*4	72	
	2N4221A	MO	n,DP,F,3	2.5(0.1/1000)	2000-5000	2-6	30	0.1	6	*6	72	
	2N4222A	MO	n,DP,F,3	2.5(0.1/1000)	2500-6000	5-15	30	0.1	6	*8	72	
	2N3452	SI	n,DPE,F,3	2.0 (.1/1000)	200-1200	0.8-4.0	50	–0.1	6	–9.8 (max)	72	AL
	2N3453	SI	n,DPE,F,3	2.0 (.1/1000)	150-900	0.2-1.0	50	–0.1	6	–4.8 (max)	72	AL
	2N3454	SI	n,DPE,F,3	2.0 (.1/1000)	100-600	0.05-0.25	50	–0.1	6	–2.3 (max)	72	AL
	2N4342	FA	p,PP,F,3	1.5(0.1/10)	2000-6000	4-12	25	10	5	5.5	18	
	2N4343	FA	p,PP,F,3	1.5(0.1/10)	4000-8000	10-30	25	10	5	10	18	
	2N4360	FA	p,PP,F,3	1.5(0.1/10)	2000-8000	3-30	20	10	5	10	18	
	2N3332	TI	p,DP,F,3	1(1/1000)	1000-2200	1-6	–	10	20	*6 (max)	72	
FET 63	2N4338	SI	n,DPE,F,3	1(1/1000)	500-2000	0.2-0.6	–50	–0.1	6	–(0.3-1.0)	72	
	2N4339	SI	n,DPE,F,3	1(1/1000)	600-2500	0.5-1.5	–50	–0.1	6	–(0.5-2)	72	
	2N4340	SI	n,DPE,F,3	1(1/1000)	1000-3000	1.2-3.6	–50	–0.1	6	–(0.9-3.5)	72	
	2N4341	SI	n,DPE,F,3	1(1/1000)	1300-4000	3-9	–50	–0.1	6	–(2-6)	72	
	2N4867	SI	n,DPE,3	1(1/10,000)	700-2000	0.4-1.2	–40	–0.25	25	–(0.7-2)	72	
	2N4868	SI	n,DPE,3	1(1/10,000)	1000-3000	1-3	–40	–0.25	25	–(1-3)	72	
	2N4869	SI	n,DPE,3	1(1/10,000)	1300-4000	2.5-7.5	–40	–0.25	25	–(1.8-5)	72	
	2N3088A	CT	n,F,3	0.5 (.01/1000)	300-900	0.5-2.0	15	1.0	5	5 (typ)	5	
	2N3089A	CT	n,F,3	0.5 (.01/1000)	300-900	0.5-2.0	15	1.0	5	5 (typ)	18	
	U204	SI	n,DPE,3	0.5(15/1000)	300-2000	0.5-2.0	–30	–1	6	–(1-5)	72	
FET 64	DN3066A	DIC	n,DPE,F,3	0.25(1/1000)	400-1000	0.8-4.0	50	1.0	10	– (3.5-10)	18	
	DN3067A	DIC	n,DPE,F,3	0.25(1/1000)	300-1000	0.2-1.0	50	1.0	10	– (1.5-5)	18	
	DN3068A	DIC	n,DPE,F,3	0.25 (1/1000)	300-1000	0.05-0.25	50	1	10	– (.4-2.5)	18	
	DN3069A	DIC	n,DPE,F,3	0.25 (1/1000)	1000-2500	2-10	50	–1.0	15	– (2.5-10)	18	
	DN3070A	DIC	n,DPE,F,3	0.25 (1/1000)	750-2500	0.5-2.5	50	–1.0	15	– (1.0-5)	18	
	DN3071A	DIC	n,DPE,F,3	0.25 (1/1000)	500-2500	0.1-0.6	50	–1.0	15	– (0.4-7.5)	18	
	2N3695	UC	p,F,3	0.20 (–)	1000-1750	1.25-3.75	30	0.1	5	2.5	72	
	2N3696	UC	p,F,3	0.20 (–)	750-1250	0.5-1.5	30	0.1	5	1-3.5	72	
	2N3697	UC	p,F,3	0.20 (–)	500-1000	0.2-0.6	30	0.1	5	0.6-2.0	72	
	2N3698	UC	p,F,3	0.20 (–)	250-750	0.05-0.25	30	0.1	5	0.3-1.2	72	
FET 65	2N3684	UC	n,F,3	0.15 (–)	2000-3000	2.5-7.5	50	0.1	4	2-5	72	
	2N3685	UC	n,F,3	0.15 (–)	1500-2500	1-3.5	50	0.1	4	1-3.5	72	
	2N3686	UC	n,F,3	0.15 (–)	1000-2000	0.4-1.2	50	0.1	4	0.6-2.0	72	
	2N3687	UC	n,F,3	0.15 (–)	500-1500	0.1-0.5	50	0.1	4	0.3-1.2	72	
	UC240	UC	n,F,3	0.02 (–)	1200 (min)	1-10	50	0.1	18	5-18	18	
	2N2386	TI	p,DP,F,3	–	1000 (min)	–	–	10	50	8 (max)	5	SI
	2N2497	TI	p,DP,F,3	–	1000-2000	1-3	–	10	32	15 (max)	5	SI
	2N2498	TI	p,DP,F,3	–	1500-3000	2-6	–	10	32	15 (max)	5	SI
	2N2499	TI	p,DP,F,3	–	2000-4000	5-15	–	10	32	15 (max)	5	SI
	2N2500	TI	p,DP,F,3	–	1000-2200	1-6	–	10	32	15 (max)	5	
FET 66	2N3819	TI	n,EP,F,3	–	2000-6500	2-20	25	2	8	*8 (max)	72	
	2N3820	TI	p,PL,F,3	–	800-5000	0.3-15	20	20	32	*8 (max)	72	
	2N3909	TI	p,PL,F,3	–	1000-5000	0.3-15	20	10	32	*0.3-7.9	72	SI
	3N128	RCA	n,DP,MOS,4	–	5000-12,000	5-30	20	0.05	5.8	–	104	
	TIS14	TI	n,EP,F,3	–	1000-7500	0.5-15	30	1	8	*6.5 (max)	72	
	TIS34	TI	n,EP,F,3	–	3500-6500	4-20	30	5	6	1-8	72	
	TIXS11	TI	p,PL,M,3	–	800 (min)	–	30	0.003	8	3-6	72	
	TIXS35	TI	n,EP,F,4	–	10,000-20,000	10-50	30	10	12	*1-5	72	
	TIXS35	TI	n,EP,F,4	–	10,000-20,000	10-50	30	10	12	*1-5	72	
	TIXS36	TI	n,EP,F,4	–	10,000-20,000	40-200	30	10	12	*3-10	72	

Field-Effect *(continued)*

Type 3(c). High-frequency (f≧1MHz) ac amplifiers

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	g_{fs} [Min.-Max.] (μmhos)	C_{rss} [Max.] (pF)	C_{iss} [Max.] (pF)	g_{iss} [Max.] (μmhos)	BV_{GSS} or $^*BV_{DSS}$ [Min.] (volts)	I_{DSS} [Min.-Max.] (mA)	V_P or $^*V_{GS\,(off)}$ [Min.-Max.] (volts)	NF [Max.] dB at (f in KHz / Rgen in KΩ)	TO-	Alternate Sources and Remarks
FET 67	3N89	SI	p,DP,F,4	450-1300	–	3	–	30	–(0.5-2.5)	3.3 (typ)	–	72	
	U89	SI	p,DP,F,4	450-1800	–	3	–	30	– (0.5-5.0)	3.3 (typ)	–	72	
	DE1004	PH	p,M,4	600 (min)	3	10	–	*–20	0.0001	–	–	18	
	2N3608	PH	p,M,4	800 (min)	2.5	8	–	*–30	0.00003	–	–	5	
	TIXS11	TI	p,PL,M,3	800 (min)	3	8	–	30	–	3-6	–	72	
FET 68	2N3376	SI	p,DP,F,3	800-2300	3	5	–	30	0.6-6	1-5	–	72	
	2N3377	SI	p,DP,F,3	800-2300	2	4	–	30	0.6-6	1-5	–		
	2N3820	TI	p,PL,F,3	800-5000	16	32	–	20	0.3-15	*8 (max)	–	72	
	K1001	KMC	n,M,4	1000 (min)	0.7	4.5	800	15	5-12	6 (max)	4.5 (200 MHz)	18	
	K1201	KMC	n,M,4	1000 (min)	0.3	3.0	800	15	1-5	5 (max)	4.5 (450 MHz)	18	
	K1202	KMC	n,M,4	1000 (min)	0.3	3.0	800	15	1-10	5 (max)	–	72	
	K1501	KMC	p,M,4	1000 (min)	0.6	2.0	800	50	–	3-7	–	72	
	K1502	KMC	p,M,4	1000 (min)	0.6	2.0	800	50	–	3-7	–	72	
	TIS14	TI	n,EP,F,3	1000-7500	4	8	–	30	0.5-15	* 6.5 (max)	–	72	
	TIS58	TI	n,EP,F,3	1300-4000	3	6	–	25	2.5-8	*0.5-5	–	92	
FET 69	2N3378	SI	p,DP,F,3	1500-2300	3	5	–	30	3-6	4-5	–	72	
	2N3379	SI	p,DP,F,3	1500-2300	2	4	–	30	3-6	4-5	–	FP	
	2N3380	SI	p,DP,F,3	1500-3000	3	5	–	30	3-20	5-9.5	–	72	
	2N3381	SI	p,DP,F,3	1500-3000	2	4	–	30	3-20	5-9.5	–	FP	
	2N4038	TRWS	n,DP,M,3	1500-3000	0.2	2.5	–	*20	0-0.1	0-2	3(100 MHz/1 MΩ)	72	
	2N4039	TRWS	n,DP,M,3	1500-3000	0.2	2.5	–	*20	0-0.1	– (2-6)	3(100 MHz/1 MΩ)	72	
	2N3821	TI	n,EP,F,3	1500-4500	3	6	–	50	0.5-2.5	*4 (max)	5(0.01 kHz/1 MΩ)	72	SI
	2N3819	TI	n,EP,F,3	2000-6500	4	8	–	25	2-20	*8 (max)	–	72	
	2N4224	MO	n,DP,F,3	2000-7500	2	6	800	30	2-20	*– (1-7.5)	–	72	
	TIS59	TI	n,EP,F,3	2300-5000	3	6	–	25	6-25	*1-9	–	92	
FET 70	2N3822	TI	n,EP,F,3	3000-6500	3	6	–	50	2-10	*6	5(0.01 kHz/1 MΩ)	72	
	2N4223	MO	n,DP,F,3	3000-7000	2	6	800	30	3-18	*– (1-7)	5(200 MHz/1 kΩ)	72	
	2N3823	TI	n,EP,F,3	3500-6500	2	6	–	30	1-7.5	*8 (max)	2.5(100 MHz/1 kΩ)	72	
	40460	RCA	n,DP,MOS,4	3500 (typ)	1.2	5	–	±25	9 (typ)	–	–	72	
	40461	RCA	n,DP,MOS,4	3500 (typ)	1.2	5	–	±25	4-14	–6 (max)	–	72	
	TIS34	TI	n,EP,F,3	3500-6500	2	6	–	30	4-20	1-8	–	72	
	K1003	KMC	n,M,4	4000 (min)	1.0	3.5	800	15	12-20	6 (max)	4.5(200 MHz)	18	
	2N4416	UC	n,F,PL,3	4500-7500	0.8	4.0	1000	–30	5.0-15	–6.0 (max)	–	72	
	2N4417	UC	n,F,PL,3	4500-7500	0.8	3.5	1000	–30	5.0-15	–6.0	–	3	
	3N128	RCA	n,DP,MOS,4	5000-12,000	0.2	5.8	–	20	5-30	–	–	104	
FET 71	TIXM12	TI	p,DPE,ge,F,3	5000-20,000	4	15	1000	20	–(5-25)	*1-3.5	–	–	
	FT57	FA	n,EP,M,4	6000 (min)	0.8	2.7	60 (typ)	25	9-26	10 (max)	4 at 0.1 GHz/2.5 kΩ)	–	
	TIXM301	TI	p,DPE,F,ge,3	6500-20,000	4	15	3000	20	–(5-25)	*1-3.5	–	72	
	TIXS35	TI	n,EP,F,4	10,000-20,000	5	12	–	30	10-50	*1-5	–	72	
	CP651	CT	n,EP,F,3	75,000-200,000	20	50	–	20	100-500	2-10	–	5	
	CP650	CT	n,EP,F,3.	100,000-250,000	20	50	–	25	300-1200	2-10	–	5	

Circle as many numbers on the reader-service card as you like.

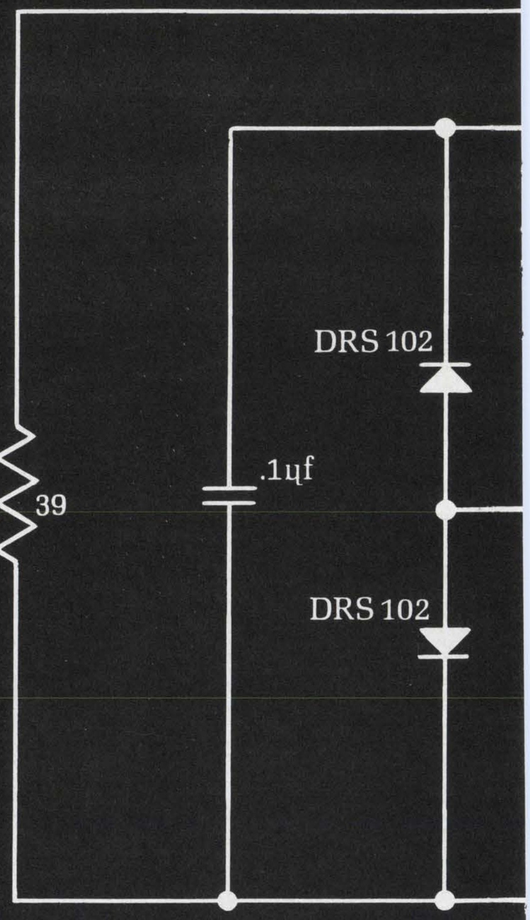
Get detailed spec sheets and application notes: use the reader-service card!

Need a FREE personal copy of this Directory? Circle number **419.**

Complete listing of semiconductor manufacturers starts on page 86.

Valuable reprints are FREE if you circle them on the reader-service card.

Want to convert high energy at high efficiency?



Convert to circuit designs using Delco high voltage silicon power.

The DC to DC converter above operates directly from a 150V DC source and delivers 180 watts to the load at an efficiency of over 94 percent. The 1.1 kHz circuit operates over a temperature range of −65°C to 100°C. Frequencies of up to 25 kHz may be obtained with selected transformer core materials. And the switching job is handled easily by just two Delco NPN DTS-423 silicon transistors—priced at just $4.95 each in 1,000 and up quantities.

Delco pioneered the development of high voltage silicon power transistors to provide you high energy capability at the lowest cost. Among the many circuit benefits you get are: high reliability, reduced assembly time, and a reduction in the number, weight and complexity of the electronic components needed. Coupled with the low prices of the Delco silicon power line, these benefits mean real cost advantages to you.

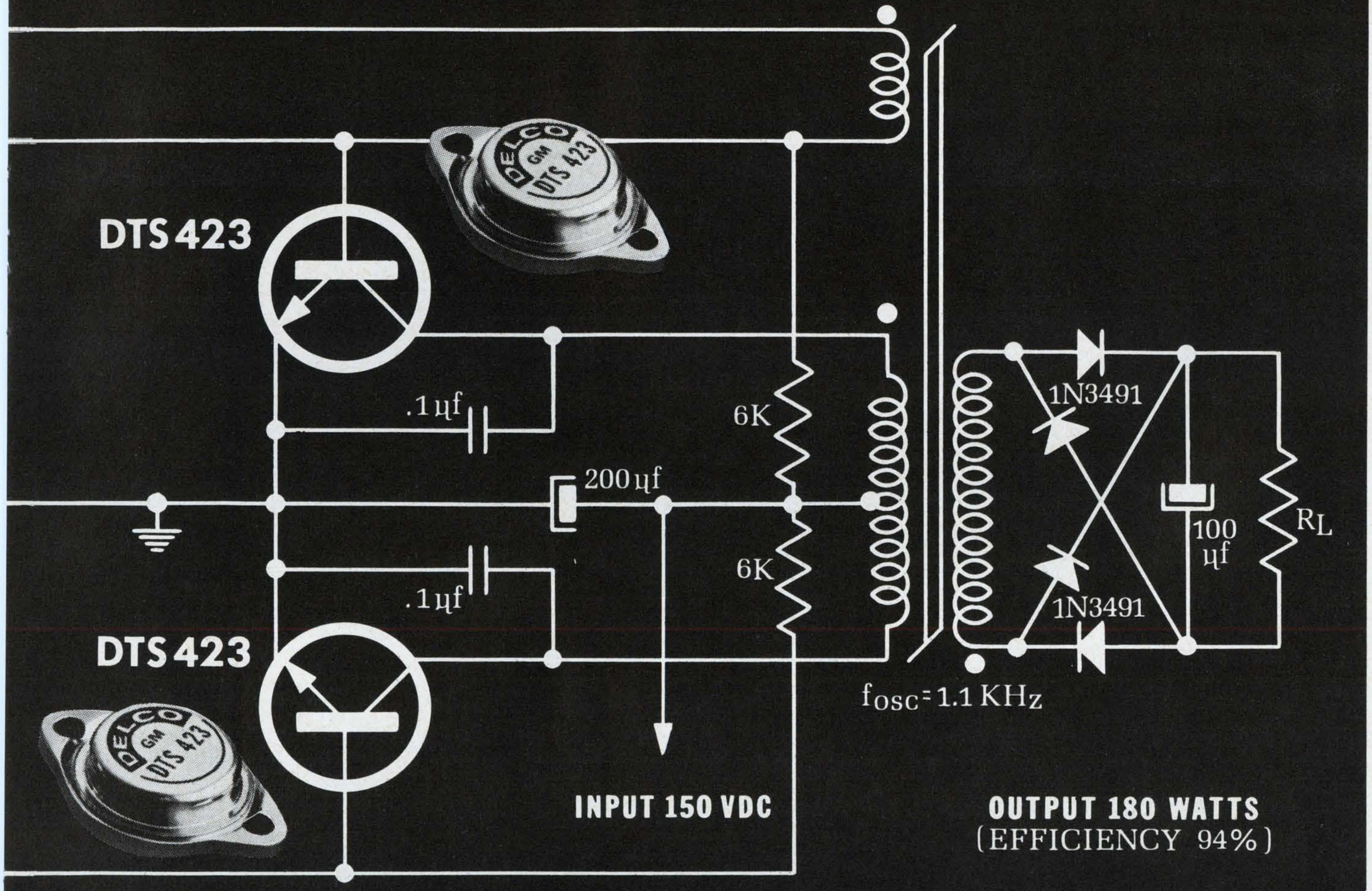
Other applications? They've proven their capability in such high energy circuits as: DC and switching regulators, ultrasonic power supplies, VLF class C amplifiers, off-line class A audio output and CRT deflection (several major TV manufacturers use them for big screen horizontal and vertical deflection).

Availability? With Delco's lead in know-how and plant facilities it's no problem. Samples or production quantities can be shipped promptly. Contact one of our distributors or a Delco sales office right now and see.

For more details on the DC-DC converter circuit—ask for application note number 32.

ON READER-SERVICE CARD CIRCLE 91

Application of Delco high voltage silicon power transistors: the DC to DC Converter.



DEVICE TYPE	V_{CEX}	V_{CEO}/sus (min.)	h_{FE} min. @ I_C V_{CE}=5 V		I_C max.	P_D max.
DTS-410	200	200	10	2.5A	3.5A	80W
DTS-411	300	300	10	2.5A	3.5A	100W
DTS-413	400	325	15	1.0A	2.0A	75W
DTS-423	400	325	10	2.5A	3.5A	100W
DTS-430	400	300	10	3.5A	5.0A	125W
DTS-431	400	325	10	3.5A	5.0A	125W

NPN silicon transistors packaged in solid copper TO-3 case.

GM
MARK OF EXCELLENCE

DELCO RADIO

DIVISION OF GENERAL MOTORS • KOKOMO, INDIANA

Field Sales Offices

Union, New Jersey* 07083
Box 1018 Chestnut Station
(201) 687-3770

Syracuse, New York 13203
1054 James Street
(315) 472-2668

Detroit, Michigan 48202
57 Harper Avenue
(313) 873-6560

Chicago, Illinois* 60656
5151 N. Harlem Avenue
(312) 775-5411

Santa Monica, Calif.* 90401
726 Santa Monica Blvd.
(213) 393-1465

General Sales Office:
700 E. Firmin, Kokomo, Ind. 46901
(317) 459-2175

*Office includes field lab and resident engineer for applications assistance.

How To Use The Transistor Cross Index

Types are listed in numerical sequence. JEDEC numbered devices come first, followed by house-numbered types. The code following each type identifies its application category and the block of ten types in which it is located. A3, for example, means that the type can be found in the third block of the Audio section.

Key to the Letter Codes

A = audio and general purpose

P = power

HF = high frequency

LL = low-level switching

HL = high-level switching

FET = field-effect

UJT = unijunction

2N35	A46
2N43A	A21
2N78A	HF6
2N94	HF2
2N94A	HF3
2N102	A4
2N109	A29
2N117	A4
2N118	A11
2N119	A22
2N120	A35
2N122	P22
2N128	HF14
2N139	HF3
2N140	HF7
2N144	HF93
2N156	P31
2N158	P31
2N158A	P31
2N167A	HF6
2N169	A25
2N173	P86
2N174	P86
2N174A	P86
2N175	A27
2N176	P68
2N178	P68
2N211	HF3
2N212	HF3
2N213	A29
2N213A	A36
2N214	A23
2N215	A21
2N217	A30
2N218	HF3
2N219	HF7
2N219A	HL36
2N220	A27
2N231	HF93
2N233	HF2
2N233A	HF2
2N234A	P34
2N235A	P34
2N235B	P35
2N236A	P53
2N236B	P53
2N243	A6
2N244	A15
2N250A	P68
2N251A	P68
2N257	P68
2N262	HF93
2N268	P68
2N268A	P68
2N270	A28
2N274	HF11
2N277	P86
2N278	P86
2N279	A13
2N280	A22
2N281	A28
2N282	A28
2N284	LL40
2N284A	LL40
2N285A	P35
2N285B	P35
2N297A	P69
2N301	P26
2N301A	P26
2N306	A13
2N315	LL7
2N315A	LL7
2N315B	LL7
2N316	LL13
2N316A	LL13
2N317	LL16
2N317A	LL17
2N326	P20
2N327A	LL1
2N328A	LL1
2N328B	LL1
2N239	LL1
2N329A	LL1
2N329B	LL2
2N330A	A12
2N331	A46
2N332	A4
2N332A	A3
2N333	A11
2N333A	A7
2N334	A18
2N334A	A7
2N335	A22
2N335A	A18
2N336	A35
2N336A	A31
2N337	LL40
2N337A	LL14
2N338	LL40
2N338A	LL18
2N339	P2
2N339A	A11
2N340	P2
2N340A	A11
2N341	P2
2N341A	A11, P1
2N342	P2
2N342A	P2
2N342B	P2
2N343	P2
2N343A	P2
2N343B	P3
2N344	HF11
2N345	HF11
2N346	HF19
2N350A	P69
2N351A	P69
2N356	LL5
2N356A	LL5
2N357	LL8
2N357A	LL8
2N358	LL11
2N358A	LL12
2N370	HF19
2N374	HF93
2N375	P69
2N376A	P69
2N384	HF30
2N388	LL7
2N388A	LL7
2N389	P62
2N389A	P62
2N393	HF13
2N398	LL40
2N398A	LL21
2N399	P35
2N400	P44
2N401	P35
2N404	LL6
2N404A	LL6
2N405	A15
2N406	A16
2N407	A28
2N408	A28
2N409	HF5
2N410	HF5
2N411	HF7
2N412	A30
2N414	LL11
2N418	P35, HL42
2N419	P35
2N420	P35, HL42
2N420A	P35, HL42
2N424	P62
2N424A	HL42
2N426	LL5
2N427	LL7
2N428	LL12
2N441	P87
2N442	P87
2N443	P87
2N444	HF1
2N444A	HF1
2N445	HF2
2N445A	HF2
2N446	HF3
2N446A	HF3
2N447	HF7
2N447A	HF7
2N447B	HF7
2N449	A25
2N456A	P51
2N456B	HL14
2N457A	P51
2N457B	HL14
2N458A	P51
2N458B	HL14
2N463	P51
2N466	HF30
2N470	A3
2N471	A4
2N471A	HF5
2N472	A4
2N472A	A4, HF5
2N473	HF5
2N474	HF5
2N474A	HF5
2N475	HF6

2N869A	HF82
2N870	HF28, P7, HL32
2N871	HF30, P7, HL34
2N909	HL28
2N910	HF28, P7, HL32
2N911	HF21, P7, HL30
2N912	HF20, P7, HL28
2N914	HF71, P4
2N914/46	HF65, LL30, HL19
2N914/51	HF65
2N915	HF65, P4, HL39
2N916	HF75, P4, HL40
2N917	A22, HF88, LL39, HL42
2N918	A22, HF89, LL39
2N923	A5
2N924	A11
2N925	A3
2N926	A11
2N927	A1
2N928	A7
2N929	A26, HF95
2N929A	HF56
2N930	A39, HF96
2N930A	HF64
2N934	A18
2N935	A1
2N936	A6
2N937	A16
2N938	A1
2N939	A6
2N940	A17
2N941	LL16
2N942	LL12
2N943	LL3
2N944	LL3
2N945	LL3
2N946	LL3
2N947	HF56, P4, HL38
2N955	HF90
2N955A	LL40
2N956	HF30
2N957	A26, HF56, P2
2N960	HF79, LL36
2N961	HF79, LL36
2N962	HF79
2N963	HF66
2N964	HF79, LL36
2N964A	HF79
2N965	HF80, LL36
2N966	HF80, LL36
2N967	HF66
2N968	HF70
2N969	HF70
2N970	HF70
2N971	HF70
2N972	HF70
2N973	HF70
2N974	HF70
2N975	HF70
2N976	HF83
2N978	P5, HL28
2N979	HF30
2N980	HF31
2N982	HF79
2N983	HF79
2N984	HF71
2N985	HF96, LL43
2N987	HF31
2N988	HF66
2N989	HF66
2N990	HF26
2N993	HF26
2N995	HF42, P4
2N996	HF56, P4
2N997	A46
2N998	HF96
2N999	LL43
2N1000	LL10
2N1010	A16
2N1011	P44, HL44
2N1012	LL5
2N1014	P51
2N1015	HL10
2N1015A	HL10
2N1015B	HL10
2N1015C	P88, HL10
2N1015D	HL10
2N1015E	HL10
2N1016	HL10
2N1016A	HL10
2N1016B	HL11
2N1016C	HL11
2N1016D	HL11
2N1016E	HL11
2N1021	P52
2N1022	P52
2N1023	HF38
2N1024	A2
2N1025	A2
2N1026	A6
2N1027	A6
2N1028	A2
2N1031	P70
2N1031A	P70
2N1031B	P71
2N1031C	P71
2N1032	P71
2N1032A	P71
2N1032B	P71
2N1032C	P71
2N1034	LL2
2N1035	LL2
2N1036	LL2
2N1037	LL2
2N1038	HL44
2N1039	HL44
2N1040	HL44
2N1041	HL44
2N1042	P31
2N1043	P31
2N1044	P31
2N1045	P31
2N1046	HL44
2N1046A	HL44
2N1046B	HL44
2N1047	P45
2N1047A	P46
2N1047B	P46
2N1047C	P46
2N1048	P46
2N1048A	P46
2N1048B	P46
2N1048C	P46
2N1049	P46
2N1049A	P46
2N1049B	P46
2N1049C	P46
2N1050	P47
2N1050A	P47
2N1050B	P47
2N1050C	P47
2N1051	A15, LL6
2N1052	HF96
2N1054	HF6
2N1055	HL22
2N1058	HF3
2N1059	A23
2N1060	LL19
2N1065	HF11
2N1066	HF38
2N1067	P16
2N1068	P23
2N1069	P52
2N1070	P52
2N1073	P54, HL44
2N1073A	P54, HL44
2N1073B	P54, HL45
2N1079	P54
2N1080	P54
2N1082	A4
2N1086	A42
2N1086A	A43
2N1087	A43
2N1090	HF3, LL7
2N1091	LL3
2N1097	A26
2N1098	A26
2N1099	P88
2N1100	P88
2N1101	A14
2N1102	A14
2N1116	HL24
2N1117	HL23
2N1118	HF6
2N1118A	HF6
2N1119	LL10
2N1120	P51
2N1121	A26
2N1122	HF14
2N1122A	HF14
2N1131	P8, HL30
2N1131A	LL21
2N1132	P8, HL34
2N1132A	LL22
2N1132B	LL22
2N1136	P71
2N1136A	P71
2N1136B	P71
2N1137	P71
2N1137B	P72
2N1138	P72
2N1138A	P72
2N1138B	P72
2N1139	LL22
2N1141	HF96
2N1141A	HF96
2N1142	HF96
2N1142A	HF96
2N1143	HF96
2N1143A	HF97
2N1144	A34
2N1145	A34
2N1146	P72
2N1146A	P72
2N1146B	P72
2N1146C	P72
2N1147	P72
2N1147A	P72
2N1147B	P73
2N1147C	P73
2N1149	A5
2N1150	A11
2N1151	A18
2N1152	A22
2N1153	A35
2N1154	A2
2N1155	A2
2N1156	A2
2N1157	P100
2N1157A	P100
2N1162	P73
2N1162A	P73
2N1163	P73
2N1163A	P74
2N1164	P74
2N1164A	P74
2N1165	P74
2N1165A	P74
2N1166	P74
2N1166A	P74
2N1167	P74
2N1167A	P74
2N1169	LL6
2N1170	LL7
2N1173	HF7, LL8, HL24
2N1175A	A29
2N1177	HF41
2N1178	HF41
2N1179	HF41
2N1180	HF31
2N1183	P21
2N1183A	P21
2N1183B	P21
2N1184	P21
2N1184A	P21
2N1184B	P21
2N1185	A42
2N1186	A15
2N1187	A24
2N1188	A36
2N1189	A30
2N1190	A38
2N1191	A15
2N1192	A21
2N1193	A36
2N1194	A42
2N1195	HF82, LL37
2N1202	P43
2N1203	P43
2N1204	LL24
2N1204A	LL24
2N1206	HF8, P12
2N1207	HF8, P12
2N1208	HL45
2N1209	HL45
2N1210	P54, P62
2N1211	P54
2N1212	HL22
2N1218	P35
2N1219	A6
2N1220	A2
2N1221	A6
2N1222	A2
2N1223	A1
2N1224	HF12
2N1225	HF31
2N1226	HF12
2N1228	LL43
2N1229	LL43
2N1230	LL43
2N1231	LL43
2N1232	LL43
2N1233	LL43
2N1234	LL43
2N1235	P62
2N1238	HL45
2N1239	HL45
2N1240	HL45
2N1241	HL45
2N1242	HL45
2N1243	HL45
2N1244	HL45
2N1247	HF97
2N1248	A5
2N1250	P63
2N1251	A29
2N1252	HF28, P8, LL22, HL32
2N1253	HF37, P8, LL24, HL36
2N1254	LL22
2N1255	LL22
2N1256	LL22
2N1257	LL22
2N1258	LL23
2N1259	LL23
2N1260	P63
2N1261	P43
2N1262	P43
2N1263	P43

2N1788	HF32
2N1789	HF32
2N1790	HF32
2N1808	LL6
2N1809	P104, HL3
2N1810	P104, HL3
2N1811	P104, HL3
2N1812	P104, HL3
2N1813	P104, HL3
2N1814	P104, HL4
2N1816	P104, HL6
2N1817	P105, HL6
2N1818	P105, HL6
2N1819	P105, HL6
2N1823	P105, HL8
2N1824	P105, HL8
2N1825	P106, HL8
2N1826	P106, HL8
2N1830	P106, HL8
2N1831	P106, HL4
2N1832	P106, HL4
2N1833	P106, HL4
2N1837	P8, HL37
2N1838	P8, HL34
2N1839	P9, HL34
2N1840	P9, HL34
2N1853	LL45
2N1854	LL20
2N1864	HF17
2N1865	HF99
2N1866	HF99
2N1867	HF99
2N1868	HF99
2N1886	HL24
2N1893	HF18
2N1893A	HF32, P13, HL35
2N1899	P85, HL26
2N1900	HF18, P85
2N1901	P85, HL26
2N1902	P85, HL26
2N1903	HF18, P85
2N1904	P85, HL26
2N1905	P53
2N1906	P53
2N1907	HF8, P55, HL2
2N1908	HF8, P55, HL3
2N1917	LL45
2N1918	LL45
2N1919	LL45
2N1920	LL45
2N1921	LL45
2N1922	LL46
2N1924	A28
2N1925	A34
2N1926	A38
2N1936	P89
2N1937	P89
2N1943	P15
2N1958	HF33
2N1958A	HF33
2N1959	HF33
2N1959A	HF33
2N1960	HF99
2N1961	HF99
2N1962	HF49
2N1963	HF50
2N1964	HF33
2N1965	HF34
2N1972	HF20, HL29
2N1973	HF28, P13, HL32
2N1974	HF8, P14, HL30
2N1975	HF20, P14, HL29
2N1978	HF18, P39, HL26
2N1983	HF12, P9, HL25
2N1984	HF12, P9, HL25
2N1985	HF12, P9, HL25
2N1986	HF18, P10, HL27
2N1987	HF18, P10, HL27
2N1988	HF18, P10, HL27
2N1989	HF18, P10, HL27
2N1990	HF99, P10, HL46
2N1991	P10, HL27
2N1992	LL37
2N1994	LL46
2N1995	LL46
2N1996	LL46
2N1997	LL46
2N1998	LL46
2N1999	LL46
2N2000	LL46
2N2001	LL46
2N2015	P89
2N2016	P89
2N2017	P16, P24
2N2018	P48
2N2019	P48
2N2020	P48
2N2021	P48
2N2033	P22
2N2034	P22
2N2035	P27
2N2038	P1
2N2039	P1
2N2040	P1
2N2041	P2
2N2042	A10
2N2042A	A11
2N2043	A20
2N2043A	A20
2N2048	HF43, LL28
2N2048A	HF43
2N2049	P14
2N2060	HF20
2N2060A	HF20
2N2061A	P81
2N2062A	P81
2N2063A	P82
2N2064A	P82
2N2065A	P82
2N2066A	P82
2N2067	P24
2N2067B	P24
2N2067G	P24
2N2067O	P24
2N2067W	P24
2N2068	P25
2N2068G	P25
2N2068O	P25
2N2075	P94
2N2075A	P94
2N2076	P94
2N2076A	P94
2N2077	P94
2N2077A	P94
2N2078	P94
2N2078A	P94
2N2079	P94
2N2079A	P94
2N2080	P95
2N2080A	P95
2N2081	P95
2N2081A	P95
2N2082	P95
2N2082A	P95
2N2084	HF34
2N2089	HF26
2N2092	HF22
2N2093	HF22
2N2095	HF80
2N2096	HF75
2N2097	HF76
2N2098	HF80
2N2099	HF76
2N2100	HF76
2N2102	LL23
2N2106	P3
2N2107	P3
2N2108	P3
2N2109	P106, HL4
2N2110	P106, HL4
2N2111	P106, HL4
2N2112	P106, HL4
2N2113	P107, HL4
2N2114	P107, HL5
2N2116	P107, HL6
2N2117	P107, HL6
2N2118	P107, HL7
2N2119	P107, HL7
2N2123	P107, HL8
2N2124	P107, HL8
2N2125	P107, HL8
2N2126	P107, HL8
2N2130	P108, HL5
2N2131	P108, HL5
2N2132	P108, HL5
2N2133	P108, HL5
2N2137	P56
2N2137A	P56
2N2138	P56
2N2138A	P56
2N2139	P56
2N2139A	P56
2N2140	P56
2N2140A	P56
2N2141	P57
2N2141A	P57
2N2142	P57
2N2142A	P57
2N2143	P57
2N2143A	P58
2N2144	P58
2N2144A	P58
2N2145	P58
2N2145A	P58
2N2146	P58
2N2146A	P58
2N2147	P27
2N2148	P27
2N2150	P39
2N2151	P39
2N2152	P95
2N2152A	P95
2N2153	P95
2N2153A	P95
2N2154	P96
2N2154A	P96
2N2156	P96
2N2156A	P96
2N2157	P96
2N2157A	P96
2N2158	P96
2N2158A	P96
2N2160	UJT1
2N2162	LL14
2N2163	LL14
2N2164	LL18
2N2165	LL12
2N2166	LL12
2N2167	LL16
2N2168	HF79
2N2169	HF79
2N2170	HF72
2N2171	A38
2N2173	A14
2N2177	A5
2N2178	A5
2N2185	LL10
2N2186	LL10
2N2187	LL10
2N2188	HF29, HF99, LL46
2N2189	HF37, HF99, LL47
2N2190	HF29, HF99, LL47
2N2191	HF37, HF100, LL47
2N2192A	HF100, P12
2N2193A	HF39, P12, HL36
2N2194A	HF39, P12, HL36
2N2195A	HF39, P12, HL36
2N2196	P27
2N2197	P27
2N2201	P27
2N2202	P28
2N2203	P28
2N2204	P28
2N2205	LL26
2N2206	LL26
2N2207	HF46
2N2217	HF57, HL17
2N2218	HF57, HL17
2N2218A	HF58
2N2219	HF58, HL18
2N2219A	HF66, HL18
2N2220	HF59, HL18
2N2221	HF59, HL18
2N2221A	HF59
2N2222	HF59, HL18
2N2222A	HF66
2N2223	HF18
2N2223A	HF19
2N2225	HF12
2N2226	P90, HL3
2N2227	P90, HL3
2N2228	P90, HL3
2N2229	P90, HL3
2N2230	P90, HL2
2N2231	P90, HL2
2N2232	P90, HL2
2N2233	P90, HL2
2N2239	P28
2N2243A	HF39, P12, HL36
2N2244	A20
2N2245	A33
2N2246	A40
2N2247	A20
2N2248	A33
2N2249	A40
2N2250	A20
2N2251	A33
2N2252	A40
2N2253	A20
2N2254	A33
2N2255	A40
2N2256	HF71, LL31
2N2257	HF71, LL31
2N2258	HF71, LL31
2N2259	HF71, LL31
2N2266	P50
2N2267	P50
2N2268	P50
2N2269	P50
2N2270	P17, HL13
2N2273	HF59
2N2274	LL8
2N2275	LL8
2N2276	HF4, LL9
2N2277	HF4, LL9

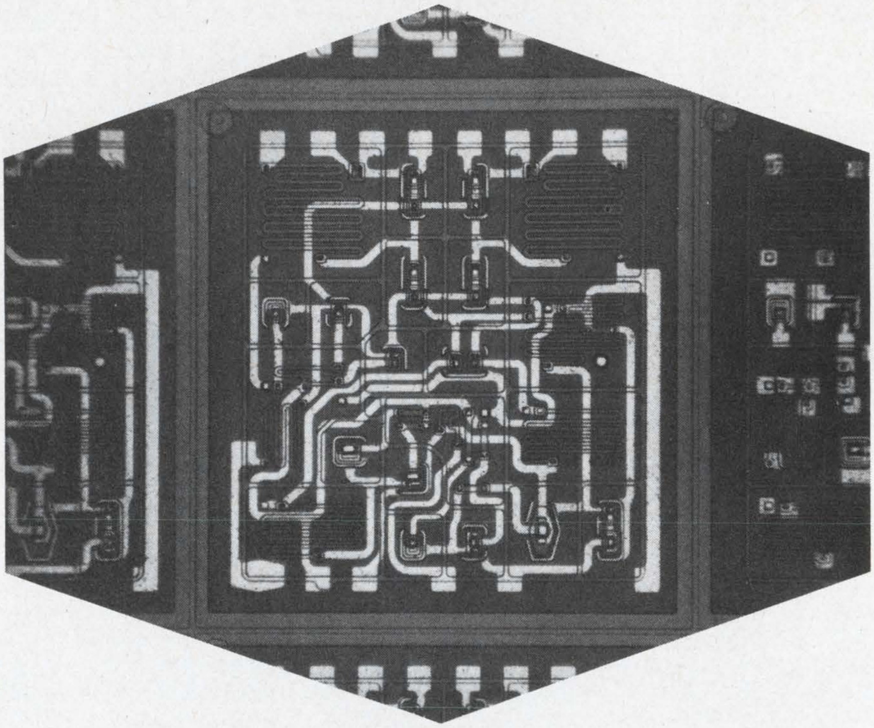
2N2278	LL10
2N2279	LL10
2N2280	LL16
2N2281	LL16
2N2282	P16
2N2283	P16
2N2284	P17
2N2285	P82, HL46
2N2286	P83, HL46
2N2287	P83, HL46
2N2288	P55, HL46
2N2289	P55, HL46
2N2290	P55, HL46
2N2291	P55, HL46
2N2292	P55, HL46
2N2293	P55, HL47
2N2294	P55, HL47
2N2295	P56, HL47
2N2296	P56, HL47
2N2297	P17
2N2303	P10
2N2304	A12
2N2305	P60
2N2308	P36
2N2310	HL12
2N2311	HL12
2N2312	HL12
2N2313	HL12
2N2314	HL12
2N2315	HL12
2N2316	HL12
2N2317	HL13
2N2318	HF66
2N2319	HF66
2N2320	HF67
2N2330	HF34, LL26
2N2331	HF34, LL26
2N2338	P90
2N2349	LL15
2N2350	LL17
2N2350A	HF39, P7, HL36
2N2351	LL17
2N2351A	HF40, P17, HL37
2N2352	LL17
2N2352A	HF40, P18, HL37
2N2353	LL18
2N2353A	HF40, P18, HL37
2N2357	P96, HL47
2N2358	P96, HL47
2N2359	P97, HL47
2N2360	HF100
2N2361	HF100
2N2362	HF100
2N2364A	HF40, P18, HL37
2N2368	HF88, P4, LL37, HL40
2N2369	HF85, P5, LL38, HL41
2N2369A	HF68, LL38, HL40
2N2370	A5
2N2371	A10
2N2372	A6
2N2373	A10
2N2377	HF6
2N2378	HF5
2N2381	HF67, LL30
2N2382	HF67, LL30
2N2383	P63
2N2384	P63
2N2386	FET11, FET17, FET28, FET48, FET53, FET65
2N2387	A27
2N2388	A39
2N2389	A16, HF100, HL47
2N2390	HL47
2N2391	A6
2N2392	A14
2N2394	HL47
2N2395	HF100, HL48
2N2397	HF50, HL15
2N2398	HF100
2N2399	HF100
2N2400	HF43
2N2401	HF50
2N2402	HF59
2N2405	HF34
2N2410	HF100, HL48
2N2411	HF101
2N2412	HF101
2N2413	HF101
2N2415	HF101
2N2416	HF101
2N2423	P82
2N2427	HF18
2N2428	A38
2N2429	A43
2N2430	A27
2N2431	A34
2N2432	HF11
2N2432A	A23, LL18
2N2451	HF29
2N2453	A40
2N2453A	A40
2N2455	HL41
2N2459	HF46
2N2460	HF50
2N2461	HF56
2N2462	FH59
2N2463	HF46
2N2464	HF50
2N2465	HF56
2N2466	HF60
2N2475	LL28, LL37
2N2476	HF60, LL28
2N2477	HF60
2N2480	HF93
2N2480A	HF80
2N2481	HL19
2N2483	HF21
2N2484	HF20
2N2485	HF101
2N2486	HF101
2N2487	HF74
2N2488	HF74
2N2489	HF67
2N2494	HF74
2N2495	HF47
2N2496	HF47
2N2497	FET2, FET15, FET25, FET48, FET65
2N2498	FET2, FET15, FET26, FET51, FET65
2N2499	FET3, FET15, FET27, FET55, FET65
2N2500	FET12, FET15, FET26, FET49, FET65
2N2501	HF72
2N2509	HF15
2N2510	HF15
2N2511	HF15
2N2512	HF46
2N2515	HF46
2N2516	HF50
2N2518	HF46
2N2519	HF46
2N2520	HF43
2N2521	HF47
2N2522	HF50
2N2523	HF60
2N2524	HF64
2N2525	HF45, P30
2N2526	P63, HL48
2N2527	P63, HL48
2N2528	P63, HL48
2N2537	HF60, LL34
2N2538	HF60, LL34
2N2539	HF60, LL34
2N2540	HF60, LL34
2N2551	LL47
2N2552	P31
2N2553	P32
2N2554	P32
2N2555	P32
2N2556	P32
2N2557	P32
2N2558	P32
2N2559	P32
2N2560	P32, HL2
2N2561	P32
2N2562	P32
2N2563	P33
2N2564	HL2
2N2565	HL2
2N2569	LL23
2N2570	LL23
2N2580	P99
2N2581	P99
2N2582	P99
2N2583	P99
2N2586	A39
2N2590	HF26
2N2591	HF34
2N2592	HF39
2N2593	HF43
2N2595	HF20
2N2596	HF29
2N2597	HF38
2N2598	HF20
2N2599	HF29
2N2599A	A14
2N2600	HF38
2N2600A	A27
2N2601	HF20
2N2602	HF29
2N2603	HF38
2N2604	HF43
2N2605	HF47
2N2605A	HF15
2N2606	FET23, FET37
2N2607	FET24, FET41
2N2608	FET24, FET48
2N2609	FET24, FET52
2N2611	P28
2N2613	A41
2N2614	A43
2N2616	A23
2N2617	A12
2N2618	HF50
2N2618/4	HF50
2N2631	P22
2N2632	P48
2N2633	P48
2N2634	P48
2N2635	HF101
2N2645	HF29
2N2646	UJT1
2N2647	UJT1, UJT3
2N2649	HF101
2N2650	HF101
2N2654	HF43
2N2656	HF63
2N2657	P15
2N2658	P15
2N2671	HF27
2N2672	HF27
2N2673	A3
2N2674	A7
2N2675	A18
2N2676	A31
2N2677	LL12
2N2678	LL18
2N2692	LL47
2N2695	HF34
2N2696	HF34
2N2697	P33
2N2698	P33
2N2706	A24, A38
2N2707	A38
2N2708	HF86
2N2709	HF1
2N2711	A15
2N2712	A30
2N2713	A15
2N2714	A30
2N2715	A33
2N2716	A38
2N2717	A25, LL30
2N2720	HF29
2N2721	HF29
2N2722	HF34
2N2723	HF102
2N2724	HF102
2N2725	HF102
2N2726	P18
2N2727	P18
2N2728	P97
2N2729	A23, HF89
2N2730	P97
2N2731	P97
2N2732	P97
2N2733	P85
2N2734	P86
2N2735	P86
2N2736	P86
2N2737	P86
2N2738	P86
2N2739	P100, HL5
2N2740	P100, HL5
2N2741	P100, HL5
2N2742	P100, HL5
2N2745	P100, HL7
2N2746	P100, HL7
2N2747	P100, HL7
2N2748	HF90, P100, HL7
2N2751	P101, HL8
2N2752	P101, HL8
2N2753	P101, HL9
2N2754	P102, HL9
2N2757	P101, HL5
2N2758	P101, HL6
2N2759	P101, HL6
2N2760	P101, HL6
2N2761	P101, HL6
2N2763	P101, HL7
2N2764	P102, HL7
2N2765	P102, HL7
2N2766	P102, HL7
2N2769	P102, HL9
2N2770	P102, HL9
2N2771	P102, HL9
2N2772	P102, HL10
2N2775	P102
2N2776	P102
2N2777	P102
2N2778	P103
2N2781	HF42, P28
2N2782	HF42, P28
2N2783	HF42, P28
2N2785	A46
2N2787	HF60, LL38
2N2788	HF60, LL38
2N2789	HF61, LL38
2N2790	HF61, LL38

2N2791	HF61, LL38
2N2792	HF61, LL39
2N2795	HF67
2N2796	HF67
2N2797	HF43
2N2798	HF38
2N2799	HF38
2N2800	LL24
2N2801	LL24
2N2808	HF90
2N2808A	HF91
2N2809	HF90
2N2809A	HF91
2N2810	HF91
2N2810A	HF91
2N2811	P53
2N2812	P53
2N2813	P53
2N2814	P53
2N2815	P103
2N2816	P103
2N2817	P103
2N2818	P103
2N2819	P103
2N2820	P103
2N2821	P103
2N2822	P103
2N2823	P103
2N2824	P104
2N2825	P104
2N2828	P48
2N2829	P48
2N2831	A12
2N2832	P64
2N2833	P64
2N2834	P64
2N2835	P31
2N2836	P44
2N2837	HF38
2N2838	HF39
2N2841	FET23, FET34, FET57
2N2842	FET24, FET36, FET57
2N2843	FET24, FET39
2N2844	FET25, FET43
2N2845	HF72
2N2846	HF72
2N2847	HF72
2N2848	HF72
2N2849	HL32
2N2850	HL28
2N2851	HL29
2N2852	HL26
2N2853	HL29
2N2854	HL32
2N2855	HL29
2N2856	HL26
2N2857	HF91
2N2858	P22
2N2859	P22
2N2860	A13
2N2861	HF102
2N2862	HF102
2N2863	HF102
2N2864	HF102
2N2865	HF102
2N2868	A19
2N2869	P39
2N2870	P39
2N2871	LL47
2N2872	LL47
2N2874	HF42, P28
2N2875	P33
2N2876	HF50
2N2877	P39
2N2878	P39
2N2879	P39
2N2880	P39
2N2881	P22
2N2882	P22
2N2883	HF80
2N2884	HF80
2N2885	HF67
2N2887	HF67, P36
2N2890	P18
2N2891	P18
2N2892	P40
2N2893	P40
2N2894	HF72, LL34
2N2894A	HL33
2N2895	HF34
2N2896	HF35
2N2897	HF35
2N2900	HF35
2N2902	P48, P104
2N2903	A38
2N2903A	A38
2N2904	HF51
2N2904A	HF51
2N2905	HF51
2N2905A	HF51
2N2906	HF51
2N2906A	HF51
2N2907	HF51
2N2907A	HF51
2N2908	P64
2N2909	A19
2N2911	P23
2N2912	P60
2N2913	HF45
2N2914	HF22
2N2915	HF23
2N2916	HF23
2N2917	HF23
2N2918	HF23
2N2919	HF23
2N2920	HF24
2N2921	HF51
2N2922	HF52
2N2923	A34
2N2924	A39
2N2925	A43
2N2926	A16
2N2927	HF43
2N2929	HF91
2N2936	HF102
2N2937	HF102
2N2942	HF43
2N2943	HF39
2N2944	HF8, LL12
2N2944A	A35, LL15
2N2945	HF4, LL8
2N2945A	A29, LL13
2N2946	HF2, LL6
2N2946A	A23, LL8
2N2947	HF35
2N2948	HF35
2N2949	HF35
2N2950	HF35
2N2951	HF52
2N2952	HF52
2N2953	A44
2N2955	HF72
2N2956	HF74
2N2957	HF76
2N2958	HF61
2N2959	HF61
2N2962	HF86
2N2963	HF86
2N2964	HF86
2N2965	HF86
2N2966	HF88
2N2968	LL12
2N2969	LL12
2N2970	LL11
2N2971	LL11
2N2972	HF24
2N2973	HF24
2N2974	HF24
2N2975	HF24
2N2976	HF24
2N2977	HF25
2N2978	HF25
2N2979	HF25
2N2980	HF21
2N2981	HF21
2N2982	HF26
2N2987	P28
2N2988	P29
2N2989	P29
2N2990	P29
2N2991	P29
2N2992	P29
2N2993	P29
2N2994	P29
2N2995	P29
2N2996	HF76
2N2997	HF76
2N2998	HF84
2N2999	HF92
2N3009	HF72, LL32
2N3010	LL37
2N3011	LL34
2N3012	LL35
2N3013	HF83, HL21
2N3014	HF83, HL21
2N3015	HF61, LL28
2N3016	HF103, P18
2N3017	HF103
2N3018	HF103, P36
2N3019	HF26, LL13
2N3020	HF26, LL13
2N3021	P36
2N3022	P36
2N3023	P36
2N3024	P37
2N3025	P37
2N3026	P37
2N3043	HF67
2N3049	HF84
2N3053	HL35
2N3054	HL22
2N3055	HL20
2N3056	HF26, P18
2N3056A	P18
2N3057	HF26, P19
2N3057A	P19
2N3058	A34
2N3059	A43
2N3060	A34
2N3061	A41
2N3062	A28
2N3063	A28
2N3064	A19
2N3065	A19
2N3066	FET46
2N3067	FET39
2N3068	FET34
2N3068A	FET35
2N3069	FET52
2N3070	FET44
2N3071	FET37
2N3074	HF47
2N3075	HF26
2N3076	P85, HL27
2N3077	A45
2N3078	A44
2N3081	HF44
2N3081/46	HF44
2N3081/51	HF44
2N3084	FET46
2N3085	FET46
2N3086	FET46
2N3087	FET46
2N3088	FET61
2N3088A	FET63
2N3089	FET61
2N3089A	FET63
2N3107	LL21
2N3108	LL22, HL34
2N3109	LL21
2N3110	LL22, HL34
2N3112	FET23, FET34
2N3113	FET23, FET34
2N3114	P19
2N3115	HF61
2N3116	HF61
2N3117	HL29
2N3118	HF61
2N3119	HF62
2N3128	A29
2N3129	A39
2N3130	A35
2N3131	LL30
2N3133	HF52
2N3134	HF52
2N3135	HF52
2N3136	HF52
2N3137	HF87
2N3138	HF103
2N3139	HF103
2N3140	HF103
2N3141	HF103
2N3142	HF103
2N3143	HF103
2N3144	HF103
2N3145	HF104
2N3146	P93
2N3147	P93
2N3149	P108
2N3150	P108
2N3151	P108
2N3154	P45
2N3155	P45
2N3156	P45
2N3157	P45
2N3158	P45
2N3163	P64
2N3164	P64
2N3165	P64
2N3166	P64
2N3167	P64
2N3168	P64
2N3169	P65
2N3170	P65
2N3171	P60
2N3172	P60
2N3173	P60
2N3174	P61
2N3175	P65
2N3176	P65
2N3177	P65
2N3178	P66
2N3179	P66
2N3180	P66
2N3181	P66
2N3182	P66
2N3183	P61
2N3184	P61
2N3185	P61
2N3186	P61
2N3187	P66
2N3188	P66
2N3189	P66
2N3190	P66
2N3191	P66
2N3192	P67
2N3193	P67
2N3194	P67
2N3195	P61
2N3196	P61

2N3197	P61
2N3198	P61
2N3199	P49
2N3200	P49
2N3201	P49
2N3202	P23
2N3203	P23
2N3204	P23
2N3205	P49
2N3206	P49
2N3207	P50
2N3208	P23
2N3209	HL41
2N3212	P26
2N3213	P26
2N3214	P27
2N3215	P27
2N3217	LL47
2N3218	LL47
2N3219	LL47
2N3220	P40
2N3221	P40
2N3222	P40
2N3223	P59
2N3227	HF81, HL20
2N3229	HF52
2N3230	P37
2N3231	P37
2N3241A	A39, P10, HL37
2N3242A	A43, P10, HL37
2N3244	HF47
2N3245	HF44
2N3248	HF62
2N3249	HF67
2N3250	HF62, LL28
2N3250A	HL18
2N3251	HF68, LL30
2N3251A	HL19
2N3252	HF52, HL15
2N3253	HF47, HL14
2N3262	HF44
2N3263	P85
2N3264	P62
2N3265	P85
2N3266	P62
2N3277	FET12, FET41
2N3278	FET12, FET46
2N3279	HF76
2N3280	HF76
2N3281	HF68
2N3282	HF68
2N3283	HF62
2N3284	HF62
2N3285	HF62
2N3286	HF62
2N3287	HF72
2N3288	HF73
2N3289	HF68
2N3290	HF68
2N3291	HF62
2N3292	HF58
2N3293	HF58
2N3294	HF58
2N3295	HF2
2N3296	HF1
2N3297	HF1
2N3298	HF53
2N3299	HF76, HL40
2N3300	HF76, HL40
2N3301	HF77, HL40
2N3302	HF77, HL40
2N3303	HF86, HL42
2N3304	HF86
2N3307	HF68
2N3308	HF68
2N3309	HF68
2N3311	P98
2N3312	P98
2N3313	P98
2N3314	P98
2N3315	P98
2N3316	P98
2N3317	HF8, LL9
2N3318	HF5, LL10
2N3319	HF8, LL14
2N3320	HF84
2N3321	HF84
2N3322	HF84
2N3323	HF53
2N3324	HF53
2N3325	HF53
2N3326	HF58
2N3327	A43, HF77
2N3328	FET48
2N3329	FET2, FET18, FET25, FET49, FET61
2N3330	FET2, FET18, FET25, FET51, FET61
2N3331	FET3, FET17, FET27, FET55, FET60
2N3332	FET12, FET18, FET26, FET49, FET62
2N3333	FET30
2N3334	FET29
2N3335	FET29
2N3336	FET29
2N3337	HF77
2N3338	HF77
2N3339	HF77
2N3340	LL21
2N3341	LL21
2N3342	LL3
2N3343	LL4
2N3344	LL3
2N3345	LL3
2N3346	LL3
2N3365	FET46
2N3366	FET39
2N3367	FET34
2N3368	FET53
2N3369	FET44
2N3370	FET37
2N3371	HF77
2N3374	P19
2N3375	HF81
2N3376	FET1, FET58, FET68
2N3377	FET1, FET58, FET68
2N3378	FET2, FET54, FET69
2N3379	FET2, FET54, FET69
2N3380	FET4, FET69
2N3381	FET4, FET69
2N3382	FET5
2N3383	FET5
2N3384	FET6
2N3385	FET6
2N3386	FET6
2N3387	FET6
2N3390	A44
2N3391	A44
2N3391A	A44
2N3392	A39
2N3393	A34
2N3394	A25
2N3395	A45
2N3396	A45
2N3397	A45
2N3398	A45
2N3399	HF84
2N3402	A30
2N3403	A41
2N3404	A30
2N3405	A42
2N3409	HF58
2N3410	HF58
2N3411	HF58
2N3414	A31
2N3415	A42
2N3416	A31
2N3417	A42
2N3418	P25
2N3419	P25
2N3420	P26
2N3421	P26
2N3423	HF84, HL41
2N3424	HF84, HL21
2N3426	HF53, HL15
2N3427	A43
2N3428	A44
2N3429	P90, HL15
2N3430	P91, HL15
2N3431	P91, HL15
2N3432	P91, HL15
2N3433	P91, HL16
2N3434	P91, HL16
2N3436	FET4, FET54
2N3437	FET3, FET47
2N3438	FET40
2N3439	P19
2N3440	P19
2N3441	P37
2N3442	P83
2N3444	HL14
2N3445	P83
2N3446	P83
2N3447	P84
2N3448	P84
2N3452	FET47, FET62
2N3453	FET40, FET62
2N3454	FET34, FET62
2N3455	FET47, FET60
2N3456	FET40, FET60
2N3457	FET35, FET60
2N3458	FET4, FET54, FET59
2N3459	FET3, FET47, FET60
2N3460	FET2, FET40, FET60
2N3462	A32
2N3463	A32
2N3467	HL14
2N3468	HL13
2N3469	P15
2N3470	P91, HL20
2N3471	P91, HL20
2N3472	P91, HL20
2N3473	P91, HL20
2N3474	P91, HL21
2N3475	P92, HL21
2N3476	P92, HL21
2N3477	P92, HL21
2N3478	HF90
2N3485	LL26, HL16
2N3485A	LL26, HL16
2N3486	LL27, HL16
2N3486A	LL27, HL16
2N3487	P84
2N3488	P84
2N3489	P84
2N3490	P84
2N3491	P84
2N3492	P84
2N3493	LL35
2N3494	HL16
2N3495	HL13
2N3496	HL16
2N3497	HL13
2N3498	HL13
2N3499	HL13
2N3500	HL13
2N3501	HL14
2N3502	HF62, HL38
2M3503	HF62, HL38
2N3504	HF63, HL19
2N3505	HF63, HL38
2N3506	HL13
2N3507	HL13
2N3508	HL21
2N3409	HL21
2N3510	HL20
2N3511	HL20
2N3512	HL39
2N3544	HF84
2N3546	HL21
2N3547	LL20
2N3548	LL21
2N3549	LL21
2N3551	P50
2N3552	P50
2N3553	HF80
2N3554	LL26
2N3563	HF90
2N3564	HF87
2N3565	HF14
2N3566	HF14
2N3567	HF21
2N3568	HF21
2N3569	HF21
2N3570	HF92
2N3571	HF91
2N3572	HF91
2N3576	HF77, LL35
2N3577	P67
2N3578	FET48
2N3579	A10
2N3580	A20
2N3581	A23
2N3582	A35
2N3583	P44
2N3584	P44
2N3585	P44
2N3588	HF56
2N3589	P29
2N3590	P29
2N3591	P30
2N3592	P30
2N3593	P21
2N3594	P21
2N3595	P30
2N3596	P30
2N3597	P83
2N3598	P83
2N3599	P83
2N3600	HF88
2N3605	LL30
2N3506	LL30
2N3507	LL30
2N3608	FET5, FET19, FET58, FET67
2N3610	FET1
2N3611	P67
2N3612	P67
2N3613	P67
2N3614	P67
2N3615	P67
2N3616	P67
2N3617	P68
2N3618	P68
2N3619	HF53
2N3620	HF53
2N3621	HF53
2N3622	HF53
2N3623	HF53
2N3624	HF54

(continued on p. 180)

Union Carbide's New Integrated Circuit Operational Amplifier



The 15nA Operational Amplifier

ADVANCED DATA SHEET FOR YOUR USE

- 15nA differential input offset current (max)
- 175pA/°C differential input offset current drift (max)
- 5mV input offset voltage (max)
- 10μV/°C input offset voltage drift (max)
- 50nA input biasing current (max)
- ±10V common mode voltage (min)
- ±10V output voltage swing (min)
  2mA output current drive (min)
- 20,000 open loop voltage gain (min)
- −55°C to +125°C operating temp. in TO-101
- Offset Voltage adjustable to zero with external potentiometer
- Off the shelf delivery

applications: A to D converter • Bridge amplifier • DC amplifier • Differential amplifier
Integrater (DC to AC) • Sample and hold amplifier

UNION
CARBIDE
ELECTRONICS

ON READER-SERVICE CARD CIRCLE 77

UNION CARBIDE

ELECTRONICS

MONOLITHIC OPERATIONAL AMPLIFIERS
LINEAR INTEGRATED CIRCUITS
UC4000/UC4001/UC4002

The UC4000 series of operational amplifiers are constructed on a single silicon chip. The amplifier has the following features:
• Offset voltage adjustable to zero with external potentiometer • ±10V common mode voltage • 15 nA differential input offset current • 100 pA/°C differential input current drift • 10 μV/°C input offset voltage drift

MAXIMUM RATINGS

T_A = 25°C (UNLESS OTHERWISE NOTED)

	UC4000/UC4001/UC4002
Supply Voltage	±18.0 Volts
Internal Power Dissipation 125°C Ambient Temp. (Note 1)	200 mW
Output Short Circuit Duration	5 sec
Differential Input Voltage	±10.0 Volts
Input Voltage, Common Mode	±10.0 Volts
Storage Temperature Range	−65°C to +200°C
Operating Ambient Temperature Range	−55°C to +125°C
Lead Temperature Soldering for 60 seconds	+300°C

Note 1. Rating applies for ambient temperatures to 125°C; derate linearly at 2.6 mW/°C for ambient temperatures above 125°C.

ELECTRICAL CHARACTERISTICS

@ 25°C and Supply Voltage ±15.0 Volts in Test Circuit Figure No. 4 (UNLESS OTHERWISE NOTED)

		UC4000			UC4001			UC4002				
SPECIFICATION	Sym.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Unit	TEST CONDITIONS
Large Signal, Open Loop Voltage Gain	A_v	20K		80K	20K		80K	20K		80K		V_{IN} = 100 μV rms R_L = 10 K ohms f = 100 Hz
Large Signal, Open Loop Voltage Gain	A_v	15K			15K			15K				V_{IN} = 100 μV rms R_L = 10 K ohms, f=100 Hz (T_A = −55°C to +125°C)
Differential Input Impedance	R_{in} C_{in}	0.8	3.0 1.0		0.8	3.0 1.0		0.8	3.0 1.0		MΩ pF	V_{out} = 7 V rms f = 1 KHz
Open Loop Output Resistance	R_{out}		100			100			100		ohm	V_{out} ≤1 V p-p f = 100 Hz
Output Voltage Swing	V_{out}	±10			±10			±10			V	R_L = 10 K ohms (T_A = −55°C to +125°C)
Output Current	I_{out}	±2			±2			±2			mA	R_L = 5 K ohms
Equivalent Input Offset Voltage (2)	V_{os}		3.0	5.0		5.0	10.0		7.0	10.0	mV	R_L = 10 K ohms
Equivalent Input Offset Voltage Change with Temp.	ΔV_{os}			1.8			3.6			7.2	mV	R_L = 10 K ohms (T_A = −55°C to +125°C)
Equivalent Average Offset Voltage Drift	ΔV_{os}			10			20			40	μV/°C	R_L = 10 K ohms (T_A = −55°C to +125°C)
Offset Voltage Change with Power Supply Variation	ΔV_{os}		25	150		25	150		25	150	μV/V	R_L = 10 K ohms, V_{out} = 0 ΔV_{PS} = 1 V rms, f = 100 Hz
Offset Voltage Drift with Time	ΔV_{os}		40			100			160		μV/24 hr	V_{OS} = 0 at start, t = 24 hrs.
Differential Input Offset Current	I_{os}			15			30			50	nA	V_{out} = 0, R_L = 10 K ohms
Differential Input Offset Current Change with Temp.	ΔI_{os}			31.5			63.0			126	nA	V_{out} = 0, R_L = 10 K ohms (T_A = −55°C to +125°C)

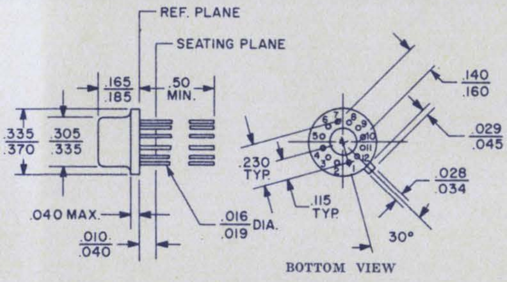
April 1967

ELECTRICAL CHARACTERISTICS

@ 25°C and Supply Voltage ±15.0 Volts in Test Circuit Figure No. 4 (UNLESS OTHERWISE NOTED)

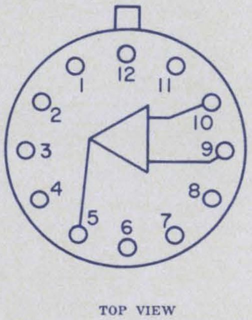
SPECIFICATION	Sym.	UC4000 Min.	UC4000 Typ.	UC4000 Max.	UC4001 Min.	UC4001 Typ.	UC4001 Max.	UC4002 Min.	UC4002 Typ.	UC4002 Max.	Unit	TEST CONDITIONS
Average Differential Input Offset Current Drift	ΔI_{os}			175			350			700	pA/°C	$V_{out} = 0$, $R_L = 10$ K ohms ($T_A = -55$°C to 125°C)
Differential Input Offset Current Change with Power Supply Variation	ΔI_{os}		500			500			500		pA/V	$V_{out} = 0$, $R_L = 10$ K ohms $\Delta V_{PS} = 1$ V rms, f= 100 Hz
Differential Input Offset Current Change with Time	ΔI_{os}		1			3			5		nA/24 hr	$V_O = 0$ at start, t = 24 hrs. $R_L = 10$K Ω
Common Mode Rejection	CMR	90	100		90	100		90	100		dB	$e_{in} = 1$ V rms, f= 100 Hz
Common Mode Voltage Range (Note 3)	V_{CM}	±10			±10			±10			V	$R_L = 10$ K, $R_f = \infty$ f = 100 Hz, $V_{out} = 7$ Vrms
Common Mode Input Resistance	R_{CM}		400			400			400		MΩ	$V_{out} = 7.0$ V rms $V_{CM} = 7.0$ V rms
Input Bias Current	I_{Bias}		40	50		60	100		80	150	nA	$V_{out} = 0$
Input Bias Current	I_{Bias}		150	250		300	400		500	600	nA	$V_{out} = 0$ ($T_A = -55$°C)
Input Spot Noise Voltage	e_n		200			200			200		nv/$\sqrt{\sim}$	f = 100 Hz $R_L = 10$KΩ
Small Signal Bandwidth—(Note 3)	BW	1.0	2.0		1.0	2.0		1.0	2.0		MHz	$R_f = 0$, $R_{in} = \infty$, $e_{in} \leq 100$ mV
P.S. Current Drain. +15 V				7.0			7.0			7.0	mA	$V_{out} = 0$
P.S. Current Drain. −15 V				8.0			8.0			8.0	mA	$V_{out} = 0$
Slewing Rate (Note 3)	$\Delta V/\Delta t$	1.0			1.0			1.0			V/μs	$R_L = 10$ K -10 V $< V_{out} < +10$ V $t_r = 10$ ns, PRR= 1 KHz
Full Power Frequency (Note 3)		15			15			15			KHz	$R_L = 10$ K, $V_{out} = 7$ V rms $R_i = R_f = 100$KΩ

Notes:
2) Adjustable to zero by external 20 KΩ potentiometer.
3) With compensation to provide 6 dB per octave roll-off (see Figure 3).
4) If balance potentiometer is not used, connect pins 7 and 12 through 10K ohm resistors to pin 6 (see Figure 4).
5) Case connected to negative supply pin 2.

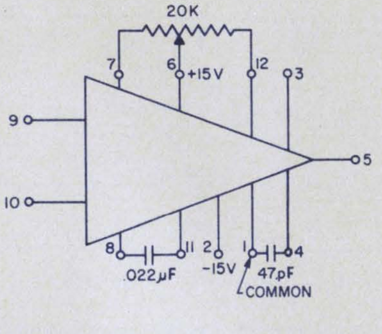


JEDEC OUTLINE TO-101.
PHYSICAL DIMENSIONS
FIGURE 1.

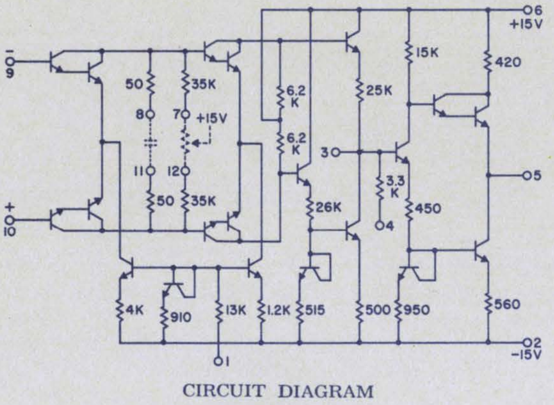
(1) Common
(2) Negative Supply (Ref: Note 5)
(3) Output Compensation (Fig. 3 & 4)
(4) Output Compensation (Internal Resistor)
(5) Output
(6) Positive Supply
(7) Balance Potentiometer
(8) Input Compensation (Fig. 3 & 4)
(9) Input (Inverting)
(10) Input (Non-inverting)
(11) Input Compensation (Fig. 3 & 4)
(12) Balance Potentiometer (Fig. 3 & 4)



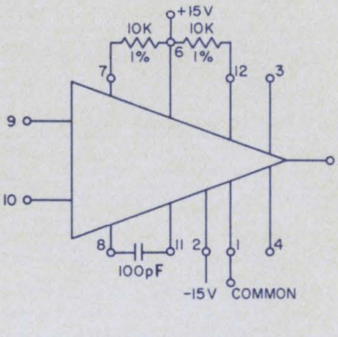
CONNECTION DIAGRAM
FIGURE 2.



FREQUENCY COMPENSATION CIRCUIT FOR 6 dB/OCTAVE ROLLOFF (Ref: Note 3)
FIGURE 3.



CIRCUIT DIAGRAM



STANDARD TEST CIRCUIT
(Ref: Note 4)
FIGURE 4.

PRINTED IN U.S.A.

UNION CARBIDE
ELECTRONICS
365 Middlefield Road, Mountain View, California 94040/Tel: (415) 961-3300; TWX: 910-379-6942

PULL OUT

ENGINEERING DATA SHEET

If somebody beat you to it, write to: Union Carbide Electronics or call your UCE distributor IN THE WEST

ARIZONA, Phoenix
Avnet Electronics • (602) 272-6821

CALIFORNIA,
Culver City
Avnet Electronics • (213) 870-6141
Los Angeles
K-Tronics • (213) 685-5888
Mountain View
Avnet Electronics • (415) 961-7700
Newport Beach
Western Electronic Components • (714) 540-1322 (213) 631-6119
Palo Alto
Kierulff Electronics, Inc. • (415) 968-6292
San Diego
Avnet Electronics • (714) 279-1550
San Diego
Kierulff Electronics • (714) 278-2112

COLORADO, Denver
Newark-Denver Electronics • (303) 757-3351

WASHINGTON, Seattle
Washington Electronics • (206) 682-8981

Factory Sales Offices
CALIFORNIA
Mountain View
(415) 969-9390
Fullerton
(213) 691-0958

UNION CARBIDE

ELECTRONICS

PROCURE-MENT DATA

AFTER YOU PULL OUT UNION CARBIDE'S DATA SHEET

CALL

SCHWEBER

FOR SAME DAY SHIPMENT OF ALL ITEMS

P.S.: FOR A COMPLETE PRICE LIST CIRCLE NUMBER BELOW.

ALABAMA, Huntsville	205/539-2756
MARYLAND, Silver Spring	301/587-2900
MASS., Waltham	617/891-8484
OHIO, Cleveland	216/333-7020
NEW YORK, Westbury	516/334-7474

78

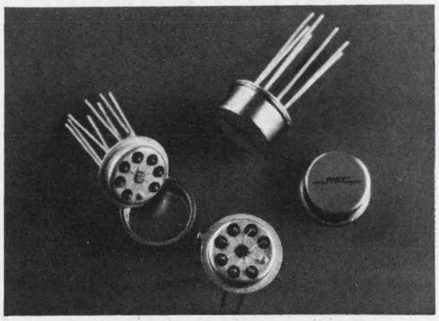
Westbury, New York 516/334-7474 / Waltham, Mass. 617/891-8484 / Cleveland, Ohio 216/333-7020 / Huntsville, Ala. 205/539-2756

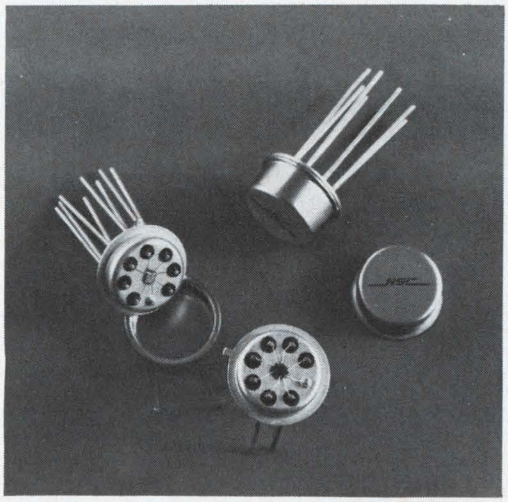
SCHWEBER ELECTRONICS

◀ ON READER-SERVICE CARD CIRCLE 77

(continued from p. 177)

2N3625	HF54
2N3626	HF54
2N3627	HF54
2N3628	HF54
2N3629	HF54
2N3630	HF54
2N3631	FET4, FET18
2N3632	HF77
2N3633	HF92
2N3634	HL14
2N3635	HL16
2N3636	HL14
2N3637	HL17
2N3638	HF44
2N3638A	HL37
2N3639	LL36
2N3640	LL37
2N3641	LL28
2N3642	LL29
2N3643	LL29
2N3644	LL27
2N3645	LL27
2N3646	LL37
2N3647	LL32, HL19
2N3648	LL35, HL20
2N3660	P19
2N3661	P19
2N3662	HF90
2N3663	HF90
2N3665	P19
2N3666	P20
2N3677	LL8, LL15
2N3683	HF84
2N3684	FET53, FET65
2N3685	FET49, FET65
2N3686	FET42, FET65
2N3687	FET37, FET65
2N3688	HF78
2N3689	HF78
2N3690	HF78
2N3691	A21, HF54
2N3692	A37, HF54
2N3693	HF54
2N3694	HF55
2N3695	FET50, FET64
2N3696	FET43, FET64
2N3697	FET39, FET64
2N3698	FET35, FET64
2N3699	P20
2N3701	HF55
2N3702	HF35
2N3703	HF35
2N3704	HF35
2N3705	HF36
2N3706	HF36
2N3707	A37
2N3708	A22
2N3709	A21
2N3710	A34
2N3711	A42
2N3712	HF14
2N3713	P92, HL23
2N3714	P92, HL20
2N3715	P92, HL23
2N3716	P92, HL23
2N3719	P20, HL29
2N3720	P20, HL29
2N3721	A27
2N3722	LL35
2N3723	LL35
2N3724	HL39
2N3725	HL39
2N3728	HF78
2N3729	HF78
2N3730	P26
2N3731	P20
2N3732	P14
2N3733	HF78
2N3734	HF63, HL19
2N3735	HF63, HL19
2N3736	HF63, HL19
2N3737	HF63, HL19
2N3738	P33, HL24
2N3939	P34, HL24
2N3740	P37, HL23
2N3741	P37, HL24
2N3742	HF12
2N3743	HF13
2N3744	P40
2N3745	P40
2N3746	P40
2N3747	P40
2N3748	P40
2N3749	P41
2N3750	P41
2N3751	P41
2N3752	P41
2N3762	HF47, HL38
2N3763	HF44, HL37
2N3764	HF48, HL38
2N3765	HF44, HL37
2N3766	HF55, P34, HL24
2N3767	P34, HL25
2N3771	P92
2N3772	P92
2N3773	P92
2N3783	HF88
2N3784	HF86
2N3785	HF87
2N3789	P93
2N3790	P83
2N3791	P93
2N3792	P93
2N3793	A11
2N3794	A35
2N3796	FET12, FET25, FET45, FET59
2N3797	FET12, FET26, FET55, FET59
2N3798	HF36
2N3799	HF36
2N3800	HF36
2N3801	HF36
2N3802	HF36
2N3803	HF36
2N3804	HF36
2N3805	HF36
2N3806	HF37
2N3807	HF37
2N3808	HF37
2N3809	HF37
2N3810	HF37
2N3811	HF37
2N3818	HF44
2N3819,	FET12, FET17, FET27, FET53, FET66, FET69
2N3820	FET12, FET17, FET24, FET41, FET66, FET68
2N3821	FET12, FET19, FET25, FET44, FET48, FET59, FET69
2N3822	FET12, FET27, FET45, FET52, FET59, FET70
2N3823	FET13, FET17, FET26, FET49, FET61, FET70
2N3824	FET5, FET17, FET21
2N3825	HF55
2N3826	A21, HF55
2N3827	HF55
2N3828	HF74
2N3829	HF73, LL32
2N3830	LL27
2N3831	LL27
2N3832	HF88, LL39
2N3837	P38
2N3838	A37, P38, LL27
2N3839	HF91
2N3840	LL9
2N3841	LL4
2N3842	LL4
2N3843	HF40
2N3943A	HF40
2N3844	HF40
2N3844A	HF40
2N3845	HF40
2N3845A	HF40
2N3846	P93
2N3847	P93
2N3848	P93
2N3849	P93
2N3850	P41, HL12
2N3851	P42, P50, HL11
2N3852	P42, HL12
2N3853	P42, HL11
2N3854	HF68
2N3854A	HF68
2N3855	HF73
2N3855A	HF73
2N3856	HF74
2N3856A	HF74
2N3857	LL6
2N3858	A27
2N3858A	A27
2N3859	A36
2N2859A	A36
2N3860	A40
2N3866	HF88
2N3877	A10
2N3877A	A10
2N3878	P44
2N3879	HL29
2N3880	HF92
2N3883	LL23
2N3900	A44
2N3900A	A44
2N3903	HF63, LL29
2N3904	HF69, LL31
2N3905	HF63, LL27
2N3906	HF69, LL29
2N3909	FET13, FET21, FET24, FET41, FET66
2N3916	P20
2N3917	P34
2N3919	P30, HL33
2N3920	P30, HL33
2N3921	FET31
2N3922	FET31
2N3924	HF82
2N3925	HF82
2N3926	HF82
2N3927	HF82
2N3930	A32
2N3931	A32
2N3932	HF92
2N3933	HF92
2N3934	FET31
2N3935	FET30
2N3946	HF63, LL29
2N3947	HF69, LL31
2N3948	HF87, P3
2N3950	HF44, P59
2N3953	HF92
2N3954	FET31
2N3955	FET31
2N3956	FET30
2N3957	FET30





New LM200—Temperature range: 0 to 70°C.
LM100—Temperature range: −55 to +125°C.

Now...a Monolithic Voltage Regulator for less than $20

Second of a new line of monolithic linear integrated circuits

- **Output adjustable from 2V to 30V.**
- **Output currents in excess of 5A using external power transistors.**
- **Can be used as either a linear or a high-efficiency switching regulator.**

The new LM200 has the same performance characteristics as the LM-100 over the commercial range.

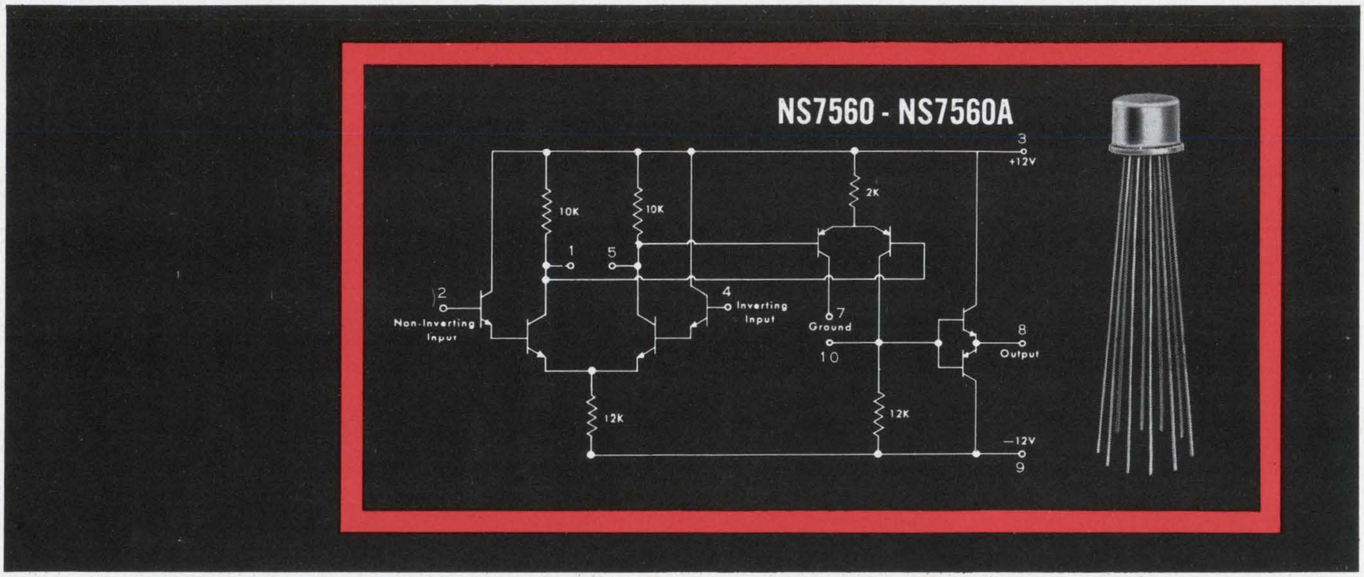
These versatile regulators feature regulation better than 1 percent for widely varying load and line conditions. Temperature stability is better than 1 percent over full temperature range. As linear regulators, both devices provide current limiting, excellent transient response and unconditional stability with any combination of resistive or reactive loads. As switching regulators, circuits will operate at frequencies up to 100KHZ with efficiencies better than 85 percent.

Both LM200 and LM100 are immediately available from distributor stock.

NSC

MICROCIRCUITS DIVISION
NATIONAL SEMICONDUCTOR CORPORATION
2950 SAN YSIDRO WAY, SANTA CLARA
CALIFORNIA 95051 (408) 245-4320

ON READER-SERVICE CARD CIRCLE 83



Did you ever design or use a basic circuit like this?

Then you know the NSC line of Hybrid Operational Amplifiers

- Hybrid construction allows component for component miniaturization of discrete designs.
- Superior input characteristics (input impedance = 1 megΩ max.) darlington configuration.
- Closer temperature tracking (input offset voltage T.C. max. 30 or 10µ v/°C max.) NPN dice.
- Output stage uses high quality PNP and NPN devices as a complementary emitter follower. Currents are possible as high as ±50 ma with a 100Ω load.
- Investigate NCS's other standard hybrid products and custom circuit capability.

SPECIFICATIONS	NS 7560	NS 7560A
Input Offset Voltage (Maximum)	10 mv	3 mv
Input Offset Voltage Temperature Coefficient (Maximum)	30µ v/°C	10µ v/°C
Input Bias Current (Maximum)	100 na	25 na
Differential Input Current (Maximum)	50 na	2 na
Input Bias Current Temperature Coefficient (Maximum)	2 na/°C	1 na/°C
Peak Output Current (Maximum)	±50 ma	±50 ma

See NSC distributor listing on page 180

NSC

NATIONAL SEMICONDUCTOR CORPORATION, DANBURY, CONN.
(203) 744-0060

ON READER-SERVICE CARD CIRCLE 84

2N3958	FET30
2N3959	HF92, LL40
2N3960	HF92, LL40
2N3961	HF82
2N3962	HF45
2N3963	HF45
2N3964	HF45
2N3965	HF45
2N3966	FET6
2N3967	FET27
2N3968	FET26
2N3969	FET25
2N3970	FET16
2N3971	FET8, FET18, FET20
2N3972	FET7, FET20, FET21
2N3973	LL32
2N3974	LL32
2N3975	LL32
2N3976	LL32
2N3977	LL4
2N3978	LL4
2N3979	LL4
2N3980	UJT2, UJT3
2N3993	FET6, FET19
2N3994	FET5, FET21, FET26
2N3995	HF85
2N3996	P42
2N3997	P42
2N3998	P42
2N3999	P42
2N4000	P30
2N4001	P30
2N4002	P83
2N4003	P83
2N4004	P50
2N4005	P50
2N4006	LL18
2N4007	LL15
2N4008	LL16
2N4012	HF82
2N4013	HL39
2N4014	HL39
2N4017	A44
2N4018	A45
2N4019	A45
2N4020	A46
2N4021	A46
2N4022	A46
2N4023	A46
2N4024	A47
2N4025	A47
2N4026	A20, HL35
2N4027	A21, HL35
2N4028	A37, HL35
2N4029	A37, HL35
2N4030	A21
2N4031	A21
2N4032	A37
2N4033	A37
2N4035	LL36
2N4036	HL29
2N4037	HL30
2N4038	FET69
2N4039	FET69
2N4040	P31
2N4041	P26
2N4046	LL36
2N4047	LL36
2N4048	P98
2N4049	P98
2N4050	P98
2N4051	P98
2N4052	P99
2N4053	P99
2N4058	A37, LL48

2N4059	A22, LL48
2N4060	A22, LL48
2N4061	A34, LL48
2N4062	A42, LL48
2N4063	P26
2N4064	P26
2N4065	FET22
2N4066	FET19
2N4067	FET19
2N4068	HL35
2N4069	HL36
2N4070	P58
2N4071	P59
2N4072	HF83
2N4073	HF83
2N4074	A39, P10, HL33
2N4075	P42
2N4076	P42
2N4077	P22
2N4078	P22
2N4079	P108
2N4082	FET32
2N4083	FET31
2N4084	FET32
2N4085	FET31
2N4086	A40
2N4091	FET10
2N4092	FET8
2N4093	FET7
2N4104	A44, HF30
2N4105	P6
2N4106	P6
2N4107	P109
2N4108	A45
2N4109	A45
2N4117	FET34
2N4117A	FET34
2N4118	FET36
2N4118A	FET36
2N4119	FET39
2N4119A	FET39
2N4120	FET22
2N4121	LL37
2N4122	LL37
2N4123	HF64, LL29
2N4124	HF69, LL31
2N4125	HF55, LL27
2N4126	HF64, LL29
2N4136	P109
2N4137	HL40
2N4138	A23, HF11, LL18
2N4139	FET57
2N4207	LL38
2N4208	LL39
2N4209	LL39
2N4220	FET13, FET22, FET25, FET45, FET60
2N4220A	FET62
2N4221	FET13, FET22, FET26, FET52, FET60
2N4221A	FET62
2N4222	FET13, FET22, FET28, FET56, FET60
2N4222A	FET62
2N4223	FET60, FET70
2N4224	FET69
2N4234	P20, HL22
2N4235	P20, HL22
2N4236	P20, HL22
2N4240	P44
2N4241	P45
2N4248	A23
2N4249	A36
2N4250	A36
2N4251	HL42
2N4252	HF85
2N4253	HF85
2N4254	HF85

2N4255	HF85
2N4257	LL38
2N4258	LL39
2N4259	HF91
2N4260	HF92, LL40
2N4261	HF93, LL40
2N4264	HF69, LL31
2N4265	HF69, LL31
2N4267	FET19
2N4268	FET20
2N4284	A16
2N4285	A16
2N4286	A40
2N4287	A40
2N4288	A41
2N4289	A41
2N4290	A24
2N4291	A37
2N4292	A10
2N4293	A10
2N4296	A24, P34, HL30
2N4297	A31, P34, HL30
2N4298	A13, P34, HL30
2N4299	A24, P34, HL30
2N4300	P30, HL25
2N4301	P53, HL26
2N4304	LL35
2N4313	LL39
2N4314	HL30
2N4315	HF104
2N4338	FET39, FET63
2N4339	FET43, FET50, FET63
2N4340	FET50, FET55, FET63
2N4341	FET54, FET63
2N4342	FET4, FET18, FET27, FET62
2N4343	FET4, FET16, FET28, FET62
2N4347	P84
2N4348	P84
2N4351	FET21
2N4352	FET21
2N4353	FET33
2N4354	A24, LL23
2N4355	A24, LL23
2N4356	LL23
2N4357	A32
2N4358	A32
2N4360	FET3, FET16, FET27, FET62
2N4381	FET5, FET21, FET28, FET54, FET61
2N4382	FET5, FET20, FET28, FET56, FET61
2N4391	FET10
2N4392	FET8
2N4393	FET7
2N4400	HF55, LL27
2N4401	HF64, LL29
2N4402	HF45, LL26
2N4403	HF55, LL28
2N4409	HF69
2N4410	HF69
2N4411	HF78, LL35
2N4416	FET70
2N4417	FET70
2N4418	HF82, LL36
2N4419	HF78, LL35
2N4420	HF73, LL32
2N4421	LL31
2N4422	LL33
2N4423	LL35
2N4424	A42
2N4425	A42
2N4427	HF88
2N4428	HF87

2N4429	HF87
2N4430	HF85
2N4431	HF85
2N4433	HF55
2N4434	HF69
2N4435	HF56
2N4440	HF82
2N4445	FET11
2N4446	FET11
2N4447	FET11
2N4448	FET11
2N4854	A37, LL28
2N4855	A21, LL28
2N4856	FET11, FET18
2N4857	FET10, FET20
2N4858	FET8, FET21
2N4859	FET11, FET18
2N4860	FET10, FET20
2N4861	FET8, FET21
2N4862	P21
2N4863	P21
2N4864	P39
2N4865	P108
2N4866	P108
2N4867	FET42, FET63
2N4868	FET49, FET63
2N4869	FET53, FET63
2N4874	HF90
2N4875	HF88
2N4876	HF86
2N4881	FET51
2N4882	FET56
2N4883	FET51
2N4884	FET56
2N4885	FET51
2N4886	FET56
2N4891	UJT2
2N4892	UJT2
2N4893	UJT1
2N4894	UJT3
2N4895	P59
2N4896	P59
2N4897	P59
2N4932	HF45
2N4933	HF45
2N4947	UJT2
2N4948	UJT3
2N4949	UJT3
2N4960	HL38
2N4961	HL38
2N4962	HL38
2N4963	HL38
3N45	P61
3N46	P62
3N47	P62
3N48	P62
3N49	P82
3N50	P82
3N51	P82
3N52	P82
3N71	LL24
3N72	LL24
3N73	LL24
3N74	A47, LL19
3N75	A47, LL19
3N76	A47, LL19
3N77	A47, LL19
3N78	A47, LL19
3N79	A47, LL19
3N89	FET44, FET67
3N90	HF4
3N91	HF4
3N92	HF4
3N93	HF4
3N94	HF4
3N95	HF4
3N96	FET31
3N97	FET30

3N108	A47, LL14
3N109	A47, LL14
3N110	A48, LL14
3N111	A48, LL14
3N112	HF4
3N113	HF5
3N114	HF9
3N115	HF9
3N116	HF9
3N117	HF10
3N118	HF10
3N119	HF10
3N123	LL9
3N124	FET13, FET22, FET24, FET41
3N125	FET13, FET22, FET26, FET50
3N126	FET13, FET22, FET27, FET54
3N128	FET56, FET66, FET70
3N129	LL13
3N130	LL13
3N131	LL13
3N132	LL13
3N133	LL13
517	FET33
40460	FET70
40461	FET55, FET70
C680	FET36
C681	FET36
C682	FET42
C683	FET42
C684	FET50
C685	FET50
C6690	FET3
C6691	FET3
C6692	FET1
CM600	FET7
CM601	FET9
CM602	FET9
CM603	FET10
CM640	FET5
CM642	FET9
CM643	FET10
CM646	FET10
CM647	FET11
CP650	FET71
CP651	FET71
D1101	FET47
D1102	FET40
D1177	FET47
D1178	FET40
D1180	FET52
D1181	FET44
D1182	FET37
D1183	FET4, FET54
D1184	FET3, FET47
D1185	FET40
D1201	FET52
D1202	FET44
D1203	FET37
D1301	FET4, FET54
D1302	FET3, FET47
D1303	FET2, FET40
DE1004	FET5, FET19, FET58, FET67
DN3066A	FET47, FET64
DN3067A	FET40, FET64
DN3068A	FET35, FET64
DN3069A	FET52, FET64
DN3070A	FET44, FET64
DN3071A	FET37, FET64
DNX1	FET47
DNX2	FET38
DNX3	FET34
DNX4	FET52
DNX5	FET44
DNX6	FET37
DNX7	FET4
DNX8	FET3
DNX9	FET2
FI100	FET20
F10049	FET5, FET20
FP4339	FET43
FP4340	FET50
FT57	FET71
HA2000	FET19
HA2001	FET58
HA2010	FET6
HA2020	FET28
K1001	FET68
K1003	FET70
K1004	FET45
K1201	FET68
K1202	FET68
K1501	FET68
K1502	FET68
K1504	FET1
M100	FET18, FET50
M101	FET17, FET55
M103	FET6
M511	FET7
MEM511	FET33
MEM520	FET33
MEM551	FET30
MFE2093	FET13, FET22, FET25, FET38
MFE2094	FET13, FET22, FET25, FET42
MFE2095	FET14, FET22, FET25, FET49
MFE2097	FET57
MFE2098	FET57
MFE2133	FET8
MFE3001	FET45
MPF103	FET49
MPF104	FET52
MPP105	FET56
P102	FET61
P1003	FET46
P1004	FET53
P1005	FET56
SJ993	UJT2
SJ1034	UJT1
SJ1127	UJT2
SJ1158	UJT1
SJ1159	UJT1
SJ5898	UJT1
SU2078	FET31
SU2079	FET30
SU2080	FET31
SU2081	FET30
TIS05	FET7, FET16
TIS14	FET14, FET17, FET25, FET45, FET66, FET68
TIS25	FET30
TIS26	FET29
TIS27	FET29
TIS34	FET14, FET21, FET27, FET55, FET66, FET70
TIS41	FET11, FET16
TIS42	FET8, FET16
TIS58	FET53, FET68
TIS59	FET56, FET69
TIXM12	FET71
TIXM301	FET71
TIXS11	FET2, FET20, FET28, FET58, FET66, FET67
TIXS33	FET8, FET16
TIXS35	FET14, FET21, FET28, FET57, FET66, FET71
TIXS36	FET10, FET19, FET28, FET57, FET66
TIXS41	FET11, FET16
TIXS42	FET8, FET16
U89	FET45, FET67
U110	FET38
U112	FET48
U114	FET37
U133	FET41
U139	FET7
U139D	FET6
U146	FET57
U147	FET57
U148	FET58
U149	FET58
U168	FET46
U182	FET10, FET18
U183	FET53
U197	FET36
U198	FET46
U199	FET54
U203	FET61
U204	FET63
U1277	FET50
U1278	FET45
U1279	FET41
U1280	FET38
U1281	FET56
U1282	FET55
U1283	FET49
U1284	FET41
U1285	FET37
U1286	FET39
U1287	FET58
U1325	FET43
UC20	FET42
UC21	FET38
UC22	FET42
UC23	FET38
UC40	FET40
UC41	FET36
UC42	FET40
UC43	FET36
UC200	FET57
UC201	FET7
UC210	FET55
UC220	FET49
UC240	FET50, FET65
UC250	FET10
UC251	FET7
UC400	FET56
UC401	FET6
UC410	FET52
UC420	FET45
UC450	FET8
UC451	FET7
UC701	FET38
UC703	FET38
UC704	FET41
UC705	FET45
UC707	FET53
UC714	FET53
UC750	FET34
UC751	FET36
UC752	FET41
UC753	FET48
UC801	FET35
UC803	FET35
UC804	FET38
UC805	FET42
UC807	FET48
UC814	FET42
UC850	FET38
UC851	FET48
UC852	FET33
UC853	FET36
UC854	FET39
UC855	FET42

1967 Diode Manufacturers' List

(According to Device Type)

To find the manufacturers of a specific type of diode, locate the device type in the columns on top. Dots are placed in the column to identify the manufacturers, listed at the left.

To determine the diode product line of a specific manufacturer, locate the company name in the horizontal rows at the left. Dots are placed in that manufacturer's row under each type of diode device that forms a part of his product line.

Manufacturer	General Purpose	Rectifiers	R F	Computer & Hi-Speed	Four Layer	Noise	Matched	Microwave	Varactor & Varicap	Tunnel	Varistor	Zener (Regulator)	Reference (Low Temp. Coefficient Types)	S C R s	S C S s & Gate-Controlled Types	Photo	Special Purpose
Airtron Div., Litton Industries							●	●	●								
Alpha Industries Inc.	●		●	●			●	●	●								N, P
American Electronics Labs, Inc.			●					●	●								N, R, A, E
American Semiconductor Inc.							●					●	●				
Amperex Electronic Corp.	●	●	●	●	●		●		●			●	●	●	●	●	D, F, B
Atlantic Semiconductor Inc.		●															B, H, St
Bell, F. W., Inc.																	Ha
Bendix Semiconductor Div.	●	●															
Bradley Semiconductor Corp.	●	●															
Burroughs Corp.	●			●											●		
Computer Diode Corp.	●	●	●	●			●	●	●		●	●	●				C, B, D, Df, N, R, St, U
Conant Labs.		●															B, Se
Continental Device Corp.	●	●	●	●		●	●				●	●	●				D, F, Df, S, St
Crystalonics Inc.							●		●								
Delco Radio Div., Gen. Motors	●	●															D
Delta Semiconductors Inc.	●	●	●	●		●	●	●	●			●	●				F
Dickson Electronics Corp.		●					●		●	●		●	●				B, C, D, St, H
Diodes Inc.	●	●		●			●					●					B, D, H, St, S
Eastern Delta Corp.		●									●						B, S, St
Eastron Corp.							●		●			●					C, St
Edal Industries	●	●					●				●						B, Df, H, S, SE
Edgerton, Germeshausen & Grier																●	R
Electro-Optical Systems Inc.																●	
Electronic Control														●			
Electronic Devices Inc.	●	●										●					B, D, H, M, V
Erie Technological Products	●	●		●			●										B
Fairchild Semiconductor	●	●		●		●	●	●	●			●	●	●		●	A, E, B
Gemini Semiconductors	●		●	●	●		●	●	●	●							A, B, Bi, Df, E, N, P, T
General Electric Co.	●	●	●	●	●		●	●		●	●	●	●	●	●	●	La, P
General Instruments Corp.	●	●	●	●			●		●			●	●	●		●	

Need a FREE personal copy of this Directory? Circle number **419.**

Complete listing of semiconductor manufacturers starts on page 86.

Get detailed spec sheets and application notes: use the reader-service card!

Key to special purpose diodes category

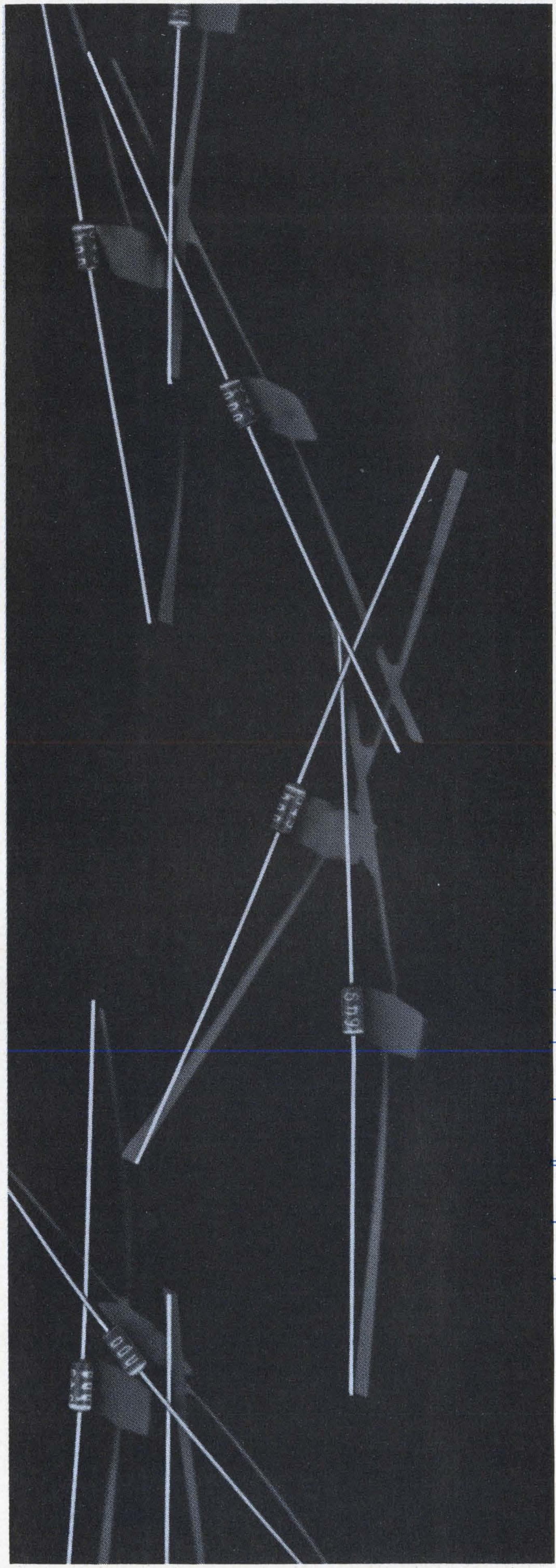
A = Arrays
B = Bridges, stacked, or special assemblies
Bi = Bilateral switch
C = Multi-junction forward regulators
CC = Constant-current source
D = TV dampers
Df = Specially diffused silicon diodes
E = Light emitting diodes
F = Controlled forward conductance diodes
H = High voltage elements
Ha = Hall effect generators
La = Lasers
N = Pin diodes
P = Snap diodes
Ph = Photo SCRs
R = Radiation detectors
S = Suppressors
Se = Selenium rectifiers
St = Stabistors
Sym = Symmetrical switch
T = Thin-film applications types
Tr = Trigger diode
U = Multi-current reference
Y = Relay diode

Manufacturer	General Purpose	Rectifiers	R F	Computer & Hi-Speed	Four Layer	Noise	Matched	Microwave	Varactor & Varicap	Tunnel	Varistor	Zener (Regulator)	Reference (Low Temp. Coefficient Types)	S C R s	S C S s & Gate-Controlled Types	Photo	Special Purpose
General Semiconductors Inc.	●	●					●		●			●	●				B, C, H, U
Green Rectifier Corp.		●									●						B, S, St
H P Associates	●		●	●			●	●								●	E, N, P, F, B
Heliotek Div. Textron Electronics Inc.																●	
Hoffman Electronics Corp.	●	●		●						●		●	●	●			
Hughes Aircraft Co. Microelectronics Div.	●	●		●			●	●	●			●					A
Hunt Electronics Co.															●		Bi, Sym
ITT Semiconductor	●	●	●	●	●		●										
Instrument Systems Corp.																	Ha
International Diode Corp.	●			●			●										
International Electronics Corp.	●	●	●	●			●		●		●	●		●		●	
International Rectifier Corp.	●	●										●	●	●			
I R C Semiconductor	●	●										●	●	●			B
K M C Semiconductor Corp.				●			●	●		●							E, R
Kemtron Electron Prod.																	St, Y
Korad Corp.																	La
Ledex		●															
MS I Electronics Inc.								●	●								
Mallory Semiconductor Co.		●										●					B, Tr, St
MicroSemiconductor Corp.	●	●	●	●			●	●	●			●	●				T, A, B, C, F, H, J
Microstate Electronics Corp.				●			●	●	●	●							E, N, X
Microwave Associates Inc.			●				●	●	●	●							N, P, Df, F
Motorola Semiconductor Products Inc.		●	●		●	●	●	●	●			●	●	●			CC, B, Tr
National Electronics Corp.														●			
Nucleonic Products Co., Inc.	●	●	●	●		●	●		●		●	●	●	●		●	B
Ohmite Mfg. Co.	●		●	●			●										
Philco Corp.			●	●				●	●	●						●	B, CC, La, N, P, Sym, T, U, Y, E, A
Power Components Inc.	●	●			●		●		●			●	●				St
Radiation, Inc.																	A
Radio Corp. of America		●								●			●	●		●	B, La

Key to special purpose diodes category

A = Arrays
B = Bridges, stacked, or special assemblies
Bi = Bilateral switch
C = Multi-junction forward regulators
CC = Constant-current source
D = TV dampers
Df = Specially diffused silicon diodes
E = Light emitting diodes
F = Controlled forward conductance diodes
H = High voltage elements
Ha = Hall effect generators
La = Lasers
N = Pin diodes
P = Snap diodes
Ph = Photo SCRs
R = Radiation detectors
S = Suppressors
Se = Selenium rectifiers
St = Stabistors
Sym = Symmetrical switch
T = Thin-film applications types
Tr = Trigger diode
U = Multi-current reference
Y = Relay diode

Manufacturer	General Purpose	Rectifiers	R F	Computer & Hi-Speed	Four Layer	Noise	Matched	Microwave	Varactor & Varicap	Tunnel	Varistor	Zener (Regulator)	Reference (Low Temp. Coefficient Types)	S C R s	S C S s & Gate- Controlled Types	Photo	Special Purpose
Raytheon Co.	●		●	●			●	●	●	●		●	●			●	E, N
Rectico Inc.		●															
Sanford Miller		●															
Saratoga Semiconductor Div., Espey Mfg.												●	●				
Sarkes Tarzian Inc.	●	●										●		●	●		B, H, Ph, Se
Schauer Mfg. Corp.							●				●	●	●				
Semcor Div., Components Inc.	●					●	●					●	●				
Semicon Inc.	●	●					●							●			H, B, C, St
Semiconductor Devices Inc.				●				●	●								N, P
Semiconductor Specialists Inc.							●					●	●				
Semi-Elements Inc.	●	●	●		●		●	●	●			●				●	E, La
Semtech Corp.	●	●		●			●					●	●				B, H, St
Siemens America	●	●	●	●			●		●	●		●				●	
Silicon Transistor Corp.														●	●		
Slater Electric Inc.		●															B, D, Df, H
Solar Systems Inc.																	Df
Solid State Products Inc.					●									●	●	●	Ph
Solitron Devices Inc.	●	●	●			●	●		●		●	●	●				N
Sylvania Electric Products	●	●	●	●		●	●	●	●	●	●				●		N
Syntron Co.		●													●		B, H
T R W Semiconductors	●	●	●	●			●	●	●			●	●				St
Texas Instruments Inc.	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	E, St, A, F, N
Transitron Electronic Corp.	●	●	●	●		●	●	●		●		●	●	●	●		U
Trio Laboratories Inc.												●					
Unitrode Corp.	●	●		●	●		●					●	●				B, C, H, N, S
Vactec Inc.																●	
Varian/Bomac Div.							●	●	●								N, P
Varo, Inc., Special Products Div.		●		●													H, B, D, Df
Wagner Electric	●													●			B
Western Semiconductor Inc.	●	●		●	●		●		●			●	●	●	●		B, DF
Westinghouse Electric Corp., Semiconductor Div.	●	●		●										●	●		



HOT CARRIER DIODES...

- Negligible charge storage
- Low leakage, high forward conductance
- Available in matched pairs and quads
- Low cost

...from HPA

The performance specifications and prices in the table below show why the HPA 2900 is ideally suited for commercial applications requiring ultra-fast switching, RF/UHF mixing, detecting and limiting. Call your local HP field engineer or write direct for your data sheet. HP Associates, 620 Page Mill Road, Palo Alto, California 94304.

<table>
<tr><th colspan="6">Typical specifications</th></tr>
<tr><th colspan="3">Forward Current
I_F</th><th colspan="3">Breakdown Voltage
V_{BR}</th></tr>
<tr><td colspan="3">20 mA min. @ $V_F=1.0$ V
1.0 mA min. @ $V_F=0.4$ V</td><td colspan="3">10 V @ $I_R=10\ \mu$A</td></tr>
<tr><th colspan="2">Leakage Current
I_R</th><th colspan="2">Lifetime
τ</th><th colspan="2">Price</th></tr>
<tr><td colspan="2">100 nA @ $V_R=-5.0$ V</td><td colspan="2">120 ps</td><td colspan="2">1 to 99, $3.00
100 to 999, $2.25</td></tr>
</table>

HEWLETT
PACKARD **hp** HP
ASSOCIATES

2585

ON READER-SERVICE CARD CIRCLE 67

1. Diode-Transistor Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Adders A		Half	A51	SI	35	–	–	–	5	40	5	1.1	2.7	700	0 to 70	A, D	
		Half	UC1004B	SPR	40	–	–	–	5	130	6,-3	0.4	5.8	500	–	–	
Binary Elements B	1	R-S Flip Flop	RD-208	RAD	7	–	4	–	7	20	5	0.250	4.5	800	–	D	Expandable
		R-S Flip Flop	RD-308	RAD	7	–	4	–	4	20	5	0.25	5	800	–	D	Expandable
		R-S Flip Flop	RD-508	RAD	7	–	4	–	7	20	5	0.25	5	800	0+75	D	Expandable
		–	NC/PC8	GI	8	–	–	–	5	200	12, 4.2	0	5	–	–	A, E	MC RCDT
		–	NC/PC12	GI	8	–	1	–	22	–	12, 4.2	0	5	–	–	A, E	
		–	PC-13	GI	8	–	–	–	5	200	12, 4.2	0	5	–	–	E	MC RCDT
		–	8200	VAR	10	–	–	2	4	100	6, 3	0.5	3.5	–	–	–	TF
		Counter	UC1002B	SPR	14	–	–	–	5	65	6,-3	0.4	5.8	500	–	–	
		Flip-Flop	MC282G	MO	18	–	–	–	–	7.5	–	–	–	550	–	A	
		R-S Flip-Flop	DTμL950	FA	20	–	2	–	12	40	5.0	0.2	5	600	–	A, C	SSD, RA, ITT
		Pulse-triggered	MC850	MO	20	–	–	–	10	40	5	0.2	5	–	0 to 75	A,C,G, P,DIP	Mod-DTL
		Pulse-triggered	MC950	MO	20	–	–	–	8	40	5	0.2	5	–	–	A, C	Mod-DTL
		–	ND1003	NA	20	–	2	–	4	20	6	0.2	4.0	750	–	–	
		J-K Flip-Flop	RD-207	RAD	20	–	3	–	12	95	5	0.25	3	800	–	D	
		J-K Flip Flop	RD-307	RAD	20	–	–	–	3	95	5	0.25	3	800	–	D	
		Dual	RD-221	RAD	20	–	–	–	8	24	5.0	0.45	3.3	800	–	D	
		J-K Flip Flop	RD-307	RAD	20	–	–	–	3	95	5	0.25	3	800	–	D	
		Dual	RD-321	RAD	20	–	–	–	5	24	5.0	0.45	3.3	800	–	D	
		J-K Flip Flop	RD-507	RAD	20	–	3	–	12	95	5	0.25	3	800	0+75	D	
		R-S	SW201	SW	20	–	–	–	10	7	6	0.35	2.0	550	–	A, C, D	
		R-S	SW212	SW	20	–	–	–	10	7	6	0.35	2.0	550	–	A, D	And Expand.
		Pulse Triggered	950	SW	20	2	–	10	–	24	5	0.2	5.0	600	–	A, C	
		R-S	RC202T	RA	32	–	–	10	–	9.5	6	–	–	0.55	–	A, D	
		R-S	RC212T	RA	32	–	–	10	–	9.5	6	–	–	0.55	–	A, D	
	2	Shift Reg.	A09	SI	32(0 to 1) 52(1 to 0)	–	–	–	5	54	5	1.0	2.7	900	–	A, D	
		Shift-Reg	A49	SI	32(0-1) 52(1-0)	–	–	–	5	54	5	1.1	2.7	700	0 to 70	A, D	
		J-K	WC215	WH	33	–	–	–	12	60	5.7-6.3	1.0	2.0	600	0 to 75	A, D	
		J-K	WC225	WH	36	–	3	–	6	72	5.7-6.3	1.0	2.0	600	0 to 75	A, D	
		R-S Flip Flop	WC213	WH	38	–	–	–	12	60	5.7-6.3	1.0	2.0	600	0 to 75	A, D	
		R-S, J-K	DTμL948	FA	40	–	2	–	12	45	5.0	0.2	5	600	0 to 75	A, C	SSD,RA,ITT,SY
		Clocked R-S, J-K	MC831	MO	40	–	–	–	7	20	5	0.2	5	500	0 to 75	A, C	Modified DTL
		Clocked R-S, J-K	MC831P	MO	40	–	–	–	7	20	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL
		Clocked R-S, J-K	MC845P	MO	40	–	–	–	12	35	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL
		R-S, J-K	MC848	MO	40	–	–	–	11	45	5	0.2	5	500	0 to 75	A, C	Modified DTL
		Clocked R-S, J-K	MC848P	MO	40	–	–	–	.11	45	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL
		Clocked R-S, J-K	MC931	MO	40	–	–	–	7	20	5	0.2	5	500	–	A, C	Modified DTL
		R-S, J-K	MC948	MO	40	–	–	–	9	45	5	0.2	5	500	–	A, C	Modified DTL
		Clocked J-K R-S	948	SW	40	2	–	11	–	47	5	0.2	5.0	1000	–	A, C	
		Dual J-K	909451	FA	40	–	–	–	11	160	4.5-5.5	0.4	4	1000	–	C, G	
		Dual J-K	909456	FA	40	–	–	–	11	160	4.5-5.5	0.4	4	1000	–20 to +100	C, G	
		Dual J-K	909459	FA	40	–	–	–	9	180	5	0.45	4.3	1000	0 to +75	C, G	
		Dual J-K	909751	FA	40	–	–	–	11	160	4.5-5.5	0.4	4	1000	–	C, G	
		Dual J-K	909756	FA	40	–	–	–	11	160	4.5-5.5	0.4	4	1000	–20 to +100	C, G	
		Dual J-K	909759	FA	40	–	–	–	9	180	5	0.45	4.3	1000	0 to +75	C, G	
		Dual J-K	909951	FA	50	–	–	–	12	140	4.5-5.5	0.4	3.1	1000	–	C, G	
		Dual J-K	909959	FA	50	–	–	–	10	160	5	0.45	3.1	1000	0 to +75	C, G	
		Dual Rank	911151	FA	40	–	–	–	7	80	4.5-5.5	0.4	4.0	1000	–	C, G	
		Dual Rank	911159	FA	40	–	–	–	7	140	5	0.45	4.3	1000	0 to +75	C, G	
	3	Shift Reg.	A03	SI	40(0 to 1) 60(1 to 0)	–	–	–	5	40	5	1.0	2.7	900	–	A, D	
		Shift Reg	A43	SI	40(0-1) 60(1-0)	–	–	–	5	40	5	1.1	2.7	700	0 to 70	A, D	
		R-S J-K	SI948	SI	40	–	2	–	12	45	5	0.2	5.0	600	–25 to +125	D	
		R-S J-K	SI948D	SI	40	–	2	–	12	45	5	0.2	5.0	600	0 to 75	D	
		RS/JK	SW931	SW	40	–	–	8	10	20	4 to 6	0.3	3.0	1000	–	A	
		R-S J-K Clocked	SW948	SW	40	2	–	8	–	48	4-6	0.4	2.6	1000	–	DIP	
		J-K/R-S	SN15848	TI	45	–	–	–	9	35	4.5-5.5	–	–	750	0-75	D,C	
		Pulse Triggered	SN15850	TI	45	–	–	–	8	–	4.5-5.5	–	–	750	0-75	D,DIP	
		J-K/R-S	SN15948	TI	45	–	–	–	9	35	4.5-5.5	–	–	750	–	D	
		Pulse Triggered	SN15950	TI	45	–	–	–	8	–	4.5-5.5	–	–	750	–	D	
		Clocked JK-RS	DTμL931	FA	50	–	2	–	7	20	5	–	5	5	–	A, C	ITT, SY
		R-S, J-K	DTμL945	FA	50	–	2	–	9	35	5.0	0.2	5	600	–	A, C	SSD,RA,ITT,SY
		–	MC209	MO	50	–	–	–	8	16	8, -8	0.6	2.0	500	–	A, C	
		R-S, J-K	MC845	MO	50	–	–	–	12	35	5	0.2	5	500	0 to 75	A, C	Modified DTL
		R-S, J-K	MC945	MO	50	–	–	–	10	35	5	0.2	5	500	–	A, C	Modified DTL
		J-K	PL931	PH	50	–	–	–	7	20	3-6	0.2	4.0	500	–	C	
		Clocked J-K R-S	SI931	SI	50	–	2	–	7	20	5	0.2	5	500	–	D	
		Clocked J-K R-S	SI931D	SI	50	–	2	–	7	20	5	0.2	5	500	0 to 75	D	
		R-S J-K	SI945	SI	50	–	2	–	9	35	5	0.2	5	600	–25 to +125	D	
		R-S J-K	SI945D	SI	50	–	2	–	9	35	5	0.2	5	600	0 to 75	D	
		J-K/R-S	SN15831	TI	50	–	–	–	7	20	4.5-5.5	–	–	750	0-75	D,DIP	
		–	SN15845	TI	50	–	–	–	9	30	4.5-5.5	–	–	750	0-75	D, DIP	
		J-K/R-S	SN15931	TI	50	–	–	–	7	20	4.5-5.5	–	–	750	–	D	
		J-K/R-S	SN15945	TI	50	–	–	–	10	30	4.5-5.5	–	–	750	–	D	
		R-S J-K Clocked	SW945	SW	50	2	–	9	–	42	4-6	0.4	2.6	1000	–	–	
		Clocked R-S J-K	945	SW	50	–	2	12	–	35	5	0.2	5.0	1000	–	A, C	
		Dual J-K	909351	FA	50	–	–	–	12	140	4.5-5.5	0.4	3.1	1000	–	C, G	
		Dual J-K	909356	FA	50	–	–	–	12	160	4.5-5.5	0.4	3.1	1000	–20 to +100	C, G	
		Dual J-K	909359	FA	50	–	–	–	10	160	5	0.5	3.1	1000	0 to +75	C, G	
		Dual J-K	909956	FA	50	–	–	–	12	140	4.5-5.5	0.4	3.1	1000	–20 to +100	C, G	
		J-K	WM503	WH	†20MHz	–	–	10	–	47	4.5	0.40	1.8	500	–	D	†ft
		J-K	SE125	SIG	55	–	–	–	8	40	+4	0.4	3.9	1000	–	F	
		Clocked R-S	MC259	MO	60	–	–	–	8	16	4	4	.3	500	0 to 75	A, C	

1. DTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Binary Elements **B**	4	–	MC260	MO	60	–	–	–	8	16	4	4	.3	500	0 to 75	A, C	
		Single	CS704	SIG	60	–	–	–	7	20	+4-2	0.4	3.9	1000	–	A, C	
		Single	CS729	SIG	60	–	–	–	7	30	+4	0.4	3.9	1000	–	F	
		Single	SE124	SIG	60	–	–	–	8	16	+4, –2	0.4	3.9	1000	–	A, C, F	
		Single Phase J-K	SN530	TI	60	–	–	–	10	27	3 – 4	–	–	300	–	D	Modified DTL
		J-K	SN5301	TI	60	–	–	–	10	27	3-4	–	–	300	–	D	Preset & Clr
		Dual J-K	SN5302	TI	60	–	–	–	10	27	3-4	–	–	300	–	D	Preset
		Dual J-K	SN5304	TI	60	–	–	–	10	27/	3-4	–	–	300	–	D	Preset & Clr
		J-K	SN7301	TI	60	–	–	–	10	27	3-4	–	–	–	0-70	D	Preset & Clr
		J-K	SN7300	TI	60	–	–	–	10	27	3-4	–	–	300	0-70	D	Preset
		Dual J-K	SN7302	TI	60	–	–	–	10	27/ff	3-4	–	–	–	0-70	D	Preset
		Dual J-K	SN7304	TI	60	–	–	–	10	27/ff	3-4	–	–	–	0-70	D	Preset & Clr
		R-S-T - J-K	311BG	AL	60	6	–	–	6	120	12	1200	12000	4800	–	G	
		R-S-T - J-K	311CG	AL	60	6	–	–	6	120	12	1200	12000	4800	0 to +100	G	
		R-S-T - J-K	311CJ	AL	60	6	–	–	6	120	12	1200	12000	4800	0 to +70	G, DIP	
		–	WM213	WH	†12MHz	–	–	–	9	35	6	1.0	2.0	550	–	A, C, D	††t, RA
		Pulse	RC213T	RA	†11MHz	–	–	8	–	40	6	–	–	–	–	A, D	†clock rate
		R-S-T	SP629	SIG	10 MHz	–	–	–	5	40	4.5	0.45	3.9	1000	15 to 55	G	also available 0°C to 70°C
		8-input	CD2203	RCA	150	–	8	–	5	15	5	0.1	3.4	12	–	F	
		–	RC203T	RA	†5MHz	–	–	4	–	75	6	–	–	0.55	–	A, D	†clock rate
		JK	RC215T	RA	†5MHz	–	–	9	–	56	6	–	–	0.55	–	A, D	†clock rate
		J-K	SP620	SIG	5 MHz	–	–	–	5	28	4.5	0.45	3.9	1000	15 to 55	G	
		J-K	WM215	WH	†5MHz	–	–	–	9	45	6.0	1.0	2.0	550	0 to 125	A, C, D	†fT
		–	NC/PC19	GI	–	–	–	–	5	200	12, 4.2	0	5	–	–	A, E	RCT
		J-K	WM225G	WH	–	–	–	–	10	55	6	1.0	2.0	550	–	D	
Drivers / Buffers **C**	1	Dual 4-input	RD-209	RAD	7	–	4	–	12	22	5	0.25	3	800	–	D	Expandable
		Dual 4-input	RD-309	RAD	7	–	4	–	8	22	5	0.25	3	800	–	D	Expandable
		Dual 4-input	RD-509	RAD	7	–	4	–	12	22	5	0.25	3	800	0+75	D	Expandable
		Hex*	RD-235	RAD	12	–	–	–	8	10	5.0	0.55	35	–	–	D	*Node inputs
		3-input	UC1003B	SPR	14	–	15	–	15	55	6,-3	0.4	5.8	500	–	–	
		–	8213	VAR	15	–	–	–	10	–	6, 3, -3	0.5	3.5	–	–	–	TF
		Dual	SE155	SIG	16	–	4	–	19	30	+4	0.4	3.9	1000	–	F	
		Dual	SE156	SIG	18	–	4	–	19	30	+4	0.4	3.9	1000	–	F	
		Dual	MC832P	MO	20	–	–	–	25	30	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL,
		8-input	WM234G	WH	25	–	–	–	11	20	6	1.0	2.0	550	–	D	
		Dual 4-input	DTμL932	FA	20	–	4	–	25	30	5	0.2	5	750	–	A, C	SSD,RA,ITT,SY
		Dual 4-input	MC832	MO	20	–	–	–	25	30	5	0.2	5	500	0 to 75	A, C	Modified DTL
		Dual 4-input	MC932	MO	20	–	–	–	25	30	5	0.2	5	500	–	A, C	Modified DTL
		Dual 4-input	PL932	PH	20	–	–	–	25	90	3-6	0.2	4.0	500	–	C	
		4-input	SI932	SI	20	–	4	–	25	30	5	0.2	5	750	–	D	
		4-input	SI932D	SI	20	–	4	–	25	30	5	0.2	5	750	0 to 75	D	
		Dual	CS715	SIG	20	–	2	–	19	30	+4-2	0.4	3.9	1000	–	A	
		Dual	SE157	SIG	20	–	3	–	19	30	+4, -2	0.4	3.9	1000	–	A	
		Dual 3-input	SP659	SIG	25	–	3	–	12	34	4.5	0.45	3.9	1000	15 to 55	G	
		Dual	729	SW	25	5	–	–	100 mA	42	5	–	–	1000	–	A, C	
		Dual 4-input	SW932	SW	25	100	–	25	–	25	4-6	0.4	2.6	1000	–	–	Expandable
		Dual 4-input	932	SW	25	4	–	30	–	27	5	0.2	5.0	1000	–	A, C	Expandable
		Dual 4-input	SW944	SW	25	100	–	27	–	20	4-6	0.4	2.6	1000	–	–	Expandable
		Dual 4-input	SN15832	TI	25	–	–	–	20	15/	4.5-5.5	–	–	750	0-75	D, DIP	
	2	Dual 4-input	SN15932	TI	25	–	–	–	20	15/	4.5-5.5	–	–	750	–	D	
		Quad Inverter/	SN535	TI	30	–	–	–	10	9/	3-4	–	–	300	–	D	Modified DTL
		Quad	SN7350	TI	30	–	–	–	10	9/inv	3-4	–	–	–	0-70	D, J	
		Dual	RC210T RC210G	RA	32	–	–	11	–	9.5/	6	–	–	0.55	–	A, D	
		–	ND1002	NA	35	–	2	20	–	20	6	0.2	4.0	750	–	–	
		Dual	WM210	WH	37	3	3	–	22	24	6	0.35	2.0	550	–	A, C, D	RA
		Single	SE750	SIG	40	–	2	–	20	36	+4, –2	0.4	3-9	1000	–	A, C	
		Dual 3-input	WC210	WH	40	–	3	–	16	40	5.7-6.3	1.0	2.0	600	0 to 75	A, D	
		Dual 3-input	WC220	WH	40	–	3	–	16	40	5.7-6.3	1.0	2.0	600	0 to 75	A, D	Expandable
		–	MC205	MO	55	2	–	–	20	50	6, -6	0.6	2.5	300	–	A, C	1000 ohm Load
		–	MC255	MO	55	–	–	–	20	50	4	–	–	–	0 to 75	A, C	
		Dual 5-input	301BG	AL	60	5	–	–	6	300	12	1200	12000	4800	–	G	
		Dual 5-input	301CG	AL	60	5	–	–	6	300	12	1200	12000	4800	0 to +100	G	
		Dual 5-input	301CJ	AL	60	5	–	–	6	300	12	1200	12000	4800	0 to +70	G, DIP	
		Dual input	SN343A	TI	500	–	–	–	13	25	24, 6-3	–	–	500	0 to 65	D	Minuteman
		Dual output	SN346A	TI	850	–	–	–	11	160	–	–	–	500	0 to 65	D	Minuteman Type
		Dual	A20	SI	–	–	4	–	–	7	5	1.0	2.7	–	–	A, D	
		Dual	A60	SI	–	–	4	–	–	7	5	1.1	2.7	700	0 to 70	A, D	
Gates **D**	AND 1	–	MC203	MO	4	6	–	–	–	100	6, 8	0.6	2.0	500	–	A, C	
		–	A44	SI	4	–	6	–	–	–	–	–	–	–	–	A, D	Diode Array
		–	SWA04	SW	4	–	6	–	–	–	–	–	–	–	–	–	
		5-input	SN7320	TI	5	–	–	–	4	10	3-4	–	–	–	0-70	D	
		–	8207	VAR	10	–	–	6	10	–	6	–	–	–	–	–	TF, Expand.
		–	8208	VAR	10	–	–	6	10	–	6	–	–	–	–	–	TF, Expand.
		–	8209	VAR	10	–	–	6	10	–	6	–	–	–	–	–	TF, Expand.
		–	8210	VAR	10	–	–	6	10	–	6	–	–	–	–	–	TF, Expand.
		3-4 input	MC1111	MO	15	3-4	–	–	–	200	10	–	–	–	–	A	
		–	MC1112	MO	15	2,2,2	–	–	–	300	10	–	–	–	–	A	
		–	MC1113	MO	15	2,1	1,1	–	–	300	10	–	–	–	–	A	
		8-Diode	MC1114	MO	15	8	–	–	–	100	10	–	–	–	–	A	
		Dual 5-input	331BG	AL	60	5	–	–	–	15	12	1200	12000	4800	–	G	
		Dual 5-input	331CG	AL	60	5	–	–	–	15	12	1200	12000	4800	0 to +100	G	
		Dual 5-input	331CJ	AL	60	5	–	–	–	15	12	1200	12000	4800	0 to +70	G, DIP	

Temperature range is —55 to 125°C unless otherwise stated.

1. DTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates D	2	Dual 4-input	DTμL933	FA	–	–	4	–	–	–	–	–	–	–	–	A, C	Diode Array, SSD,ITT,RA,SY
		Dual 3-input	MC215	MO	–	–	–	–	–	–	–	4	.3	–	–	A, C	
		6-input	MC253	MO	–	–	–	–	–	–	–	4	.3	–	0 to 75	A, C	
		Dual 3-input	MC265	MO	–	–	–	–	–	–	–	4	.3	–	0 to 75	A, C	
		Dual	CS705	SIG	–	–	3	–	6	5	+4, 2	0.4	3.9	1000	–	A, C	
		Dual 4-input	MC833	MO	–	–	–	–	–	–	–	–	–	–	0 to 75	A, C	Modified DTL,
		Dual 4-input	MC833P	MO	–	–	–	–	–	–	–	–	–	–	0 to 75	G,P,DIP	Mod-DTL
		Dual 4-input	MC933	MO	–	–	–	–	–	–	–	–	–	–	–	A, C	Modified DTL
		Dual 4-input	PL933	PH	–	–	–	–	–	–	3-6	0.2	4.0	500	–	C	
		Dual 4-input	RD211	RAD	–	–	4	–	–	–	–	–	–	–	–	D	Expandable
		Dual 4-input	RD511	RAD	–	–	4	–	–	–	–	–	–	–	0 to 75	D	Expandable
		Dual 4-input	SI933	SI	–	–	4	–	–	–	–	–	–	–	–	D	Diode Array
		Dual 4-input	SI933D	SI	–	–	4	–	–	–	–	–	–	–	0 to 75	D	Diode Array
		Dual	CS709	SIG	–	–	3	–	1	–	–	–	–	–	–	A, C	
	3	Quad	CS731	SIG	–	–	2	–	1	–	–	–	–	–	–	F	
		Single	CS732	SIG	–	–	12	–	1	–	–	–	–	–	–	F	
		6 - input	SE105	SIG	–	–	6	–	1	–	–	–	–	–	–	A, C	
		Dual	SE106	SIG	–	–	5	–	1	–	–	–	–	–	–	F	
		Quad 2-input	SP631	SIG	–	–	2	–	–	–	4.5	0.45	3.9	1000	15 to 55	G	
		–	UC1005B	SPR	–	8	–	–	–	–	–	–	–	–	–	–	
		–	UC1006B	SPR	–	5	–	–	–	–	–	–	–	–	–	–	
		Dual 4-input	SW933	SW	–	4	–	–	–	–	4-6	–	–	–	–	–	
		Quad 2-input	727	SW	–	–	2	–	–	–	–	–	–	–	–	A, C	Diode array
		Dual 4-input	933	SW	–	–	4	–	–	–	–	–	–	–	–	A, C	Diode array
		Dual 4 - input	SN15833	TI	–	–	–	–	4	–	4.5 - 5.5	–	–	750	0 - 75	D	
		Dual 4 - input	SN15933	TI	–	–	–	–	4	–	4.5 - 5.5	–	–	750	–	D, DIP	
		Dual	WM217	WH	–	7	7	–	–	–	–	–	–	–	–	A, C, D	RA
		Triple	WM227	WH	–	11	11	–	–	–	–	–	–	–	–	D	RA
	AND/OR 4	5 - input	SN532	TI	5	–	–	–	4	10	3 - 4	–	–	300	–	D	Modified DTL
		Dual	SN534	TI	5	–	–	–	4	10/	3 - 4	–	–	300	–	D	Modified DTL
	NAND 5	–	NC-11	GI	8	–	4	–	5	60	12, 4.2,	0	5	–	–	A	MC RCDT
		–	PC-11	GI	8	–	6	–	5	60	12, 4.2, -3	0	5	–	–	E	MC RCDT
		Dual	PC-15	GI	8	–	3+3	–	5	60	12, 4.2 -3	0	5	–	–	E	MC RCDT
		Dual	8214	VAR	10	5	15	2	4	50	6, 3, -3	0.5	3.5	–	–	–	TF
		Dual	SWA05	SW	12	–	4	–	10	15	5	0.8	4.8	900	–	A	
		Quad 2-input	CA2201	RCA	15	–	8	–	24	9.2	5	0.1	3.4	1200	–	F	
		–	UC1001B	SPR	15	20	15	8	4	30	6,-3	0.4	5.0	500	–	–	
		Dual	SW708	SW	15	4	10	10	15	15	4 to 6	0.3	3.0	1000	–	A	Expandable
		Dual	SW930	SW	17	4	10	–	8	5	4 to 6	0.3	3.0	1000	–	A	And Expand.
		–	SWA01	SW	18	–	4	–	15	7	5	0.8	2.5	900	–	A	And Expand.
		Dual	SWA02	SW	18	–	4	–	15	7	5	0.8	2.5	900	–	A	
		Triple	WM226G	WH	19	–	–	–	16	59	6	2	1	550	–	D	Expandable
		8 - input	WM234G	WH	19	–	–	–	16	20	6	2	1	550	–	D	
		Triple 3 - input	WM236G	WH	19	–	–	–	16	59	6	2	1	550	–	D	
		Dual 4 - input	WM241G	WH	19	–	–	–	16	39	6	2	1	550	–	D	
		Dual	WM261G	WH	19	–	–	–	16	39	6	2	1	550	–	D	Expandable
		Sextuple	WM296G	WH	19	–	–	–	16	117	6	2	1	550	–	D	
		Dual 4-input	PL930	PH	20	4	–	–	8	4	3-6	0.2	4.0	500	–	C	
		Quad 2-input	PL946	PH	20	–	2	–	8	4	3-6	0.2	4.0	500	–	C	
		–	SW101	SW	20	4	–	5	7	6	+4, -2	0.6	2.0	500	–	A, E	And Expand.
			SW102	SW	20	3	–	5	7	6	+4, -2	0.6	2.0	500	–	A, E	And Expand.
	6	Dual	SW115	SW	20	–	2	5	7	6	+4,-2	0.6	2.0	500	–	A, E	
		Dual	SW201	SW	20	–	3	–	11	7	6	0.35	2.0	550	–	A, C, D	
		–	SW204	SW	20	4	–	–	11	7	6	0.35	2.0	550	–	A	And Expand.
		Dual	SW211	SW	20	–	4	–	11	7	6	0.35	2.0	550	–	A, D	
		Dual	SW221	SW	20	3	–	–	11	7	6	0.35	2.0	550	–	A, D	And Expand.
		–	SW224	SW	20	8	–	–	11	7	6	0.35	2.0	550	–	A	And Expand.
		Dual	SW231	SW	20	4	–	–	11	7	6	0.35	2.0	550	–	D	And Expand.
		Dual 4-input	SW930	SW	20	50	–	8	–	7	4-6	0.4	2.6	1000	–	–	Expandable
		Quad 2-input	SW946	SW	20	2	–	8	–	7	4-6	0.4	2.6	1000	–	–	
		Triple 3-input	SW962	SW	20	3	–	8	–	7	4-6	0.4	2.6	1000	–	–	
		Dual	WM201	WH	23	3	3	–	11	16	6	1.0		550	–	A, C, D	RA
		Triple	WM206	WH	23	3	3	–	11	22.5	6.0	1.0	2.0	550	–	D	Exp, RA
		Dual	WM211	WH	23	4	4	–	11	16	6	1.0	2.0	550	–	A, D	RA
		Triple	WM216	WH	23	3	3	–	11	22.5	6.0	1.0	2.0	550	–	D	RA
			WM221	WH	23	3	3	–	11	16	6	1.0	2.0	550	–	A, D	RA
		Dual	WM231	WH	23	4	4	–	11	16	6	1.0	2.0	550	–	D	RA
		Quad	WM246	WH	23	2	2	–	11	32	6.0	1.0	2.0	550	0 to 125	D	RA
		Dual 4-input	CD2202	RCA	24	–	8	–	50	56	5	0.1	3.4	1200	–	F	
		–	RC223	RA	25	4	–	6	–	6	4.0	0.2	4.0	500	–	–	
		Dual	RC224	RA	25	2, 3	–	2, 6	–	2, 6	4.0	0.2	4.0	500	–	–	
		–	RC243	RA	25	4	–	6	–	6	4.0	0.2	4.0	500	–	–	
		Dual 4 - input	SN15830	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	0 - 75	D, DIP	
		Dual 4 - input	SN15844	TI	25	–	–	–	20	15/	4.5 - 5.5	–	–	750	0 - 75	D, DIP	
	7	Quad 2 - input	SN15846	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	0 - 75	D, DIP	
		Triple 3 - input	SN15862	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	0 to 75	D, J, DIP	
		Dual 4 - input	SN15930	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	–	D	
		Dual 4 - input	SN15944	TI	25	–	–	–	20	15/	4.5 - 5.5	–	–	750	–	D	
		Quad 2 - input	SN15946	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	–	D	
		Triple 3 - input	SN15962	TI	25	–	–	–	8	5/	4.5 - 5.5	–	–	750	–	D	
		Triple	WC206	WH	25	–	3	–	8	24	5.7-6.3	1.0	2.0	600	0 to 75	D	Expandable
		Dual 4-input	WC211	WH	25	–	4	–	8	16	5.7-6.3	1.0	2.0	600	0 to 75	A	
		Triple	WC216	WH	25	–	3	–	8	24	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Dual 3-input	WC221	WH	25	–	3	–	8	16	5.7-6.3	1.0	2.0	600	0 to 75	A	Expandable
		Single 8-input	WC224	WH	25	–	8	–	8	8	5.7-6.3	1.0	2.0	600	0 to 75	A, D	Expandable

Temperature range is —55 to 125°C unless otherwise stated.

TRY TI TTL IC's FROM EW...ASAP!

Series 74 TTL devices from Texas Instruments offer *more* performance, *more* circuits and *more* economy than other types of digital ICs presently available. And now you can get them FAST — from the big stocks at EW.

TTL circuits provide the optimum balance of performance for most applications. Key benefits: *Speed* (propagation delay — 13 nsec, flip-flop speeds — 30-40 nsec); *Noise immunity* (D-C noise margin — 400 mV worse case, one volt typical); *Economy* (Because of higher complexity level, Series 74 TTL devices offer outstanding value on a cost-per-function basis.

You'll find Electronic Wholesalers the BEST place to buy TI TTL circuits and the other semiconductors you need. Call us . . . ASAP!

"SERVING THE ENTIRE SOUTHEASTERN U.S."

ELECTRONIC WHOLESALERS INC.

WASHINGTON, D. C.
2345 Sherman Ave., N.W.
Phone 202—483-5200

BALTIMORE, MARYLAND
3200 Wilkens Avenue
Phone 301—646-3600

WINSTON-SALEM, N. C.
938 Burke Street
Phone 919—725-8711

MIAMI, FLORIDA
9390 N.W. 27th Avenue
Phone 305—696-1620

ORLANDO, FLORIDA
345 Graham Avenue
Phone 305—841-1550

ON READER-SERVICE CARD CIRCLE 88

1. DTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gate		Triple	WC226	WH	25	–	3	–	8	33	5.7-6.3	1.0	2.0	600	0 to 75	D	Expandable
D		Triple	WM226G	WH	25	–	–	–	11	33	6	1.0	2.0	550	–	D	Expandable
		Dual 4-input	WC231	WH	25	–	4	–	8	16	5.7-6.3	1.0	2.0	600	0 to 75	D	Expandable
		Single 8-input	WC234	WH	25	–	8	–	8	11	5.7-6.3	1.0	2.0	600	0 to 75	A, D	Expandable
		Triple 3-input	WC236	WH	25	–	3	–	8	33	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Dual 4-input	WC241	WH	25	–	4	–	8	22	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Quad 2-input	WC246	WH	25	–	2	–	8	32	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Dual 4-input	WC261	WH	25	–	4	–	8	22	5.7-6.3	1.0	2.0	600	0 to 75	D	Expandable
		Quad 2-input	VC266	WH	25	–	2	–	8	44	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Hex	WC286	WH	25	–	1	–	8	48	5.7-6.3	1.0	2.0	600	0 to 75	D	
		Hex	WC296	WH	25	–	1	–	8	66	5.7-6.3	1.0	2.0	600	0 to 75	D	
	8	Triple 3-input	WM236G	WH	25	–	–	–	11	33	6	1.0	2.0	550	–	D	
		Dual 4-input	WM241G	WH	25	–	–	–	11	22	6	1.0	2.0	550	–	D	RA
		Dual	WM261G	WH	25	–	–	–	11	22	6	1.0	2.0	550	–	D	Expandable
		Sextuple	WM296G	WH	25	–	–	–	11	66	6	1.0	2.0	550	–	D	
		–	WM204	WH	28	4	4	–	11	7	6	1.0	2.0	550	–	A, C, D	RA
		–	WM214	WH	28	6	6	–	11	7	6	1.0	2.0	550	–	A, C, D	RA
		–	WM224	WH	28	8	8	–	11	7	6	1.0	2.0	550	–	A, D	RA
		Dual 3-input	CD2205	RCA	30	–	6	–	12	12.2	5	0.1	3.5	1200	–	F	
		Dual 3-input	RC201T	RA	30	–	–	11	–	9.5	6	–	–	0.55	–	A	
		Dual 4 input	RC211T	RA	30	–	–	11	–	9.5	6	–	–	0.55	–	A, D	
		Dual 3-input	RC221T	RA	30	–	–	11	–	9.5	6	–	–	0.55	–	A, D	
		Dual 4-input	RC231G	RA	30	–	–	11	–	9.5	6	–	–	0.55	–	D	
		Dual 4-input	SP616	SIG	30	–	4	–	5	34	4.5	0.45	3.9	1000	15 to 55	G	
		Triple 3-input	SP670	SIG	30	–	3	–	5	15	4.5	0.45	3.9	1000	15 to 55	G	
		Quad 2-input	SP680	SIG	30	–	2	–	5	15	4.5	0.45	3.9	1000	15 to 55	G	
		Quad 2-input	WM246G	WH	30	–	–	–	11	32	6	2	1	550	–	D	
		Sextuple	WM286G	WH	30	–	–	–	11	48	6	2	1	550	–	D	
		Triple	RC206G	RA	32	–	–	11	–	9.5	6	–	–	0.55	–	D	
		3-input	RC216G	RA	32	–	–	11	–	9.5	6	–	–	0.55	–	D	
		4-input	RC204T	RA	35	–	–	11	–	9.5	6	–	–	0.55	–	A, D	
		6-input	RC214T	RA	35	–	–	11	–	9.5	6	–	–	0.55	–	A, D	
		8-input	RC224T	RA	35	–	–	11	–	9.5	6	–	–	0.55	–	A, D	
	9	Quad 2-input	321BG	AL	60	2	–	6	–	96	12	1200	12000	4800	–	G	
		Quad 2-input	321CG	AL	60	2	–	–	6	96	12	1200	12000	4800	0 to +100	G	
		Quad 2-input	321CJ	AL	60	2	–	–	6	96	12	1200	12000	4800	0 to +70	G, DIP	
		Dual 5-input	322BG	AL	60	5	–	–	6	98	12	1200	12000	4800	–	G	
		Dual 5-input	322CG	AL	60	5	–	–	6	98	12	1200	12000	4800	0 to +100	G	
		Dual 5-input	322CJ	AL	60	5	–	–	6	98	12	1200	12000	4800	0 to +70	G, DIP	
		Quad 2-input	323BG	AL	60	2	–	–	100	15	12	1200	12000	4800	–	G	
		Quad 2-input	323CG	AL	60	2	–	–	100	15	12	1200	12000	4800	0 to +100	G	
		Quad 2-input	323CJ	AL	60	2	–	–	100	15	12	1200	12000	4800	0 to +70	G, DIP	
		Dual 4-input	CA2200	RCA	65	–	8	–	12	4.6	5	0.1	3.4	1200	–	F	
		Dual 4-input	CD2204	RCA	–	–	20	–	–	–	–	–	–	–	–	F	
	NAND/NOR	Triple 3-input	RD-205	RAD	7	–	3	–	8	10	5	0.25	5	800	–	D	
		Quad 2-input	RD-206	RAD	7	–	2	–	8	10	5	0.25	5	800	–	D	
		Dual 4-input	RD-210	RAD	7	–	4	–	8	10	5	0.25	5	800	–	D	Expandable
		Triple 3-input	RD-305	RAD	7	–	3	–	5	10	5	.250	4.5	800	–	D	
		Quad 2-input	RD-306	RAD	7	–	2	–	5	10	5	.250	4.5	800	–	D	
		Dual 4-input	RD-310	RAD	7	–	4	–	5	10	5	.250	4.5	800	–	D	Expandable
		Triple 3-input	RD-505	RAD	7	–	3	–	8	10	5	0.25	5	800	0+75	D	
		Quad 2-input	RD-506	RAD	7	–	2	–	8	10	5	0.25	5	800	0+75	D	
		Dual 4-input	RD-510	RAD	7	–	4	–	8	10	5	0.25	5	800	0+75	D	Expandable
		Quad Inverter	μL927	FA	10	–	1	–	5	24	3.0	0.21	0.844	250	–	A, C	SSD
		Dual	A05	SI	12	–	4	–	10	15	5	1.0	2.7	900	–	A, D	Line Driver
		–	A10	SI	12	–	4	–	10	15	5	1.0	2.7	900	–	–	Expandable
	10	Dual	A12	SI	12	–	4	–	5	15	5	1.0	2.7	900	–	–	
		–	A13	SI	12	–	4	–	5	15	5	1.0	2.7	900	–	–	Expandable
		Dual Line Driver	A45	SI	12	–	4	–	10	15	5	1.1	2.7	700	0 to 70	A, D	
		Single 4-input	A50	SI	12	–	4	–	10	15	5	1.1	2.7	700	0 to 70	A, D	W/expander
		Dual 4-input	A52	SI	12	–	4	–	5	15	5	1.1	2.7	700	0 to 70	A, D	
		3-input	UC1001B	SPR	12	–	15	–	4	35	6,-3	0.4	5.8	500	–	–	
		Dual	MC281G	MO	18	–	–	–	–	7.5	–	–	–	550	–	A	
		–	MC284G	MO	18	–	–	–	–	7.5	–	–	–	550	–	–	
		–	A01	SI	18	–	4	–	15	7	5	1.0	2.7	900	–	A, D	
		Dual	A02	SI	18	–	4	–	15	7	5	1.0	2.7	900	–	A, D	
		–	A06	SI	18	–	4	–	5	7	5	1.0	2.7	900	–	A, D	
		Dual	A07	SI	18	–	4	–	5	7	5	1.0	2.7	900	–	A, D	
		Quad	A14	SI	18	–	2	–	5	7	5	1.0	2.7	900	–	D	
		Quad	A15	SI	18	–	2	–	10	7	5	1.0	2.7	900	–	D	
		Single 4-input	A41	SI	18	–	4	–	15	7	5	1.1	2.7	700	0 to 70	A, D	
		Dual 4-input	A42	SI	18	–	4	–	15	7	5	1.1	2.7	700	0 to +70	A, D	
		Single 4-input	A46	SI	18	–	4	–	5	7	5	1.1	2.7	700	0 to 70	A, D	
		Dual 4-input	A47	SI	18	–	4	–	5	700	5	1.1	2.7	700	0 to 70	A, D	
		Single 4-input	A53	SI	18	–	4	–	5	15	5	1.1	2.7	700	0 to 70	A, D	W/expander
		Quad	A54	SI	18	–	2	–	5	7	5	1.1	2.7	700	0 to 70	D	
		Quad	A55	SI	18	–	2	–	10	7	5	1.1	2.7	700	0 to 70	D	
		Dual	SE111	SIG	19	–	4	–	19	24	+4	0.4	3.9	1000	–	F	
	11	Dual	SE113	SIG	19	–	3	–	19	24	+4	0.4	3.9	1000	–	A	
		Dual	CS700	SIG	20	–	3-2	–	6	10	+4, -2	0.4	3.9	1000	–	A, C	
		Dual	CS701	SIG	20	–	3.2	–	6	10	+4-2	0.4	3.5	1000	–	A, C	
		Dual	CS716	SIG	20	–	2	–	19	30	+4,–2	0.4	3.9	1000	–	A	
		Quad	CS720	SIG	20	–	2	–	6	10	+4	0.4	3.9	1000	–	F	
		Triple	CS721	SIG	20	–	3	–	6	10	+4	0.4	3.9	1000	–	F	
		Triple	CS727	SIG	20	–	2	–	6	10	+4	0.4	3.9	1000	–	F	
		Dual	CS730	SIG	20	–	5	–	6	10	+4	0.4	3.9	1000	–	F	
		Dual	SE112	SIG	20	–	3	–	19	24	+4	0.4	3.9	1000	–	F	

Temperature range is —55 to 125°C unless otherwise stated.

1. DTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates D	12	Triple	SE170	SIG	20	–	3	–	6	10	+4	0.4	3.9	1000	–	F	
		Quad	SE180	SIG	20	–	2	–	6	10	+4	0.4	3.9	1000	–	F	
		Dual 4-input	961	SW	20	4	–	9	–	6	5	0.2	5.0	1000	–	A, C	Expandable
		Triple 3-input	963	SW	20	–	3	9	–	6	5	0.2	5.0	1000	–	A, C	
		Dual 4-input	DTμL930	FA	25	–	4	–	8	5	5	0.2	5	750	–	A, C	Expandable, SSD,RA,SY,ITT
		Quad	DTμL946	FA	25	–	2	–	8	5	5	0.2	5	750	–	A, C	Expandable, SSD,RA,ITT,SY
		Triple	DTμL962	FA	25	–	3	–	8	5	5	0.2	5	750	–	A, C	Expandable, SSD,RA,ITT,SY
		Dual 4-input	MC830	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	A, C	Modified DTL, Expandable
		Dual 4-input	MC830P	MO	25	–	–	–	8	5	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL
		Quad 2-input	MC846	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	C	Modified DTL, Expandable
		Quad 2-input	MC846P	MO	25	–	–	–	8	5	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL,
		Triple 3-input	MC862	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	C	Modified DTL, Expandable
		Triple 3-input	MC862P	MO	25	–	–	–	8	5	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL,
		Dual 4-input	MC930	MO	25	–	–	–	8	5	5	0.2	5	500	–	A, C	Modified DTL, Expandable
		Quad 2-input	MC946	MO	25	–	–	–	8	5	5	0.2	5	500	–	C	Modified DTL, Expandable
		Triple 3-input	MC962	MO	25	–	–	–	8	5	5	0.2	5	500	–	C	Modified DTL, Expandable
	13	Dual 4-input	SI930	SI	25	–	8	–	8	5	5	0.2	5.0	750		D	
		Dual 4-input	SI930D	SI	25	–	8	–	8	5	5	0.2	5.0	750	0 to 75	D	
		Quad	SI946	SI	25	–	2	–	8	5	5	0.2	5	750	–	D	
		Quad	SI946D	SI	25	–	2	–	8	5	5	0.2	5	750	0 to 75	D	
		Triple	SI962	SI	25	–	3	–	8	5	5	0.2	5	750	–	D	
		Triple	SI962D	SI	25	–	3	–	8	5	5	0.2	5	750	0 to 75	D	
		Single	SE101	SIG	25	–	4	–	5	6	+4,–2	0.4	3.9	1000	–	A, C	
		Single	SE102	SIG	25	–	3	–	5	6	+4,–2	0.4	3.9	1000	–	A, C	
		Dual	SE115	SIG	25	–	2	–	5	24	+4,–2	0.4	3.9	1000	–	A, C	
		Dual 4-input	930	SW	25	4	–	10	–	6	5	0.2	5.0	1000	–	A, C	Expandable
		Dual	944	SW	25	4	–	32	–	22	5	0.2	6.0	1000	–	A, C	Expandable
		Quad 2-input	946	SW	25	–	2	10	–	6	5	0.2	5.0	1000	–	A, C	
		Quad 2-input	949	SW	–	–	2	9	–	6	5	0.2	5.0	1000	–	A, C	
		Triple 3-input	962	SW	25	–	3	9	–	6	5	0.2	5.0	1000	–	A, C	
		–	MC201	MO	30	4	–	–	5	6	8, -8	0.6	2.5	500	–	A, C	
		–	MC202	MO	30	3	–	–	5	6	8, -8	0.6	2.5	500	–	A, C	
		Dual	MC206	MO	30	2-2	–	–	5	12	8, -8	0.6	2.5	500	–	A, C	
		Dual	MC207	MO	30	–	2-3	–	5	12	4	4	.3	500	–	A, C	
		Dual	MC208	MO	30	–	2-3	–	4	30	4	4	.3	500	–	A, C	
		Dual 3-input	MC212	MO	30	–	3-3	–	5	12	4	4	.3	500	–	A, C	
		Dual 3-input	MC213	MO	30	–	3-3	–	4	30	4	4	.3	500	–	A, C	
		4-input	MC251	MO	30	–	–	–	5	6	4	0.6	2.5	500	0 to 75	A, C	
		3-input	MC252	MO	30	–	–	–	5	6	4	0.6	2.5	500	0 to 75	A, C	
		Dual 2-input	MC256	MO	30	2	–	–	5	12	4	4	.3	500	0 to 75	A, C	
		Dual	MC257	MO	30	–	2-3	–	5	12	4	4	.3	500	0 to 75	A, C	
	14	Dual	MC258	MO	30	–	2-3	–	4	30	4	4	.3	500	0 to 75	A, C	
		Dual 3-input	MC262	MO	30	–	3-3	–	5	12	4	4	.3	500	0 to 75	A, C	
		Dual 3-input	MC263	MO	30	–	3-3	–	4	30	4	4	.3	500	0 to 75	A, C	
		5-input	SN531	TI	30	–	–	–	10, 4	10	3 to 4	–	–	300	–	D	Modified DTL
		Dual 3-input	SN533	TI	30	–	–	–	10, 10	10, 10	3 to 4	–	–	300	–	D	Modified DTL
		Dual 5-input	SN5311	TI	30	–	–	–	10	10/gate	3-4	–	–	300	–	D	Modified DTL
		Triple 3-input	SN5331	TI	30	–	–	–	10	10/gate	3-4	–	–	300	–	D	Modified DTL
		Quad 2-input	SN5360	TI	30	–	–	–	10	10/gate	3-4	–	–	300	–	D	Modified DTL
		5-input	SN7310	TI	30	–	–	–	10	10	3-4	–	–	–	0-70	D	Expandable
		Dual 5-input	SN7311	TI	30	–	–	–	10	10/gate	3-4	–	–	–	0-70	D	
		Dual 3-input	SN7330	TI	30	–	–	–	10	10/gate	3-4	–	–	–	0-70	D	
		Triple 3-input	SN7331	TI	30	–	–	–	10	10/gate	3-4	–	–	–	0-70	D	
		Quad 2-input	SN7360	TI	30	–	–	–	10	10/gate	3-4	–	–	–	0-70	D	
		Single	SE110	SIG	35	–	3	–	20	36	+4,–2	0.4	3.9	1000	–	A, C	
		3-input	MC254	MO	40	3	–	–	20	30	4	4	.3	500	0 to 75	A, C	
		Dual	SI944	SI	40	–	4	–	27	20	–	0.2	5	750	–	D	
		Dual	SI944D	SI	40	–	4	–	27	20	–	0.2	5	750	0 to 75	D	
		Dual 3-input	MC650G	MO	50	–	4	–	5	180	10	9.7	.70	5V	0 to 75	A	Modified DTL
		Dual 4-input	MC651F	MO	50	–	5	–	5	180	10	9.7	.70	5V	0 to 75	C	Modified DTL
	NOR 15	–	NC-10	GI	8	–	4	–	5	170	12, 4.2, -3	0	5	–	–	A	MC RCDT
		–	PC-10	GI	8	–	6	–	15	170	12, 4.2, -3	0	5	–	–	E	MC RCDT
		Dual	PC-14	GI	8	–	3+3	–	5	170	12, 4.2, -3	0	5	–	–	E	MC RCDT
		–	8204	VAR	10-15	–	9	3	4	100	6,3	0.5	3.5	–	–	–	TF
		Dual 3-input	999552	FA	17	–	–	–	16	200	3	0.25	0.85	300	0 to 1000	C, G	Buffer
	Exclusive-OR 16	–	ND1006	NA	35	–	3	10	–	20	6	0.2	4.0	750	–	–	
		Dual 4-input	DTμL944	FA	40	–	4	–	27	20	5.0	0.2	5	750	–	A, C	SSD,RA,ITT,SY
		–	MC204	MO	40	3	–	–	20	40	6, -6	0.6	2.5	500	–	A, C	

Temperature range is —55 to 125°C unless otherwise stated.

1. DTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates **D**	Exclusive-OR	Dual 4-input	MC844	MO	40	–	–	–	27	20	5	0.2	5	500	0 to 75	A, C	Modified DTL
		Dual 4-input	MC844P	MO	40	–	–	–	27	20	5	0.2	5	–	0 to 75	G,P,DIP	Mod-DTL
		Dual 4-input	MC944	MO	40	–	–	–	27	20	5	0.2	5	500	–	A, C	Modified DTL
		Dual	341BG	AL	60	4	–	–	6	70	12	1200	12000	4800	–	G	
	17	Dual	341CG	AL	60	4	–	6	–	70	12	1200	12000	4800	0 to +100	G	
		Dual	341CJ	AL	60	4	–	–	6	70	12	1200	12000	4800	0 to +70	G, DIP	
		Dual	SN5370	TI	90	–	–	–	10	20/	3-4	–	–	300	–	D	Modified DTL
		Dual	SN7370	TI	90	–	–	–	10	20/	3-4	–	–	–	0-70	D	
Gate Expanders **E**		–	RC226	RA	2	2,3	6	–	–	–	–	–	–	–	–	–	
		–	RC246	RA	2	–	6	–	–	–	–	–	–	–	–	–	
		–	A04	SI	4	–	6	–	–	–	–	–	–	–	–	A, D	Diode Array
Interface **F**		Input	361BG	AL	30	1	–	–	8	50	12	1200	12000	4800	–	G, C	
		Input	361CG	AL	30	1	–	–	8	50	12	1200	12000	4800	0 to +100	G, C	
		Input	361CJ	AL	30	1	–	–	8	50	12	1200	12000	4800	0 to +70	G	Dip
		Output	362BG	AL	11	1	–	–	6	150	12	1200	12000	4800	–	G, C	
		Output	362CG	AL	11	1	–	–	6	150	12	1200	12000	4800	0 to +100	G, C	
		Output	362CJ	AL	30	1	–	–	6	150	12	1200	12000	4800	0 to +70	G, DIP	
Inverter **G**		Hex	RD-220	RAD	7	–	1	–	8	10	5.0	0.25	4.5	800	–	D	
		Hex*	RD-234	RAD	7	–	–	–	8	10	5.0	0.25	4.5	–	–	D	*Node inputs
		Hex	RD-320	RAD	7	–	1	–	5	10	5.0	0.25	4.5	800	–	D	
		Hex*	RD-334	RAD	7	–	–	–	5	10	5.0	0.25	4.5	–	–	D	*Node inputs
		Hex	RD-520	RAD	7	–	1	–	8	10	5.0	0.25	4.5	800	0-75	D	
		Hex*	RD-534	RAD	7	–	–	–	8	10	5.0	0.25	4.5	–	0 to +75	D	*Node inputs
		Hex	RD-223	RAD	12	–	1	–	–	10	5.0	0.55	*35	800	–	D	*Output break-
		Quad	SE181	SIG	20	–	1	–	6	20	+4	0.4	3.9	1000	–	A	
		Hex Inverter	937	SW	20	–	1	9	–	6	5	0.2	5.0	1000	–	A, C	
		Hex Inverter	936	SW	25	–	1	10	–	6	5	0.2	5.0	1000	–	A, C	
		Hex	993751	FA	30	–	–	–	7	150	4.5-5.5	0.4	3.8	1000	–	C, G	
		Hex	993759	FA	30	–	–	–	7	160	5	0.5	4.3	1000	0 to +75	C, G	
		Hex	993651	FA	35	–	–	–	8	90	4.5-5.5	0.4	2.6	1000	–	C, G	
		Hex	993659	FA	35	–	–	–	8	100	5	0.45	2.6	1000	0 to +75	C, G	
		Dual	MC1115	MO	Toff=45 Ton=20			–	–	250	–	–	–	–	–	A	
Logic Amplifier **H**		–	8201	VAR	10	1	–	4	–	50	6, 3, -3	0.5	3.5	–	–	–	TF
		–	8202	VAR	–	2	–	8	–	100	6, 3, -3	0.5	3.5	–	–	–	TF
Multivibrators **I**		Single-shot	NC/PC16	GI	8	–	–	–	5	200	12, 4.2	0	5	–	–	A, E	MC RCDT
		Single-shot	PC-18	GI	8	–	–	–	5	200	12, 4.2	0	5	–	–	E	MC RCDT
		Monostable	728	SW	24	–	5	–	16	25	5	0.2	5.0	1000	–	A, C	
		2-input	DTμL951	FA	25	–	–	–	10	35	5.0	0.2	5	950	–	A, C	RA, SSD, ITT
		Monostable	MC851	MO	25	–	–	–	10	30	5	0.2	5	–	0 to 75	A,C,G, P,DIP	Mod-DTL
		Monostable	MC951	MO	25	–	–	–	10	30	5	0.2	5	–	–	A, C	Mod-DTL
		Monostable	951	SW	25	2	–	12	–	32	5	0.2	5.0	1000	–	A, C	Expandable
		Single-shot	A08	SI	30	–	1	–	5	42	5	1.0	2.7	900	–	A, D	
		Single-shot	A48	SI	30	–	1	–	5	42	5	1.1	2.7	700	0 to 70	A, D	
		Single-shot	8203	VAR	30	–	–	2	4	100	6, 3	0.5	3.5	–	–	–	TF
		Monostable	WC218	WH	40	–	2	–	8	105	5.7-6.3	1.0	2.0	600	0 to 75	A, C	
		Single-shot	SN15851	TI	50	–	–	–	–	–	4.5-5.5	–	–	750	0-75	D, DIP	
		Single-shot	SN15951	TI	50	–	–	–	–	–	4.5-5.5	–	–	750	–	D	
		Dual 1-shot	342BG	AL	60	1	–	–	6	100	12	1200	12000	4800	–	G	
		Dual 1-shot	342CG	AL	60	1	–	–	6	100	12	1200	12000	4800	0 to +100	G	
		Dual 1-shot	342CJ	AL	60	1	–	–	6	100	12	1200	12000	4800	0 to +70	G, DIP	
		Single-shot	SN5380	TI	100	–	–	–	10	30	3-4	–	–	300	–	D	Modified DTL
		Single-shot	SN7380	TI	100	–	–	–	10	30	3-4	–	–	–	0-70	D	
		Single-shot	SE160	SIG	–	–	2	–	4	25	+4, –2	0.4	3.9	1000	–	A, C	
		Single-shot	SE161	SIG	–	–	1	–	4	25	+4	0.4	3.9	1000	–	A, F	
Shift Bit **J**		–	RC205T	RA	200	–	–	4	–	75	6	–	–	0.55	–	–	

Temperature range is —55 to 125°C unless otherwise stated.

Circle as many numbers on the reader-service card as you like.

Complete listing of semiconductor manufacturers starts on page 86.

Reader-Service cards are good all year.

2. Resistor-Transistor Logic and Direct-Coupled Transistor Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Adders **A**	1	Full	μL904	FA	14	–	2	–	5	45	3.0	0.15	1.0	250	–	A, C	SSD
		Half	MC704	MO	14	–	–	–	16	65	3.6	0.1	1.1	–	15 to 55	A	
		Half	MC804	MO	14	–	–	–	5	45	3	0.1	1.1	–	0 to 100	A, C	
		Half	MC904	MO	14	–	–	–	5	45	3	0.1	1.1	–	–	A, C	
		Half	PL904	PH	14	2	–	–	5	45	3.0	0	0.8	–	–	–	
		Half	NB1004	NA	17	–	2, 2	4, 5	–	45	3	0.18	1.2	300	–	–	
		Dual H/A	9997021	FA	20	–	–	–	16	120	3	0.2	0.82	350	–	C, G	
		Dual H/A	9997022	FA	20	–	–	–	16	120	3	0.25	0.85	300	0 to 100	C, G	
		Dual H/A	9997029	FA	20	–	–	–	16	180	3.6	0.3	0.9	300	0 to 70	C, G	
		Half	141A	AL	21	2	–	–	10	42	3	250 mV	810 mV	300	–	A, C	
		Half	H11001	AL	22	–	–	–	–	42	3	0.12	1.1	–	–	B	
		Half	H11004	AL	22	–	–	–	–	42	3	0.12	1.1	–	70	B	
	2	Half	141B	AL	23	2	–	–	6	42	3	250	810	265	–	A, C	
		Half	141C	AL	25	2	–	–	5	42	3	250	810	250	0 to 70	A	
		–	A11	SI	35	–	–	–	5	40	5	–	–	900	–	A, D	
		Full	MC708	MO	60	–	–	–	4	15	3.6	0.1	1.1	–	15 to 55	A	
		Full	MC908	MO	60	–	–	–	4	10	3	0.1	1.1	–	–	A	
		Half	MC712	MO	66	–	–	–	4	12	3.6	0.1	1.1	–	15 to 55	A	
		Half	MC912	MO	66	–	–	–	4	8	3	0.1	1.1	–	–	A	
		–	SN17908L	TI	70/105	–	–	–	3	10	3	–	–	150	–	A, D	
		–	SN17912L	TI	70/105	–	–	–	4	8	3	–	–	150	–	A, D	
		Full	PL908	PH	80	2	–	–	4	10	3.0	0	0.8	–	–	–	
		Half	PL912	PH	80	2	–	–	4	8	3.0	0	0.8	–	–	–	
		Full	MWμL908	FA	90	–	2	–	4	10	3.0, 4	0.220	0.805	350	–	A, C	
		Half	MWμL912	FA	90	–	2	–	4	8	3.0, 4	0.220	0.805	350	–	A, C	
Binary Element **B**	1	R-S	MC702G	MO	14	–	–	–	13	32	3.6	0.1	1.1	300	15 to 55	A	
		R-S	MC802	MO	14	–	–	–	4	22	3	0.1	1.1	300	0 to 100	A, C	
		R-S	MC902	MO	14	–	–	–	4	22	3	0.1	1.1	300	–	A, C	
		–	PL902	PH	14	1	–	–	4	22	3.0	0	0.8	–	–	–	
		–	μL902	FA	14	–	1	–	4	22	3.0	0.21 1.5	1.0	250	–	A,C	SSD
		R-S	116A	AL	13	1	–	–	3	20	3	250	810	300	–	A, C	
		R-S	116B	AL	17	1	–	–	3	20	3	250	810	265	–	A, C	
		R-S	116C	AL	17	1	–	–	3	20	3	250	810	250	0 to 70	A	
		J-K Flip-Flop	RD-207	RAD	20	–	3	–	12	95	5	0.25	3	800	–	D	
		–	PL916	PH	20	1	–	–	3	54	3.0	0	0.8	–	–	–	
		–	NB1002	NA	22	–	1	4	–	22	–	–	–	–	–	–	
		J-K	MC723	MO	35	–	–	–	10	78	3.6	0.1	1.1	300	15 to 55	A	
		J-K	MC723P	MO	35	–	–	–	10	78	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		J-K	MC726	MO	35	–	–	–	16	95	3.6	0.1	1.1	300	15 to 55	A	
		J-K	MC726P	MO	35	–	–	–	16	75	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Dual J-K	MC790P	MO	35	–	–	–	10	145	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		J-K	MC816	MO	35	–	–	–	3	54	3	0.1	1.1	300	0 to 100	A, C	
		J-K	MC816P	MO	35	–	–	–	3	78	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		J-K	MC826	MO	35	–	–	–	5	65	3	0.1	1.1	300	0 to 100	A, C	
		Dual J-K	MC890P	MO	35	–	–	–	3	145	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		J-K	MC916	MO	35	–	–	–	3	54	3	0.1	1.1	300	–	A, C	
		J-K	MC926	MO	35	–	–	–	5	65	3	0.1	1.1	300	0 to 100	A, C	
		J-K 10	111A	AL	35	1	–	–	3	84	3	250	810	300	–	A	
		J-K 10	112A	AL	35	1	–	–	3	84	3	250	810	300	–	A, C	
	2	J-K 10	111B	AL	39	1	–	–	3	84	3	250	810	265	–	A	
		J-K 10	112B	AL	39	1	–	–	3	84	3	250	810	265	–	A, C	
		–	FμL92329	FA	40	–	3	–	10	54	3, 4	0.15	1.0	300	15 to 55	A, C	SSD
		–	μL916	FA	40	–	2	–	3	54	3, 4	0.15	1.0	250	–	A, C	
		J-K 10	111C	AL	42	1	–	–	3	84	3	250	810	250	0 to 70	A	
		J-K 10	112C	AL	42	1	–	–	3	84	3	250	810	250	0 to 70	A	
		Toggle	FF1514B	IN	50	1	1	–	6	96	12	0.2	<12	2500	–	G	TF
		R-S-T	FF5551B	IN	50	3	–	–	6	66	10	0.2	<10	2.5	–	G	
		R-S-J-K	FF9551B	IN	50	4	–	–	6	66	10	0.2	<10	2.5	–	G	
		J-K	MC720	MO	50	–	–	–	2	22	3.6	0.1	1.1	250	15 to 55	A	
		J-K	MC722P	MO	50	–	–	–	4	25	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		J-K	MC920	MO	50	–	–	–	2	15	3	0.1	1.1	250	–	A	
		J-K 10	114A	AL	50	1	–	–	3	60	3	250	810	300	–	A, C	
		Dual J-K	999421	FA	50	–	–	–	10	350	3	0.2	0.82	350	–	C, G	
		Dual J-K	999422	FA	50	–	–	–	10	350	3	25	0.85	300	0 to 100	C, G	
		Dual J-K	999429	FA	50	–	–	–	10	400	3.6	0.3	0.9	300	0 to 70	C, G	
		J-K 10	114B	AL	56	1	–	–	3	60	3	250	810	265	–	A, C	
		Dual type D	MC778P	MO	60	–	–	–	3	40	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Type D	MC713	MO	75	–	–	–	3	17	3.6	0.1	1.1	–	+15 to 55	A	
		Type D	MC913	MO	75	–	–	–	3	12	3	0.1	1.1	250	–	A	
		J-K 10	114C	AL	77	1	–	–	3	60	3	250	810	250	0 to 70	A	
		–	MWμL913	FA	100	–	1	–	3	15	3.0, 4	0.220	0.805	350	–	A, C	
		JK	R12001	AL	150	–	–	–	–	3	4	1	1.7	–	–	A	
		–	A16	CBS	3000	–	5	–	25	†408	7 max	0.65	0.30	–	–	G	†μw
		gated input	A13	CBS	5000	–	1	–	4	†180	7 max	0.65	0.30	–	–	G	†μw
	3	gated	A17	CBS	5000	–	1	–	25	†528	7 max	0.65	0.30	–	–	G	†μw
		Flip-Flop	MC779P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	G, DIP	
		Flip-Flop	MC787P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	G, DIP	
		J-K	MC822P	MO	–	–	–	–	4	30	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		J-K	MC826P	MO	–	–	–	–	5	120	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Flip-Flop	MC879P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G, DIP	
		Flip-Flop	MC887P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G, DIP	
		J-K F/F	923	CDC	–	–	3	–	10	54	3.4	0.15	1.0	300	15 to 55	–	
Buffers **C**	1	–	NB1000	NA	8	–	1	5, 25	–	45	3	0.18	1.2	300	–	–	
		R-S	101A	AL	13	1	–	–	33	35	3	250	810	300	–	A, C	
		Hi Current	102A	AL	13	1	–	–	83	58	3	250	810	300	–	A, C	
		–	B11004	AL	15	–	–	–	–	30	3	0.12	1.1	–	70	B	

2. RTL and DCTL *(continued)*

					Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
	Logic Function	Type	Model	Mfr.		Typ.	Max.	Typ.	Max.			"0"	"1"				
Buffers **C**	2	–	BC11001	AL	15	–	–	–	–	30	3	0.12	1.1	–	–	B	
		–	MC700	MO	15	–	–	–	80	20	3.6	0.1	1.1	–	15 to 55	A	
		Dual	MC799P	MO	15	–	–	–	80	46	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		–	MC800	MO	15	–	–	–	25	30	3	0.1	1.1	–	0 to 100	A, C	
		Dual	MC899P	MO	15	–	–	–	25	46	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		–	MC900	MO	15	–	–	–	25	30	3	0.1	1.1	–	–	A, C	
		–	PL900	PH	15	1	–	–	25	30	3.0	0	0.8	–	–	–	
		Dual Buffer	999521	FA	15 & 12	–	–	–	80 & 16	200	3	0.2	0.82	350	–	C, G	
		Dual Buffer	999529	FA	15 & 12	–	–	–	80 & 16	250	3.6	0.3	0.9	300	0 to 70	C, G	
		Dual 3-input															
	3	–	FμL90029	FA	16	–	6	–	80	20	3.6	0.15	1.0	300	15 to 55	A, C	
		–	μL900	FA	16	–	2	–	25	30	3.0	0.15	1.0	250	–	A, C	Modified DCTL, SSD
		R-S	101B	AL	16	1	–	–	15	35	3	250	810	265	–	A, C	
		R-S	101C	AL	16	1	–	–	15	35	3	250	810	250	0 to 70	A	
		Hi Current	102B	AL	16	1	–	–	57	58	3	250	810	265	–	A, C	
		Hi Current	102C	AL	16	1	–	–	57	58	3	250	810	250	0 to 70	A	
		–	900	CDC	16	–	2	25	30	30	3	0.15	1.0	250	15 to 55	A	
		Dual	MC799	MO	20	–	–	–	80	36	3.6	0.1	1.1	–	+15 to 55	A	
		Dual	MC899	MO	20	–	–	–	25	25	3.0	0.1	1.1	–	0 to 100	A, C	
		Dual	MC999	MO	20	–	–	–	25	25	3.0	0.1	1.1	–	–	A, C	
		Dual 3-input	MC788P	MO	24	–	–	–	80	145	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Dual	MC888P	MO	24	–	–	–	25	145	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		–	MC709	MO	57	–	–	–	30	15	3.6	0.1	1.1	–	15 to 55	A	
		Dual 2-input	MC798P	MO	57	–	–	–	30	30	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
	4	Dual	MC898P	MO	57	–	–	–	30	30	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		–	MC909	MO	57	–	–	–	30	10	3	0.1	1.1	–	–	A	
		–	SN17909L	TI	70	–	–	–	30	15	3	–	–	150	–	A, D	
		–	MWμL909	FA	80	–	4	–	30	10	3.0, 4	0.220	0.805	350	–	A, C	
		–	PL909	PH	80	1	–	–	30	10	3.0	0	0.8	–	–	–	
		–	MC779P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	G, DIP	
		–	MC787P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	–	
		–	MC879P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G, DIP	
		–	MC887P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G, DIP	
Counter Adapters **D**		–	NB1001	NA	21	–	1	5	–	55	3	0.18	1.2	300	–	–	
		–	MC701	MO	22	–	–	–	16	80	3.6	0.1	1.1	–	15 to 55	A	
		–	MC801	MO	22	–	–	–	5	55	3	0.1	1.1	–	0 to 100	A, C	
		–	MC901	MO	22	–	–	–	5	55	3	0.1	1.1	–	–	A, C	
		–	PL901	PH	22	2	–	–	25	55	3.0	0	0.8	–	–	–	
		–	C11001	AL	28	–	–	–	–	50	3	0.12	1.1	–	–	B	
		–	C11004	AL	28	–	–	–	–	50	3	0.12	1.1	–	70	B	
		–	142A	AL	32	3	–	–	10	50	3	250	810	300	–	A, C	
		Hi Current	142B	AL	32	3	–	–	6	50	3	250	810	265	–	A, C	
		Hi Current	142C	AL	47	3	–	–	5	50	3	250	810	250	0 to 70	A	
Gates **E**	NAND/NOR 1	3-input	FμL90329	FA	10	–	3	–	16	20	3.6	0.25	0.86	300	15 to 55	A, C	
		2-input	FμL91429	FA	10	–	3	–	16	20	3.6	0.25	0.86	300	15 to 55	A, C	
		Dual 3-input	FμL91529	FA	10	–	3	–	16	20	3.6	0.25	0.86	300	15 to 55	A, C	
		Dual	GG3415C	IN	10	3	–	–	6	50	6	0.2	<6	1500	–	G	
		5 input	G11001	AL	12	–	–	–	–	10	3	0.12	1.1	–	–	B	
		5-input	G11004	AL	12	–	–	–	–	10	3	0.12	1.1	–	70	B	
		4-input	J11001	AL	12	–	–	–	–	10	3	0.12	1.1	–	–	B	
		4-input	J11004	AL	12	–	–	–	–	10	3	0.12	1.1	–	70	B	
		3-input	K11001	AL	12	–	–	–	–	10	3	0.12	1.1	–	–	B	
		3-input	K11004	AL	12	–	–	–	–	10	3	0.12	1.1	–	70	B	
		Dual 2-input	L11001	AL	12	–	–	–	–	20	3	0.12	1.1	–	–	B	
		Dual 2-input	L11004	AL	12	–	–	–	–	20	3	0.12	1.1	–	70	B	
		Dual 3-input	M11001	AL	12	–	–	–	–	20	3	0.12	1.1	–	–	A	
		Dual 3-input	M11004	AL	12	–	–	–	–	20	3	0.12	1.1	–	70	A	
		3-input	MC703	MO	12	–	–	–	16	20	3.6	0.1	1.1	300	15 to 55	A	
		4-input	MC707	MO	12	–	–	–	16	12	3.6	0.1	1.1	300	15 to 55	A	
		Dual 2-input	MC714	MO	12	–	–	–	16	20	3.6	0.1	1.1	300	15 to 55	A	
		Dual 3-input	MC715	MO	12	–	–	–	16	20	3.6	0.1	1.1	300	15 to 55	A	
		Dual 3-input	MC715P	MO	12	–	–	–	16	55	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Quad 2-input	MC724P	MO	12	–	–	–	16	110	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Dual 4-input	MC725P	MO	12	–	–	–	16	55	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		5-input	MC729	MO	12	–	–	–	16	28	3.6	0.1	1.1	–	+15 to 55	A	
		Triple 3-input	MC792P	MO	12	–	–	–	16	87	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		3-input	MC803	MO	12	–	–	–	5	12	3	0.1	1.1	300	0 to 100	A, C	
		4-input	MC807	MO	12	–	–	–	5	12	3	0.1	1.1	300	0 to 100	A, C	
	2	Dual 2-input	MC814	MO	12	–	–	–	5	24	3	0.1	1.1	300	0 to 100	A, C	
		Dual 3-input	MC815	MO	12	–	–	–	5	24	3	0.1	1.1	300	0 to 100	A, C	
		Dual 3-input	MC815P	MO	12	–	–	–	5	55	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Dual 4-input	MC825P	MO	12	–	–	–	5	55	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		5-input	MC829	MO	12	–	–	–	5	19	3.0	0.1	1.1	–	0 to 100	A, C	
		Quad 2-input	MC829P	MO	12	–	–	–	5	110	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Triple 3-input	MC892P	MO	12	–	–	–	5	87	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		3-input	MC903	MO	12	–	–	–	5	12	3	0.1	1.1	300	–	A, C	
		4-input	MC907	MO	12	–	–	–	5	12	3	0.1	1.1	300	–	A, C	
		Dual 2-input	MC914	MO	12	–	–	–	5	24	3	0.1	1.1	300	–	A, C	
		Dual 3-input	MC915	MO	12	–	–	–	5	24	3	0.1	1.1	300	–	A, C	
		5-input	MC929	MO	12	–	–	–	5	19	3.0	0.1	1.1	–	–	A, C	
		3-input	μL903	FA	12	–	3	–	5	12	3.0	0.15	1.0	250	–	A, C	SSD
		Dual	μL914	FA	12	–	2	–	5	24	3.0	0.15	1.0	250	–	A, C	SSD
		Dual 3-input	μL915	FA	12	–	3	–	5	24	3.0	0.15	1.0	250	–	A, C	SSD

Temperature range is —55 to 125°C unless otherwise stated.

2. RTL and DCTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates	NAND/NOR	3-input	PL903	PH	12	3	-	–	5	12	3.0	0	0.8	–	–	–	
E		4-input	PL907	PH	12	4	–	–	5	12	3.0	0	0.8	–	–	–	
		Dual 3-input	PL915	PH	12	3	–	–	5	24	3.0	0	0.8	–	–	–	
		3-input	121A	AL	12	–	3	–	10	10	3	250	810	300	0 to 70	A, C	
		3-input	121B	AL	12	–	3	–	6	10	3	250	810	265	0 to 70	A, C	
		4-input	122A	AL	12	–	4	–	10	10	3	250	810	300	–	A, C	
		4-input	122B	AL	12	–	4	–	6	10	3	250	810	265	–	A, C	
		Dual 2-input	124A	AL	12	2	–	–	10	18	3	250	810	300	–	A, C	
		Dual 2-input	124B	AL	12	2	–	–	6	18	3	250	810	265	–	A, C	
		Dual 3-input	125A	AL	12	3	–	–	10	18	3	250	810	300	–	A, C	
		Dual 3-input	125B	AL	12	3	–	–	6	18	3	250	810	265	–	A, C	
	3	Dual 3-input	126A	AL	12	3	–	–	10	18	3	250	810	300	–	A, C	
		Dual 3-input	126B	AL	12	3	–	–	6	18	3	250	810	265	55 to 125	A, C	
		Quad 2-input	128A	AL	12	2	–	–	10	18	3	250	810	300	–	A, C	
		Quad 2-input	128B	AL	12	2	–	–	2	18	3	250	810	265	–	A, C	
		Dual	914	CDC	12	–	2	–	5	24	3	0.15	1.0	250	15 to 55	A	
		5-input	123A	AL	14	–	5	–	10	10	3	250	810	300	–	A, C	
		3-input	121C	AL	16	–	3	–	5	10	3	250	810	250	0 to 70	A	
		4-input	122C	AL	16	–	4	–	5	10	3	250	810	250	0 to 70	A, C	
		Dual 2-input	124C	AL	16	2	–	–	5	18	3	250	810	250	0 to 70	A	
		Dual 3-input	125C	AL	16	3	–	–	5	18	3	250	810	250	0 to 70	A	
		Dual 3-input	126C	AL	16	3	–	–	5	18	0.3	250	810	250	0 to 70	A	
		Quad 2-input	128C	AL	16	2	–	–	5	18	3	250	810	250	0 to 70	A	
		5-input	123B	AL	17	–	5	–	6	10	3	250	810	265	–	A, C	
		3-input	GB1414B	IN	20	3	–	–	20	100	9	0.2	<9	2.5 V	–	G	
		Dual	GG1414B	IN	20	3	–	–	6	50	6	0.2	6	1.5 V	–	G	
		5-input	123C	AL	21	–	5	–	5	10	3	250	810	250	0 to 70	A	
		Dual 2-input	FμL91029	FA	25	–	2	–	4	3	3.6	0.25	0.86	300	15 to 55	A, C	
		4-input	FμL91129	FA	25	–	4	–	4	3	3.6	0.25	0.86	300	15 to 55	A, C	
		Dual 2-input	MC710	MO	27	–	–	–	4	6	3.6	0.1	1.1	250	15 to 55	A	
		Quad 2-input	MC717P	MO	27	–	–	–	4	12	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Dual 3-input	MC718	MO	27	–	–	–	4	6	3.6	0.1	1.1	250	15 to 55	A	
		Dual 3-input	MC718P	MO	27	–	–	–	4	6	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Dual 4-input	MC719P	MO	27	–	–	–	4	6	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		5-input	MC728	MO	27	–	–	–	4	6	3.6	0.1	1.1	–	+15 to 55	A	
		Triple 3-input	MC793P	MO	27	–	–	–	4	8.5	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Quad 2-input	MC817P	MO	27	–	–	–	4	12	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
	4	Dual 3-input	MC818P	MO	27	–	–	–	4	6.0	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Dual 4-input	MC819P	MO	27	–	–	–	4	6.0	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Triple 3-input	MC893P	MO	27	–	–	–	4	8.5	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Dual 2-input	MC910	MO	27	–	–	–	4	4	3	0.1	1.1	250	–	A	
		Dual 3-input	MC918	MO	27	–	–	–	4	4	3	0.1	1.1	250	–	A	
		5-input	MC928	MO	27	–	–	–	4	6	3.0	0.1	1.1	–	–	A	
		Dual 3-input	GG1514B	IN	30	3	3	–	6	96	12	0. 2	<12	2500	–		
		Dual 2 - input	SN17910L	TI	35	–	–	–	4	2.5/	3	–	–	150	–	A, D	
		4 - input	SN17911L	TI	35/70	–	–	–	4	4	3	–	–	150	–	A, D	
		Dual 2-input	PL910	PH	40	2	–	–	4	4	3.0	–	0.8	–	–	–	
		4-input	PL911	PH	40	4	–	–	4	4	3.0	–	0.8	–	–	–	
		Dual 2-input	MWμL910	FA	45	–	2	–	4	4	3.0, 4	0.15	1.0	350	–	A, C	
		4-input	MC711	MO	60	–	–	–	4	6	3.6	0.1	1.1	250	15 to 55	A	
		4-input	MC911	MO	60	–	–	–	4	4	3	0.1	1.1	250	–	A	
		4-input	MWμL911	FA	80	–	4	–	4	4	3.0, 4	0.15	1.0	350	–	A, C	
	NOR	3-input	NB1003	NA	11	–	3	5	–	19	3	0.18	1.2	300	–	–	
		4-input	NB1007	NA	11	–	4	5	–	19	3	0.18	1.2	300	–	–	
		Dual 2-input	NB1014	NA	11	–	2,2	5	–	38	3	0.18	1.2	300	–	–	
		Dual 3-input	NB1015	NA	11	–	3,3	5	–	38	3	0.18	1.2	300	–	–	
		4-input	μL907	FA	12.0	–	4	–	5	12	3.0	0.15	1.0	250	–	A, C	SSD
		Quad 2-input	999121	FA	12	–	–	–	16	160	3	0.2	0.85	350	–	C, G	
		Quad 2-input	999122	FA	12	–	–	–	16	160	3	0.25	0.85	300	0 to 100	C, G	
		Quad 2-input	999129	FA	12	–	–	–	16	250	3.6	0.3	0.9	300	0 to 70	C, G	
		Quad 2-input	999221	FA	12	–	–	–	–1.5	–	3	0.2	0.82	350	–	C, G	
		Quad 2-input	999222	FA	12	–	–	–	–1.5	–	3	0.25	0.85	300	0 to +100	C, G	
		Quad 2-input	999229	FA	12	–	–	–	–2.0	–	3.6	0.3	0.9	300	0 to 70	C, G	
		Dual 2-input	999321	FA	12	–	–	–	16	80	3	0.2	0.82	350	–	C, G	
	5	Dual 2-input	999322	FA	12	–	–	–	16	80	3	0.25	0.85	300	0 to +100	C, G	
		Dual 2-input	999329	FA	12	–	–	–	16	120	3.6	0.3	0.9	300	0 to 70	C, G	
		Dual 3-input	μ7095	PH	13	3	–	–	5	3	3-6	0.2	1.0	300	–	A	
		Dual	RC323	RA	18	–	–	5	–	4	3	–	–	300	–	A, D	
		–	RC103	RA	20	3	–	5	–	15	3.0	0.15	1.0-3.0	300	–	–	
		–	RC123	RA	20	3	–	5	–	15	3.0	0.15	1.0-3.0	300	–	–	
		Dual	RC124	RA	20	2, 3	–	2, 5	–	2, 15	3.0	0.15	1.0-3.0	300	–	–	
		Dual	RC144	RA	20	2, 3	–	2, 5	–	2, 15	3.0	0.15	1.0-3.0	300	–	–	
		–	RC1033	RA	2C	3	–	5	–	15	3.0	0.2	1.0-3.0	300	–	–	
		–	RC1233	RA	20	3	–	5	–	15	3.0	0.15	1.0-3.0	300	–	–	
		Dual	RC-1243	RA	20	2, 3	–	2, 5	–	2, 15	3.0	0.2	1.0-3.0	300	–	–	
	6	Dual	RC1443	RA	20	2, 3	–	2, 5	–	2, 15	3.0	0.2	1.0-3.0	300	–	–	
		–	RC401	RA	23.5	–	–	4	–	3.5	3	–	–	300	–	A, D	
		Dual	RC322	RA	25	2, 2	–	2, 5	–	2, 5	4.0	0.15	1.0-4.0	300	–	–	

Temperature range is —55 to 125°C unless otherwise stated.

2. RTL and DCTL *(continued)*

					Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
	Logic Function	Type	Model	Mfr.		Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates E	NOR 7	Dual	RC324	RA	25	2, 3	–	2, 5	–	2, 5	4.0	0.15	1.0-4.0	300	–	–	
		Dual	RC342	RA	25	2, 2	–	2, 5	–	2, 5	4.0	0.15	1.0-4.0	300	–	–	
		Dual	RC344	RA	25	2, 3	–	2, 5	–	2, 5	4.0	0.15	1.0-4.0	300	–	–	
	8	–	RC1031	RA	25	3	–	5	–	15	3.0	0.225	1.0-3.0	300	0 to 65	–	
		–	RC1032	RA	25	3	–	4	–	15	3.0	0.25	1.0-3.0	200	0 to 65	–	
		–	RC1231	RA	25	3	–	5	–	15	3.0	0.225	1.0 - 3.0	300	0 to 65		
		–	RC1232	RA	25	3	–	4	–	15	3.0	0.25	1.0 - 2.0	200	0 to 65		
		Dual Inverter	A10	CBS	3000	–	1	–	5	†180	7	0.30	0.65	–	–	G	†μW
		Dual	A11	CBS	3000	–	5	–	30	†816	7 max	0.30	0.65	–	–	G	†μW
		3-input	A14	CBS	3000	–	1	–	5	†120	7 max	0.30	0.65	–	–	G	†μW
Gate Expanders F		Dual 3-input	E11001	AL	12	–	–	–	–	–	3	0.12	1.1	–	–	A	
		Dual 3-input	E11004	AL	12	–	–	–	–	–	3	0.12	1.1	–	70	A	
		Quad 2-input	MC785P	MO	12	–	–	–	–	–	3.6	–	–	–	+15 to 55	G,P,DIP	
		Dual 4-input	MC786P	MO	12	–	–	–	–	–	3.6	–	–	–	+15 to 55	G,P,DIP	
		Quad 2-input	MC885P	MO	12	–	–	–	–	–	3.6	–	–	–	0 to 75	G,P,DIP	
		Dual 4-input	MC886P	MO	12	–	–	–	–	–	3.6	–	–	–	0 to 75	G,P,DIP	
		Dual 3-input	131A	AL	12	–	3	–	–	18	3	250	810	300	–	A, C	
		Dual 3-input	131B	AL	12	–	3	–	–	18	3	250	810	265	–	A, C	
		Dual 3-input	131C	AL	16	–	3	–	–	18	3	250	810	250	0 to 70	A	
		Dual 2-input	MC721	MO	17	–	–	–	–	–	3.6	0.1	1.1	250	15 to 55	A	
		Dual 2-input	MC921	MO	27	–	–	–	–	–	3	0.1	1.1	250	–	A	
		Dual 2 - input	SN17921L	TI	35	–	–	–	–	–	–	–	–	150	–	A, D	
		–	PL921	PH	40	2	–	–	3	0	3.0	0	0.8	–	–	–	
		Dual 2-input	FμL92129	FA	–	–	2.66	–	0.5	0	3.6	0.25	0.86	300	15 to 55	A, C	
		Dual 2-input	MWμL921	FA	–	–	2.66	–	0.5	–	3.0, 4	0.220	0.805	350	–	A, C	
		–	MC779P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	G, DIP	
		–	MC879P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G,DIP	
Inverters G		Quad	MC727	MO	12	–	–	–	16	28	3.6	0.1	1.1	–	15 to 55	A	
		Hex	MC789P	MO	12	–	–	–	16	165	3.6	0.1	1.1	–	+15 to 55	G,P,DIP	
		Quad	MC827	MO	12	–	–	–	5	19	3	0.1	1.1	–	0 to 100	A, C	
		Hex	MC889P	MO	12	–	–	–	5	55	3.6	0.1	1.1	–	0 to 75	G,P,DIP	
		Quad	MC927	MO	12	–	–	–	5	19	3	0.1	1.1	–	–	A, C	
		Hex Inverter	999621	FA	12	–	–	–	16	120	3	0.2	0.82	350	–	C, G	
		Hex Inverter	999622	FA	12	–	–	–	16	120	3	0.25	0.85	300	0 to 100	C, G	
		Hex Inverter	999629	FA	12	–	–	–	16	180	3.6	0.3	0.9	300	0 to 70	C, G	
		Quad	132A	AL	20	–	4	–	10	36	3	250	810	300	–	A, C	
		Quad	132B	AL	20	–	4	–	6	36	3	250	810	265	–	A, C	
		Quad	132C	AL	20	–	4	–	5	36	3	250 mV	810 mV	250	0 to 70	A	
		–	MC787P	MO	–	–	–	–	80	–	3.6	0.1	1.1	–	+15 to 55	–	
		–	MC887P	MO	–	–	–	–	–	–	3.6	0.1	1.1	–	0 to 75	G, DIP	
Multivibrator H		One-shot	4002A	AL	*50	1	–	–	9	20	3	250	810	300	–	A, C	*min. input pulse width
		One-shot	4002B	AL	*50	1	–	–	5	20	3	250	810	265	–	A, C	*New input pulse width
		One-shot	4002C	AL	*50	1	–	–	4	20	3	250	810	250	0 to 70	A	
		Single-shot	T35-002	AL	100	–	–	–	–	20	3	0.12	1.1	–	–	A	
Shift Registers I	1	Half	NB1005	NA	11	–	1	\4,5	–	53	3	0.18	1.2	300	–	–	
		Half	PL905	PH	15	1	–	–	4	53	3.0	0	0.8	–	–	–	
		Half	FμL90529	FA	18	–	3	–	5	53	3	0.25	0.86	300	15 to 55	A, C	
		Half	μL905	FA	18	–	3	–	5	53	3.0	0.15	1.0	250	–	A, C	
		Half	117A	AL	19	1	–	–	5	50	3	250	810	300	–	A, C	
		Half	MC705	MO	22	–	–	–	13	75	3.6	0.1	1.1	300	15 to 55	A	
		Half w/o inverter	MC706	MO	22	–	–	–	13	52	3.6	0.1	1.1	300	15 to 55	A	
		Half	MC805	MO	22	–	–	–	4	53	3	0.1	1.1	300	0 to 100	A, C	
		Half w/o inverter	MC806	MO	22	–	–	–	4	36	3	0.1	1.1	300	0 to 100	A, C	
		Half	MC905	MO	22	–	–	–	4	53	3	0.1	1.1	300	–	A, C	
		Half w/o inverter	MC906	MO	22	–	–	–	4	36	3	0.1	1.1	300	–	A, C	
		Half	PL906	PH	22	1	–	–	4	36	3.0	0	0.8	–	–	–	
		Half	S11001	AL	22	–	–	–	–	50	3	0.12	1.1	–	–	B	
		Half	S11004	AL	22	–	–	–	–	50	3	0.12	1.1	–	70	B	
		Half w/o Inverter	μL906	FA	22	–	3	–	4	36	3.0	0.15	1.0	250	–	A, C	SSD
	2	Half	117B	AL	22	1	–	–	2	50	3	250	810	265	–	A, C	
		Half	117C	AL	25	1	–	–	2	50	3	250	810	250	0 to 70	A	
		Full 2-Phase	P11001	AL	35	–	–	–	–	84	3	0.12	1.1	–	–	A	
		Full 2-phase	P11004	AL	35	–	–	–	–	84	3	0.12	1.1	–	70	A	
		JK Full	R11001	AL	35	–	–	–	–	84	3	0.12	1.1	–	–	A	
		JK Full	R11004	AL	35	–	–	–	–	84	3	0.12	1.1	–	70	A	
		Full	111A	AL	35	1	–	–	3	84	3	250	810	300	–	A, C	
		Full	112A	AL	35	1	–	–	3	84	3	250	810	300	–	A, C	
		Full	111B	AL	39	1	–	–	3	84	3	250	810	265	–	A, C	
		Full	112B	AL	39	1	–	–	3	84	3	250	810	265	–	A, C	
		Full	111C	AL	42	1	–	–	3	84	3	250	810	250	0 to 70	A	
		Full	112C	AL	42	1	–	–	3	84	3	250	810	250	0 to 70	A	
		Full	114A	AL	50	1	–	–	3	60	3	250	810	300	–	A, C	
		Full	114B	AL	56	1	–	–	3	60	3	250	810	265	–	A, C	
		Full	RC301	RA	60	–	–	5	–	4	3	–	–	300	–	A, D	
		–	SN17913L	TI	70	–	–	–	3	15	3	–	–	150	–	A, D	
		Full	114C	AL	77	1	–	–	3	60	3	250	810	250	0 to 70	A	
		Full	PL913	PH	80	1	–	–	3	15	3.0	0	0.8	–	–	–	

Temperature range is —55 to 125°C unless otherwise stated.

3. Transistor-Transistor Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Adders **A**		Half	SG90,SG91 SG92,SG93	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		2-Bit	SN5482	TI	†15	–	–	–	10	175	4.5-5.5	0.4	2.4	1000	–	D	†Carry
		2-bit	SN7482	TI	†15	–	–	–	10	175	4.75-5.25	0.4	2.4	1000	0 to 70	D, DIP	†Carry
		4-bit	SN7483	TI	†29	–	–	–	10	350	4.75-5.25	0.4	2.4	1000	0 to 70	D, DIP	†Carry
		Full	SN5480	TI	Add: 70 Carry: 8	–	–	–	–	105	4.5 - 5.5	–	–	1000	–	D	Includes gating
		Full	SN7480	TI	Add: 70 Carry: 8	–	–	–	–	105	4.75 5.25	–	–	1000	0 to 70	D	Includes gating
Binary Elements **B**	1	R-S	SF10,SF11 SF12,SF13	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Clocked	SF20,SF21 SF22,SF23	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Single-phase	SF30,SF31 SF32,SF33	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		J-K	SF50,51	SY	12	–	4	–	15	15	8	0.26	3.3	1000	–	D, G	
		J-K	SF52,53	SY	12	–	4	–	12	15	8	0.26	3.3	1000	0, +75	D, G	
		J-K Master Slave	900051	FA	15	–	–	–	10	50	4.5-5.5	0.2	2.7	1000	–	C, G	JJJ̄, KKK̄, JK
		J-K Master Slave	900151	FA	15	–	–	–	10	70	4.5-5.5	0.2	2.7	1000	–	C, G	JJJ, KKK, JK
		Dual J-K	902051	FA	15	–	–	–	10	–	4.5-5.5	0.2	2.7	1000	–	C, G	–
		Dual J-K-K̄	902151	FA	15	–	–	–	10	–	4.5-5.5	0.2	2.7	100	–	G	
		J-K Flip-Flop	W6F251	WH	16.0	–	3	15	6	40	5.0	1.1	1.6	800	–	D	
		J-K Master Slave	900059	FA	17	–	–	–	8	55	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	JJJ, KKK, JK
		J-K Master Slave	900159	FA	17	–	–	–	8	75	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	JJJ̄, KKK̄, JK
		Dual J-K	902059	FA	17	–	–	–	8	–	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	–
		Dual J-K-K̄	902159	FA	17	–	–	–	8	–	4.5-5.5	0.25	3.2	1050	0 to 70	G	–
		J-K	SN54H71	TI	18	†4	–	–	10	90	4.5-5.5	0.4	2.4	1000	–	D	†Gated input
		J-K	SN54H72	TI	18	†3	–	–	10	80	4.5-5.5	0.4	2.4	1000	–	D	†Gated input
		J-K	SN74H71	TI	18	4	–	–	10	90	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		J-K	SN74H72	TI	18	3	–	–	10	80	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		Dual	TFF3011	TR	18	–	3	–	20	30	5-6	0.20	3.0	1000	–	A, F	
		Dual	TFF3013	TR	18	–	3	–	7	30	5-6	0.20	3.0	1000	–	A, F	
		Dual	TFF3015	TR	18	–	2	–	20	30	5-6	0.20	3.0	1000	–	A, F	
		Dual	TFF3017	TR	18	–	2	–	7	30	5-6	0.20	3.0	1000	–	A, F	
	2	AND inputs	TFF3241-44	TR	18	–	1	–	10	100	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		OR inputs	TFF3341-44	TR	18	–	1	–	10	100	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Enable-OR input	TFF3441-44	TR	18	–	1	–	10	100	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Dual	SE826	SIG	20	–	–	–	5	50	+5	0.4	2.4	1000	–	F	
		J-K	579B	AL	20	3	–	–	9	30	5	400	3800	1000	–	–	
		Dual	SF120-121	SY	50 MHz	–	–	6	11	55/FF	–	–	–	–	–	D, G	Separate clock, RA
		Dual	SF122-123	SY	50 MHz	–	–	5	9	55/FF	–	–	–	–	0 to 75	D, G	Separate clock
		Dual	SF130-131	SY	50 MHz	–	–	6	11	55/FF	–	–	–	–	–	D, G	Common clock, RA
		Dual	SF132-133	SY	50 MHz	–	–	5	9	55/FF	–	–	–	–	0 to 75	D, G	Common clock
		J-K (AND inputs)	SF200-201	SY	50 MHz	–	–	6	11	55	–	–	–	–	–	D, G	RA
		J-K (AND inputs)	SF202-203	SY	50 MHz	–	–	5	9	55	–	–	–	–	0 to 75	D, G	
		J-K (OR inputs)	SF210-211	SY	50 MHz	–	–	6	11	55	–	–	–	–	–	D, G	RA
		J-K (OR inputs)	SF212-213	SY	50 MHz	–	–	5	9.	55	–	–	–	–	0 to 75	D, G	
	3	J-K	SF60,61	SY	25	–	4	–	15	45	5.0	.26	3.3	1000	–	D, G	
		J-K	SF62,63	SY	25	–	4	–	12	45	5.0	.26	3.3	1000	0, +75	D, G	
		Dual	SF100-101	SY	35 MHz	–	–	6	11	55/FF	–	–	–	–	–	D, G	Separate clock, RA
		Dual	SF102-103	SY	35 MHz	–	–	5	9	55/FF	–	–	–	–	0 to 75	D, G	
		Dual	SF110-111	SY	35 MHz	–	–	6	11	55/FF	–	–	–	–	–	D, G	Common clock, RA
		Dual	SF112-113	SY	35 MHz	–	–	5	9	55/FF	–	–	–	–	0 to 75	D, G	Common clock
		Single	SE825	SIG	30	–	–	–	10	50	+5	0.4	2.4	1000	–	F	
		Dual latch	SN5474	TI	30	–	–	–	10	40/ff	4.5 - 5.5	–	–	1000	–	D	
		Dual latch	SN7474	TI	30	–	–	–	10	40/ff	4.75-5.25	–	–	1000	0 to 70	D	
		†Dual FF	SN7476N	TI	30	–	–	–	10	40/ff	4.75-5.25	0.4	2.4	1000	0 to 70	DIP	†Clear & Preset
	4	4-input with buffer	TFF3111-14	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		2-input with buffer	TFF3115-18	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		4-input w/o buffer	TFF3121-24	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		2-input w/o buffer	TFF3125-28	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		Dual J-K	TFF3173-74	TR	30	–	1	–	7	150	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		3J-3K	TFF3161-64	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		2J-2K	TFF3165-68	TR	30	–	1	–	15	75	5	0.45	3.5	1000	0 to 75	D,P,DIP	
		Dual 3J-3K	TFF3181-84	TR	30	–	1	–	15	150	5	0.45	3.5	1000	0 to 75	D,P,DIP	22 leads

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Binary Elements B	5	Dual J-K	S8826	SIG	30 MHz	–	–	–	10	–	5.0	0.45	2.4	1000	–	F	
		J-K	SF250,251	SY	30MHz	–	–	–	12	55	–	0.25	3.5	1000	–	D, G	
		J-K	SF252,253	SY	30MHz	–	–	–	10	55	–	0.25	3.5	1000	0, +75	D, G	
		J-K	SF260,261	SY	30MHz	–	–	–	12	55	–	0.25	3.5	1000	–	D, G	
		J-K	SF262,263	SY	30MHz	–	–	–	10	55	–	0.25	3.5	1000	0, +75	D, G	
		J-K	SWF250	SW	30MHz	6	–	12	–	55	4.5-6	0.4	3	1000	–	–	
		J-K	SWF251	SW	30MHz	6	–	6	–	55	4.5-6	0.4	3	1000	–	–	
		J-K	SWF252	SW	30MHz	6	–	10	–	55	4.5-6	0.45	3	900	0 to +75	–	
		J-K	SWF253	SW	30MHz	6	–	5	–	55	4.5-6	0.45	3	900	0 to +75	–	
		J-K	SWF260	SW	30MHz	6	–	12	–	55	4.5-6	0.4	3	1000	–	–	
		J-K	SWF261	SW	30MHz	6	–	6	–	55	4.5-6	0.4	3	1000	–	–	
		J-K	SWF262	SW	30MHz	6	–	10	–	55	4.5-6	0.45	3	900	0 to +75	–	
		J-K	SWF263	SW	30MHz	6	–	5	–	55	4.5-6	0.45	3	900	0 to +75	–	
		Master / Slave	SN5472	TI	35	–	–	–	10	50	4.5 - 5.5	–	–	1000	–	D	
		Dual M / S	SN5473	TI	35	–	–	–	10	50/	4.5 - 5.5	–	–	1000	–	D	
		Master / Slave	SN7472	TI	35	–	–	–	10	50	4.75-5.25	–	–	1000	0 to 70	D	
		Dual M / S	SN7473	TI	35	–	–	–	10	50 / ff	4.75-5.25	–	–	1000	0 to 70	D	
	6	J-K	SN5470	TI	40	–	–	–	10	60	4.5 to 5.5	–	–	1000	–	D	Single-phase
		J-K	SN7470	TI	40	–	–	–	10	60	4.75-5.25	–	–	1000	0-70	D	Single phase
		J-K/R-S	SN54948	TI	40	–	–	–	10	60	4.5-5.5	–	–	1000	–	D	
		J-K/R-S	SN74948	TI	40	–	–	–	10	60	4.75-5.25	–	–	1000	0-70	D	
		J-K	SW5470	SW	40	6	–	10	–	65	4.5-5.5	0.4	3	1000	–	–	
		J-K	SW7470	SW	40	6	–	10	–	65	4.8-5.3	0.45	3	900	0 to +75	–	
		R-S	SN54L71	TI	47	†3	–	–	10	3.5	4.5-5.5	0.3	2.4	1000	–	D	†Gated input
		J-K	SN54L72	TI	47	†3	–	–	10	3.5	4.5-5.5	0.3	2.4	1000	–	D	†Gated input
		Dual J-K	SN54L73	TI	47	–	–	–	10	†3.5	4.5-5.5	0.3	2.4	1000	–	D	†per ff
		J-K	MC516	MO	50	–	–	–	15	50	5	0.26	3.3	1000	–	C	
		J-K	MC566	MO	50	–	–	–	7	50	5	0.26	3.3	1000	–	C	
		J-K	S8825	SIG	20 MHz	–	–	–	10	–	5.0	0.45	2.4	1000	–	F	
		R-S	SWF10	SW	20MHz	6	–	15	–	30	4.5-6	0.4	3	1000	–	–	
		R-S	SWF11	SW	20MHz	6	–	7	–	30	4.5-6	0.4	3	1000	–	–	
		R-S	SWF12	SW	20MHz	6	–	12	–	30	4.5-6	0.45	3	900	0 to +75	–	
	7	R-S	SWF13	SW	20MHz	6	–	6	–	30	4.5-6	0.45	3	900	0 to +75	–	
		Dual	SWF20	SW	20MHz	6	–	15	–	35	4.5-6	0.4	3	1000	–	–	
		Dual	SWF21	SW	20MHz	6	–	7	–	35	4.5-6	0.4	3	1000	–	–	
		Dual	SWF22	SW	20MHz	6	–	12	–	35	4.5-6	0.45	3	900	0 to +75	–	
		Dual	SWF23	SW	20MHz	6	–	6	–	35	4.5-6	0.45	3	900	0 to +75	–	
		J-K	SWF50	SW	20MHz	6	–	15	–	50	4.5-6	0.4	3	1000	–	–	
		J-K	SWF51	SW	20MHz	6	–	7	–	50	4.5-6	0.4	3	1000	–	–	
		J-K	SWF52	SW	20MHz	6	–	12	–	50	4.5-6	0.45	3	900	0 to +75	–	
		J-K	SWF53	SW	20MHz	6	–	6	–	50	4.5-6	0.45	3	900	0 to +75	–	
÷		÷ 12 Counter	SN7492	TI	60	†2	–	–	10	32/ff	4.75-5.25	0.4	2.4	1000	0 to 70	D, DIP	†Gated reset
		4-bit Binary	SN7493	TI	75	†2	–	–	10	32/ff	4.75-5.25	0.4	2.4	1000	0 to 70	D, DIP	†Gated reset
		Gated R-S FF	MC652	MO	80	–	6	–	4	200	10	10	.70	5V	0 to 75	A, C	
		J-K	539B	AL	100	3	–	–	6	14	5	250	3800	1000	–	–	
		Dual, A.C.	S8424	SIG	9 MHz	–	–	–	7	–	5.0	0.35	3.4	1000	–	F	
		Dual, A.C.	SE424	SIG	9 MHz	–	–	7	–	9.0	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		J-K	509B	AL	180	3	–	–	6	6	5	250	3800	1000	–	–	
	8	R-S	MC413	MO	–	–	–	–	12	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		J-K	MC415	MO	–	–	–	–	12	40	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		J-K	MC416	MO	–	–	–	–	12	50	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		R-S	MC463	MO	–	–	–	–	6	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		J-K	MC465	MO	–	–	–	–	6	40	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		J-K	MC466	MO	–	–	–	–	6	50	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		R-S	MC513	MO	–	–	–	–	15	30	5	0.26	3.3	1000	–	C	
		"AND"J-K	MC515	MO	–	–	–	–	15	40	5	0.26	3.3	1000	–	C	
		R-S	MC563	MO	–	–	–	–	7	30	5	0.26	3.3	1000	–	C	
		"AND"J-K	MC565	MO	–	–	–	–	7	40	5	0.26	3.3	1000	–	C	
Buffers C		Dual 4-input	900959	FA	8	–	–	–	25	22/	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	–
		Dual 4-input	900951	FA	–	–	–	–	30	20/	4.5-5.5	0.2	2.7	1000	–	C, G	–
		Dual 4-input	S8855	SIG	12	–	4	–	26	–	5.0	0.45	2.4	1000	–	F	
Drivers / Buffers D	1	Dual	SE855	SIG	15	–	4	–	30	25	+5	0.4	2.4	1000	–	F	
		Triple 2-input	SG160,161	SY	15	–	–	–	15	15	–	0.26	3.3	1000	–	D, G	
		Triple 2-input	SG162,163	SY	15	–	–	–	12	15	–	0.26	3.3	1000	0 to 75	D, G	
		Dual 4-input	SN54932	TI	18	–	–	–	30	25/	4.5-5.5	–	–	1000	–	D	
		Dual 4-input	SN74932	TI	18	–	–	–	30	25/	4.75-5.25	–	–	1000	0 to 70	D	
		Quad 2-input	TNG5511-14	TR	18	–	1	–	40	50	5	0.45	3.5	10000	0 to 75	D,P,DIP	
		Dual 4-input	SE4SJ	SIG	25	–	4	20	–	7.0	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		Dual 4-input	SG130, 131	SY	25	–	–	–	30	30	–	0.26	3.3	1000	–	D, G	
		Dual 4-input	SG132,133	SY	25	–	–	–	24	30	–	0.26	3.3	1000	0 to 75	D, G	
		Dual 4-input	540B	AL	25	4	–	–	25	30	5	250	3800	1000	–	–	w/ex & no pull up
		Dual 4-input	541B	AL	25	4	–	–	25	40	5	250	3800	1000	–	–	w/ex & no pull up
		2 NAND-2 NOR	542B	AL	25	2	–	–	15	30	7/4	250	3800	100C	–	–	

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Drivers/Buffers **D**	2	Dual 4-input	580B	AL	25	4	–	–	28	100	5	400	3800	1000	–	–	w/ex & no pull up
		2 NAND-2 NOR	582B	AL	25	2	–	–	40	40	7/4	400	3800	1000	–	–	
		2 NAND-2 NOR	585B	AL	25	2	–	–	15	40	7/4	400	3800	1000	–	–	
		Dual 4-input	S8455	SIG	28	–	4	–	20	–	5.0	0.35	3.4	1000	–	F	
		Dual 4-input	511B	AL	30	4	–	–	10	20	5	250	3800	1000	–	–	w/ex& no pull up
		Quad 2-input	TNG5611-12	TR	–	–	1	–	60mA	50	5	0.6	–	1000	0 to 75	D,P,DIP	External output
Gates **E**	AND 1	Triple	SN54H11	TI	11	–	3	–	10	35	5.5	0.4	2.4	1000	–	D	
		Dual	SN54H21	TI	11	–	4	–	10	†35	4.5-5.5	0.4	2.4	1000	–	–	†per gate
		Triple	SN74H11	TI	11	–	3	–	10	35	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		Dual	SN74H21	TI	11	–	4	–	10	35	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		Dual 4-input	MC511	MO	–	–	–	–	–	–	5	–	–	–	–	C	
		Dual 4-input	MC561	MO	–	–	–	–	–	–	5	–	–	–	–	C	Expandable
	AND/NOR 2	Dual 4-input	900651	FA	2	–	–	–	–	–	4.5-5.5	–	–	–	–	C, G	Extender
		Dual 4-input	900659	FA	2	–	–	–	10	–	4.5-5.5	–	–	–	0 to 70	C, G	Extender
		Dual Exclusive OR	900551	FA	7	–	6	–	10	25	4.5-5.5	0.2	2.7	1000	–	C, G	Extendable
		Quad 4-input	900851	FA	7	–	6	–	10	25	4.5-5.5	0.2	2.7	1000	–	C, G	Extendable
		Dual Exclusive OR	900559	F	9	–	6	–	8	25	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	Extendable
		Quad 4-input	900859	FA	9	–	6	–	8	25	4.5-5.5	0.25	3.2	1050	0 to 70	C, G	Extendable
		Dual 2-input	SG70-71	SY	12	–	–	7	15	20/	–	–	–	–	–	D, G	Expandable, RA
		Dual 2-input	SG72-73	SY	12	–	–	6	12	20/	–	–	–	–	0 to 75	D, G	Expandable
	AND/OR 3	Quad 2-input	MC409	MO	–	–	–	–	–	–	5	–	–	–	0 to 75	C,G,DIP	
		Dual 4-input	MC410	MO	–	–	–	–	–	–	5	–	–	–	0 to 75	C,G,DIP	
		Dual 4-input	MC411	MO	–	–	–	–	–	–	5	–	–	–	0 to 75	C,G,DIP	
		Quad 2-input	MC459	MO	–	–	–	–	–	–	5	–	–	–	0 to 75	C,G,DIP	
		Dual 4-input	MC460	MO	–	–	–	–	–	–	–	–	–	–	0 to 75	C,G,DIP	
		Dual 4-input	MC461	MO	–	–	–	–	–	–	5	–	–	–	0 to 75	C,G,DIP	
		Quad 2-input	MC509	MO	–	–	–	–	–	–	5	–	–	–	–	C	
		Dual 4-input	MC510	MO	–	–	–	–	–	–	5	–	–	–	–	C	
		Quad 2-input	MC559	MO	–	–	–	–	–	–	5	–	–	–	–	C	
		Dual 4-input	MC560	MO	–	–	–	–	–	–	5	–	–	–	–	C	
		–	SN54H52	TI	6	9	–	–	10	22	5.25	0.4	2.4	1000	–	D	Expandable
		Quad 2-input	MC451	MO	12	–	–	–	6	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	Expandable
		J-K Flip-Flop	W6F261	WH	16.0	–	2	15	6	50	5.0	1.1	1.6	800	–	D	
	AND/OR/NOT 4	Quad 2-input	SG150-151	SY	4	–	–	–	–	20	–	–	–	–	–	D, G	RA
		Quad 2-input	SG152-153	SY	4	–	–	–	–	15/	–	–	–	–	–	D, G	
		Dual 2 & 3-input	SG290-291	SY	7	–	–	–	–	15/	–	–	–	–	–	D, G	RA
		Dual 2 & 3-input	SG292-293	SY	7	–	–	–	–	15/	–	–	–	–	–	D, G	
		Triple 3-input	SG300-301	SY	7	–	–	6	11	36	–	–	–	–	–	D, G	Expandable,RA.
		Triple 3-input	SG302-303	SY	7	–	–	5	9	–	–	–	–	–	0 to 75	D, G	Expandable
		Dual 2-input	SG310-311	SY	7	–	–	6	11	30/	–	–	–	–	–	D, G	Expandable,RA
		Dual 2-input	SG312-313	SY	7	–	–	5	9	30/	–	–	–	–	0 to 75	D, G	Expandable
		Dual 4-input	SWG210	SW	7	4	–	12	–	30	4.5-6	0.4	3	1000	–	–	Expandable
		Dual 4-input	SWG211	SW	7	4	–	6	–	30	4.5-6	0.4	3	1000	–	–	Expandable
		Dual 4-input	SWG212	SW	7	4	–	10	–	30	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Dual 4-input	SWG213	SW	7	4	–	5	–	30	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Expandable Quad	SWG250	SW	7.5	9	–	6	–	43	4.5-6	0.4	3	1000	–	–	
		Expandable Quad	SWG251	SW	7.5	9	–	6	–	43	4.5-6	0.4	3	1000	–	–	
		Expandable Quad	SWG252	SW	7.5	9	–	10	–	43	4.5-6	0.45	3	900	0 to +75	–	
		Expandable Quad	SWG253	SW	7.5	9	–	5	–	43	4.5-6	0.45	3	900	0 to +75	–	
		Dual shaper/delay	SG80-81	SY	11	–	–	7	15	30/	–	–	–	–	–	D, G	Non-inverting, RA
		Dual shaper/delay	SG82-83	SY	11	–	–	6	12	30/	–	–	–	–	0 to 75	D, G	Non-inverting
		Dual 4-input	SG280-281	SY	11	–	–	5	10	38/	–	–	–	–	–	D, G	Non-inverting, RA
	5	Dual 4-input	SG282-283	SY	11	–	–	4	8	38/	–	–	–	–	0 to 75	D, G	Non-inverting
		Quad 2-input	MC401	MO	12	–	–	–	12	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	Expandable
		Triple 3-input	MC454	MO	12	–	–	–	6	25	5	0.26	3.3	1000	0 to 75	C.G.DIP	Expandable
		Dual	SWG5A	SW	12	–	3	–	15	15	5	0.5	3.0	1000	–	A	
		Dual	SWG5B	SW	12	–	4	–	15	15	5	0.5	3.0	1000	–	A	
		Dual 4-input	SWG110	SW	13	20	–	15	–	20	4.5-6	0.4	3	1000	–	–	Expandable
		Dual 4-input	SWG111	SW	13	20	–	7	–	20	4.5-6	0.4	3	1000	–	–	Expandable
		Dual 4-input	SWG112	SW	13	20	–	12	–	20	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Dual 4-input	SWG113	SW	13	20	–	6	–	20	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Quad 2-input	SWG50	SW	14	20	–	15	–	20	4.5-6	0.4	3	1000	–	–	Expandable
		Quad 2-input	SWG51	SW	14	20	–	7	–	20	4.5-6	0.4	3	1000	–	–	Expandable
		Quad 2-input	SWG52	SW	14	20	–	12	–	20	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Quad 2-input	SWG53	SW	14	20	–	6	–	20	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Dual	SWG21	SW	15	3	–	7	–	15	5	0.5	3.0	1000	–	A	OR Expandable
		Triple 3-input	SWG100	SW	15	20	–	15	–	25	4.5-6	0.4	3	1000	–	–	Expandable
		Triple 3-input	SWG101	SW	15	20	–	7	–	25	4.5-6	0.4	3	1000	–	–	Expandable
		Triple 3-input	SWG102	SW	15	20	–	12	–	25	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Triple 3-input	SWG103	SW	15	20	–	6	–	25	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Quad 2-input	SN7453	TI	15	–	–	–	10	25	4.75-5.25	–	–	1000	0 to 70	D	
	AND-OR-Inverter 6	–	3N54H53	TI	6	24	–	–	10	22	5.25	0.4	2.4	1000	–	D	Expandable
		Dual	SN54H50	TI	6	20	–	–	10	22	5.5	0.4	2.4	1000	–	D	Expandable
		Dual	SN74H50	TI	6	20	–	–	10	22	5.25	0.4	2.4	1000	0 to 70	D, DIP	Expandable
		–	SN74H52	TI	6	9	–	–	10	22	5.25	0.4	2.4	1000	0 to 70	D, DIP	Expandable
		–	SN74H53	TI	6	24	–	–	10	22	5.25	0.4	2.4	1000	0 to 70	D, DIP	Expandable
		Dual 3-input	MC403	MO	11	–	–	–	12	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates	AND-OR-Inverter	Dual 3-input	MC453	MO	11	–	–	–	6	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	
E		Dual 3-input	MC503	MO	11	–	–	–	15	30	5	0.26	3.3	1000	–	C	
		Dual 3-input	MC553	MO	11	–	–	–	7	30	5	0.26	3.3	1000	–	C	
		Triple 3-input	MC404	MO	12	–	–	–	12	25	5	0.26	3.3	1000	0 to 75	C,G,DIP	Expandable
		Dual 4-input	MC405	MO	12	–	–	–	12	20	5	0.26	3.3	1000	0 to 75	C,G,DIP	Expandable
		Dual 4-input	MC455	MO	12	–	–	–	6	20	5	0.26	3.3	1000	0 to 75	C,G,DIP	Expandable
	7	Quad 2-input	MC501	MO	12	–	–	–	15	30	5	0.26	3.3	1000	–	C	Expandable
		Triple 3-input	MC504	MO	12	–	–	–	15	25	5	0.26	3.3	1000	–	C	Expandable
		Dual 4-input	MC505	MO	12	–	–	–	15	20	5	0.26	3.3	1000	–	C	Expandable
		Quad 2-input	MC551	MO	12	–	–	–	7	30	5	0.26	3.3	1000	–	C	Expandable
		Triple 3-input	MC554	MO	12	–	–	–	7	25	5	0.26	3.3	1000	–	C	Expandable
		Dual 4-input	MC555	MO	12	–	–	–	7	20	5	0.26	3.3	1000	–	C	Expandable
		Dual	SN54L51	TI	33	–	4	–	10	†1.5	4.5-5.5	0.3	2.4	1000	–	D	
		Dual	SN74H60	TI	–	20	–	–	4	2	5.25	0.4	2.4	1000	0 to 70	D, DIP	
	NAND	Dual 4-input	583B	AL	4	–	–	–	6	8	5	400	3800	1000	–	C	w/ex & no pull up
		Triple	SN54H10	TI	6	–	3	–	10	20	5.5	0.4	2.4	1000	–	D	
		Dual	SN54H20	TI	6	–	4	–	10	†20	4.5-5.5	0.4	2.4	1000	–	D	†per gate
		Dual	SN54H40	TI	6	–	4	–	10	35	5.5	0.4	2.4	1000	–	D	
		Quad	SN74H00	TI	6	–	2	–	10	†20	4.75-5.25	0.4	2.4	1000	0 to 70	D, DIP	†per gate
		Triple	SN74H10	TI	6	–	3	–	10	20	5.25	0.4	2.4	1000	0 to 70	D, DIP	
	8	Dual	SN74H20	TI	6	–	4	–	10	20	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		Single	SN74H30	TI	6	–	8	–	10	20	5.25	0.4	2.4	1000	0-70	D, DIP	
		Dual	SN74H40	TI	6	–	4	–	10	35	5.25	0.4	2.4	1000	–	D, DIP	
		Quad 2-input	SWG220	SW	6	2	–	12	–	22	4.5-6	0.4	3	1000	–	–	
		Quad 2-input	SWG221	SW	6	2	–	6	–	22	4.5-6	0.4	3	1000	–	–	
		Quad 2-input	SWG222	SW	6	2	–	10	–	22	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	SWG223	SW	6	2	–	5	–	22	4.5-6	0.45	3	900	0 to +75	–	
		Dual 4-input	SWG240	SW	6	4	–	12	–	22	4.5-6	0.4	3	1000	–	–	
		Dual 4-input	SWG241	SW	6	4	–	6	–	22	4.5-6	0.4	3	1000	–	–	
		Dual 4-input	SWG242	SW	6	4	–	10	–	22	4.5-6	0.45	3	900	0 to +75	–	
		Dual 4-input	SWG243	SW	6	6	4	–	5	22	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	900251	FA	6	–	–	–	10	11/	4.5-5.5	0.2	2.7	1000	–	C, G	–
		Triple 3-input	900351	FA	6	–	–	–	10	11/	4.5-5.5	0.2	2.7	1000	–	C, G	–
		Dual 4-input	900451	FA	6	–	–	–	10	11/	4.5-5.5	0.2	2.7	1000	–	C, G	
		8-input	900751	FA	6	–	–	–	10	11/	4.5-5.5	0.2	2.7	1000	–	C, G	–
		8-input	SWG260	SW	8	8	–	12	–	22	4.5-6	0.4	3	1000	–	–	
		8-input	SWG261	SW	8	8	–	6	–	22	4.5-6	0.4	3	1000	–	–	
		8-input	SWG262	SW	8	8	–	10	–	22	4.5-6	0.45	3	900	0 to +75	–	
	9	8-input	SWG263	SW	8	8	–	5	–	22	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	900259	FA	8	–	–	–	8	12/	4.5-5.5	0.25	3.2	1050	0 to 75	C, G	–
		Triple 3-input	900359	FA	8	–	–	–	8	12/	4.5-5.5	0.25	3.2	1050	0 to 75	C, G	–
		Dual 4-input	900459	FA	8	–	–	–	8	12/	4.5-5.5	0.25	3.2	1050	0 to 75	C, G	–
		8-input	900759	FA	8	–	–	–	8	12/	4.5-5.5	0.25	3.2	1050	0 to 75	C, G	–
		Single	SE808	SIG	10	–	8	–	10	10	+5	0.4	2.4	1000	–	F	
		Dual	SE816	SIG	10	–	4	–	10	10	+5	0.4	2.4	1000	–	F	
		Triple	SE870	SIG	10	–	3	–	10	10	+5	0.4	2.4	1000	–	F	
		Quad	SE880	SIG	10	–	2	–	10	10	+5	0.4	2.4	1000	–	F	
		Dual	SW103	SW	10	–	4	–	15	20	5	0.4	3.0	1000	–	A	
		–	SW104	SW	10	–	8	–	15	20	5	0.4	3.0	1000	–	A	
		Dual	SWG4A	SW	11	–	3	–	15	15	5	0.5	3.0	1000	–	A	
		Dual	SWG4B	SW	11	–	4	–	15	15	5	0.5	3.0	1000	–	A	
		Dual	SWG14	SW	11	–	4	–	7	15	5	0.5	3.0	1000	–	A	
		8-input	S8808	SIG	12	–	8	–	10	–	5.0	0.45	2.4	1000	–	F	
		Dual 4-input	S8816	SIG	12	–	4	–	10	–	5.0	0.45	2.4	1000	–	F	
		Triple 3-input	S8870	SIG	12	–	3	–	10	–	5.0	0.45	2.4	1000	–	F	
		Quad 2-input	S8880	SIG	12	–	2	–	10	–	5.0	0.45	2.4	1000	–	F	
		Dual 4-input	SWG40	SW	12	4	–	15	–	15	4.5-6	0.4	3	1000	–	–	
		Dual 4-input	SWG41	SW	12	4	–	7	–	15	4.5-6	0.4	3	1000	–	–	
		Dual 4-input	SWG42	SW	12	4	–	12	–	15	4.5-6	0.45	3	900	0 to +75	–	
		Dual 4-input	SWG43	SW	12	4	–	6	–	15	4.5-6	0.45	3	900	0 to +75	–	
	10	Power Driver	SWG130	SW	12	4	–	15	–	30	4.5-6	0.4	3	1000	–	–	
		Power Driver	SWG131	SW	12	4	–	15	–	30	4.5-6	0.4	3	1000	–	–	
		Power Driver	SWG132	SW	12	4	–	24	–	30	4.5-6	0.45	3	900	0 to +75	–	
		Power Driver	SWG133	SW	12	4	–	12	–	30	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	SWG140	SW	12	2	–	15	–	15	4.5-6	0.4	3	1000	–	–	
		Quad 2-input	SWG141	SW	12	2	–	7	–	15	4.5-6	0.4	3	1000	–	–	
		Quad 2-input	SWG142	SW	12	2	–	12	–	15	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	SWG143	SW	12	2	–	6	–	15	4.5-6	0.45	3	900	0 to +75	–	
		Quad 2-input	SW5400	SW	13	2	–	10	–	10	4.5-5.5	0.4	3	1000	–	–	
		Triple 3-input	SW5410	SW	13	3	–	10	–	10	4.5-5.5	0.4	3	1000	–	–	
		Dual 4-input	SW5420	SW	13	4	–	10	–	10	4.5-5.5	0.4	3	1000	–	–	
		Quad 2-input	SW7400	SW	13	2	–	10	–	10	4.8-5.3	0.45	3	900	0 to +75	–	
		Triple 3-input	SW7410	SW	13	3	–	10	–	10	4.8-5.3	0.45	3	900	0 to +75	–	
		Dual 4-input	SW7420	SW	13	4	–	10	–	10	4.8-5.3	0.45	3	900	0 to +75	–	
		Quad 2-input	SN5400	TI	13	–	–	–	10	10/ gate	4.5to 5.5	–	–	1000	–	D	
		Triple 3-input	SN5410	TI	13	–	–	–	10	10/ gate	4.5to 5.5	–	–	1000	–	D	
		Dual 4-input	SN5420	TI	13	–	–	–	10	10/ gate	4.5 to 5.5	–	–	1000	–	D	
	11	Quad 2-input	SN7400	TI	13	–	–	–	10	10/ gate	4.75–5.25	–	–	1000	0-70	D	
		Triple 3-input	SN7410	TI	13	–	–	–	10	10/ gate	4.75–5.25	–	–	1000	0-70	D	
		Dual 4-input	SN7420	TI	13	–	–	–	10	10/ gate	4.75–5.25	–	–	1000	0-70	D	

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates E	NAND 12	Dual 4-input	SN54930	TI	13	–	–	–	10	10/ gate	4.5-5.5	–	–	1000	–	D	
		Quad 2-input	SN54946	TI	13	–	–	–	10	10/ gate	4.5-5.5	–	–	1000	–	D	
		Triple 3-input	SN54962	TI	13	–	–	–	10	10/ gate	4.5-5.5	–	–	1000	–	D	
		Dual 4-input	SN74930	TI	13	–	–	–	10	10/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		Triple 3-input	SN74962	TI	13	–	–	–	10	10/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		Quad 2-input	SN74946	TI	13	–	–	–	10	10/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		8-input	SW5430	SW	15	8	–	10	–	10	4.5-5.5	0.4	3	1000	–	–	
		8-input	SW7430	SW	15	8	–	10	–	10	4.8-5.3	0.45	3	900	0 to 75	–	
		8-input	SWG60	SW	15	8	–	7	–	15	4.5-6	0.4	3	1000	–	–	
		8-input	SWG61	SW	15	8	–	7	–	15	4.5-6	0.4	3	1000	–	–	
		8-input	SWG62	SW	15	8	–	12	–	15	4.5-6	0.45	3	900	0 to +75	–	
		8-input	SWG63	SW	15	8	–	6	–	15	4.5-6	0.45	3	900	0 to +75	–	
		8-input	SN5430	TI	15	–	–	–	10	10	4.5 to 5.5	–	–	1000	–	D	
		8 - input	SN7430	TI	15	–	–	–	10	10	4.75 – 5.25	–	–	1000	0 - 70	D	
		8-input	SN54965	TI	15	–	–	–	10	10	4.5-5.5	–	–	1000	–	D	
		8-input	SN74965	TI	15	–	–	–	10	10	4.75-5.25	–	–	1000	0 to 70	D	
		–	SWG16	SW	15	–	8	7	–	15	5	0.5	3.0	1000	–	A	
	13	8-input	SWG120	SW	16	20	–	7	–	15	4.5-6	0.4	3	1000	–	–	Expandable
		8-input	SWG121	SW	16	20	–	7	–	15	4.5-6	0.4	3	1000	–	–	Expandable
		8-input	SWG122	SW	16	20	–	12	–	15	4.5-6	0.45	3	900	0 to +75	–	Expandable
		8-input	SWG123	SW	16	20	–	6	–	15	4.5-6	0.45	3	900	0 to +75	–	Expandable
		Dual 4-input	SW5440	SW	17.5	4	–	30	–	10	4.5-5.5	0.4	3	1000	–	–	
		Dual 4-input	SW7440	SW	17.5	4	–	30	–	10	4.8-5.3	0.45	3	900	0 to +75	–	
		Dual 4-input	SN5440	TI	18	–	–	–	30	25/ gate	4.5 to 5.5	–	–	1000	–	D	Power gate
		Dual 4-input	SN7440	TI	18	–	–	–	30	25/ gate	4.75-5.25	–	–	1000	0-70	D	Power gate
		Quad 2-input	SE480	SIG	23	–	2	7	–	3.5	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		Quad 2-input	S8480	SIG	25	–	2	–	7	–	5.0	0.35	3.4	1000	–	F	
		Dual 4-input	SE416	SIG	30	–	4	7	–	4.5	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		Dual 3-input	SE417	SIG	32	–	3	7	–	4.5	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		Quad	SN54L00	TI	33	–	2	–	10	†1	4.5-5.5	0.3	2.4	1000	–	D	†per gate
		Triple	SN54L10	TI	33	–	3	–	10	†1	4.5-5.5	0.3	2.4	1000	–	D	†per gate
		Dual	SN54L20	TI	33	–	4	–	10	†1	4.5-5.5	0.3	2.4	1000	–	D	†per gate
		Single	SN54L30	TI	33	–	8	–	10	1	4.5-5.5	0.3	2.4	1000	–	D	
		Dual 4-input	S8416	SIG	35	–	4	–	7	–	5.0	0.35	3.4	1000	–	F	
		Dual 4-input	543B	AL	35	4	–	–	6	2.4	5	250	3800	1000	–	–	w/ex & no pull up
		Dual 4-input	544B	AL	35	4	–	–	6	4.8	5	250	3800	1000	–	–	w/ex & no pull up
	14	Dual 4-input	547B	AL	35	4	–	–	6	4.8	5	250	3800	1000	–	–	
		Dual 4-input	548B	AL	35	4	–	–	6	2.4	5	250	3800	1000	–	–	w/ex + no pull up
		Dual 4-input	570B	AL	35	4	–	–	6	8	5	400	3800	1000	–	–	w/ex + no pull up
		Quad 2-input	571B	AL	35	2	–	–	6	16	5	400	3800	100	–	C	w/ex + no pull up
		Dual 3-input	572B	AL	35	4	–	–	6	8	5	400	3800	1000	–	C	w/ex + no pull up
		Triple 3-input	573B	AL	35	3	–	–	6	12	5	400	3800	1000	–	C	w/ex + no pull up
		Dual 4-input	574B	AL	35	4	–	–	6	10.4	5	400	3800	1000	–	C	
		Quad 2-input	575B	AL	35	2	–	–	6	20.8	5	400	3800	1000	–	–	
		Dual 3-input	576B	AL	35	3	–	–	6	10.4	5	400	3800	1000	–	C	w/ex
		Triple 3-input	577B	AL	35	3	–	–	6	15.6	5	400	3800	1000	–	C	
		Dual 4-input	584B	AL	35	4	–	–	6	10.2	5	400	3800	1000	–	C	w/ex & no pull up
		Dual 4-input	587B	AL	35	4	–	–	6	8	5	400	3800	1000	–	C	w/ex & no pull up
	15	Dual 3-input	S8417	SIG	50	–	3	–	7	–	5.0	0.35	3.4	1000	–	F	
		Quad	SN54H00	TI	6	–	2	–	10	†20	4.5-5.5	0.4	2.4	1000	–	D	†per gate
		Dual	SW402	SW	100	–	3	–	5	0.10	3.0	0.3	2.0	300	–	A	
		Dual 4-input	530B	AL	100	4	–	–	6	2.4	5	250	3800	1000	–	C	
		Quad 2-input	531B	AL	100	2	–	–	6	4.8	5	250	3800	1000	–	–	
		Dual 3-input	532B	AL	100	3	–	–	6	2.4	5	250	3800	1000	–	–	w/ex + no pull up
		Triple 3-input	533B	AL	100	3	–	–	6	3.6	5	250	3800	1000	–	–	
		Dual 4-input	534B	AL	100	4	–	–	6	4.8	5	250	3800	1000	–	–	
		Quad 2-input	535B	AL	100	2	–	–	6	9.6	4	250	3800	1000	–	–	
		Dual 3-input	536B	AL	100	3	–	–	6	4.8	4	250	3800	1000	–	–	w/ex
		Triple 3-input	537B	AL	100	3	–	–	6	7.2	5	250	3800	1000	–	–	
		Dual 4-input	500B	AL	180	4	–	–	8	1	4	250	3800	1000	–	–	no pull up
		Quad 2-input	501B	AL	180	2	–	–	8	2	4	250	3800	1000	–	–	
		Dual 3-input	502B	AL	180	3	–	–	8	1	4	250	3800	1000	–	–	w/ex & no pull up

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates	NAND	Triple 3-input	503B	AL	180	3	–	–	8	1.5	4	250	3800	1000	–	–	
E		Dual 4-input	504B	AL	180	4	–	–	8	2	4	250	3800	1000	–	C	
	16	Quad 2-input	505B	AL	180	2	–	–	8	4	4	250	3800	1000	–	C	
		Dual 3-input	506B	AL	180	3	–	–	8	2	4	250	3800	1000	–	–	w/ex
		Triple 3-input	507B	AL	180	3	–	–	8	3	4	250	3800	1000	–	–	
		Dual	SN54L22	TI	–	20	–	–	10	†1	4.5-5.5	0.3	2.4	1000	–	D	†open collector
	NAND/NOR	Quad 2-input	SG220,221	SY	6	–	–	–	12	22	–	0.25	3.5	1000	–	D, G	RA
		Quad 2-input	SG222,223	SY	6	–	–	–	10	22	–	0.25	3.5	1000	0 to 75	D, G	
		Dual 4-input	SG240,241	SY	6	–	–	–	12	22	–	0.25	3.5	1000	–	D, G	
		Dual 4-input	SG242,243	SY	6	–	–	–	10	22	–	0.25	3.5	1000	0, +75	D, G	
		Quad	W6G221	WH	6.0	–	2	15	6	19/	5.0	1.1	1.6	800	–	D	
		Dual	W6G241	WH	6.0	–	4	15	6	19/	5.0	1.1	1.6	800	–	D	
		Single 8-input	SG200-201	SY	8	–	–	6	11	22	–	–	–	–	–	D, G	Expandable, RA
		Single 8-input	SG202-203	SY	8	–	–	5	9	22	–	–	–	–	0 to 75	D, G	Expandable
		Single 8-input	SG260,261	SY	8	–	–	–	12	22	–	0.25	3.5	1000	–	D, G	
		Single 8-input	SG262,263	SY	8	–	–	–	10	22	–	0.25	3.5	1000	0 to 75	D, G	
		–	BO1	SI	10	–	8	–	15	16.5	4.5	0.5	2.3	1000	-55 to 165	A, D	
		Dual	BO2	SI	10	–	4	–	15	16.5	4.5	0.5	2.3	1000	-55 to 165	A, D	
	17	Dual 4-input	MC400	MO	10	–	–	–	12	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		Quad 2-input	MC408	MO	10	–	–	–	12	60	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		Triple 3-input	MC412	MO	10	–	–	–	12	45	5	0.26	3.3	1000	–	C,G,DIP	
		Dual 4-input	MC450	MO	10	–	–	–	6	30	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		Quad 2-input	MC458	MO	10	–	–	–	6	60	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		Triple 3-input	MC462	MO	10	–	–	–	6	45	5	0.26	3.3	1000	–	C,G,DIP	
		Dual 4-input	MC500	MO	10	–	–	–	15	30	5	0.26	3.3	1000	–	C	
		Quad 2-input	MC508	MO	10	–	–	–	15	60	5	0.26	3.3	1000	–	C	
		Triple 3-input	MC512	MO	10	–	–	–	15	45	5	0.26	3.3	1000	–	C	
		Dual 4-input	MC550	MO	10	–	–	–	7	30	5	0.26	3.3	1000	–	C	
		Quad 2-input	MC558	MO	10	–	–	–	7	60	5	0.26	3.3	1000	–	C	
		Triple 3-input	MC562	MO	10	–	–	–	7	45	5	0.26	3.3	1000	–	C	
		Quad 2-input	SG140-141	SY	10	–	–	7	15	15	–	–	–	–	–	D, G	RA
		Quad 2-input	SG142-143	SY	10	–	–	6	12	15	–	–	–	–	0 to 75	D, G	
		Single 8-input	TNG3041-44	TR	10	–	1	–	10	24	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Dual 4-input	TNG3141-44	TR	10	–	1	–	10	45	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Triple 3-input	TNG3341-44	TR	10	–	1	–	10	65	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Quad 2-input	TNG3441-44	TR	10	–	1	–	10	90	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		–	TNG3041	TR	10	–	8	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3043	TR	10	–	8	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3045	TR	10	–	6	–	20	15	5-6	0.20	3.0	1000	–	A, F	
	18	–	TNG3047	TR	10	–	6	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3141	TR	10	–	4	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3143	TR	10	–	4	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3145	TR	10	–	3	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3147	TR	10	–	3	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3241	TR	10	–	4	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3243	TR	10	–	4	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3245	TR	10	–	3	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3247	TR	10	–	3	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Triple 3-input	SG190,191	SY	10	–	–	–	15	15	–	0.26	3.3	1000	–	D, G	
		Triple 3-input	SG192,193	SY	10	–	–	–	12	15	–	0.26	3.3	1000	0, +75	D, G	
		8-input	MC402	MO	12	–	–	–	12	15	4	0.26	3.3	1000	0 to 75	C,G,DIP	
		8-input	MC452	MO	12	–	–	–	6	15	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		8-input	MC502	MO	12	–	–	–	15	15	5	0.26	3.3	1000	–	C	
		8-input	MC552	MO	12	–	–	–	7	15	5	0.26	3.3	1000	–	C	
		Dual 4-input	SG40,SG41, SG42,SG43	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Single 8-input	SG60,SG61, SG62,SG63	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Expandable	SG 120,121 SG 122,123	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		–	TNG3011	TR	15	–	8	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3013	TR	15	–	8	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3015	TR	15	–	6	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3017	TR	15	–	6	–	7	15	5-6	0.20	3.0	1000	–	A, F	
	19	–	TNG3031	TR	15	–	4	–	7	15	5-6	0.20	3.0	1000	+10 to 60	A	
		Dual	TNG3111	TR	15	–	4	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3113	TR	15	–	4	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3115	TR	15	–	3	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3117	TR	15	–	3	–	7	15	5-6	0.02	3.0	1000	–	A, F	
		Dual	TNG3131	TR	15	–	2	–	7	15	5-6	0.20	3.0	1000	+10 to 60	A	
		Dual	TNG3211	TR	15	–	4	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3213	TR	15	–	4	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3215	TR	15	–	3	–	20	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3217	TR	15	–	3	–	7	15	5-6	0.20	3.0	1000	–	A, F	
		Dual	TNG3231	TR	15	–	2	–	7	15	5-6	0.20	3.0	1000	10 to 60	A	
		8-input	MC406	MO	18	–	–	–	12	15	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		8-input	MC456	MO	18	–	–	–	6	15	5	0.26	3.3	1000	0 to 75	C,G,DIP	
		8-input	MC506	MO	18	–	–	–	15	15	5	0.26	3.3	1000	–	C	
		8-input	MC556	MO	18	–	–	–	7	15	5	0.26	3.3	1000	–	C	
		Dual 4-input	TTμL103	FA	25	–	4	–	15	25	5.0	0.33	4	750	–	A, C	
	20	8-input	TTμL104	FA	30	–	8	–	15	25	5.0	0.33	4	750	–	A, C	
		Dual 4-input	μ7103	PH	30	–	4	10	–	25	5	0	3.0	500	–	–	
		8-input	μ7104	PH	30	–	8	10	–	25	5	0	3.0	500	–	–	
		Dual 4-input	μ7105	PH	30	–	4	10	–	25	5	0	3.0	500	–	–	
		8-input	μ7106	PH	30	–	8	10	–	25	5	0	3.0	500	–	–	

Temperature range is —55 to 125°C unless otherwise stated.

3. TTL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates **E**	Exclusive OR 21	Dual 4-input	SG210,211	SY	7	–	–	–	12	30	–	0.25	3.5	1000	–	D, G	
		Dual 4-input	SG212, 213	SY	7	–	–	–	10	30	–	0. 25	3.5	1000	0 to 75	D, G	
		Quad 2-input	SG250,251	SY	7.5	–	–	–	12	43	–	0.25	3.5	1000	–	D, G	Expandable
		Quad 2-input	SG252,253	SY	7.5	–	–	–	10	43	–	0.25	3.5	1000	0, +75	D, G	Expandable
		Dual	SE840	SIG	10	–	4	–	10	14	+5	0.4	2.4	1000	–	F	
		Expandable	SG90-91	SY	11	–	–	7	15	35	–	–	–	–	–	D, G	RA
		Expandable	SG92-93	SY	11	–	–	6	12	35	–	–	–	–	0 to 75	D, G	
		Dual	S8840	SIG	12	–	4	–	10	–	5.0	0.45	2.4	1000	–	F	
		Single 8-input	SG50,SG51 SG52,SG53	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Maj. Voter	SG100,101 SG102,103	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		–	SG110,111 SG112,113	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		4 x 4 input	TNG3241-44	TR	12	–	1	–	10	22	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Expandable	TNG3281-84	TR	12	–	1	–	10	22	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
	22	Dual	TNG4241-44	TR	12	–	1	–	10	44	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
		Quad 2-input	TNG4446	TR	12	–	1	–	10	90	5	0.45	3.5	1000	0 to 75	D,P,DIP	High speed,
			SWG90	SW	14	6	–	15	–	30	4.5-6	0.4	3	1000	–	–	
			SWG91	SW	14	6	–	7	–	30	4.5-6	0.4	3	1000	–	–	
			SWG92	SW	14	6	–	12	–	30	4.5-6	0.45	3	900	0 to +75	–	
			SWG93	SW	14	6	–	6	–	30	4.5-6	0.45	3	900	0 to +75	–	
		Dual	SW5450	SW	15	20	–	10	–	10	4.5-5.5	0.4	3	1000	–	–	Expandable
		Dual	SW7450	SW	15	20	–	10	–	10	4.8-5.3	0.45	3	900	0 to +75	–	Expandable
		Dual	SN5450	TI	15	–	–	–	10	14/ gate	4.5 to 5.5	–	–	1000	–	D	Expander Inputs
		Dual	SN5451	TI	15	–	–	–	10	14 gate	4.5-5.5	–	–	1000	–	D	
		Dual	SN7451	TI	15	–	–	–	10	14/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		Dual	SN54966	TI	15	–	–	–	10	14/ gate	4.5-5.5	–	–	1000	–	D	
		Dual	SN74966	TI	15	–	–	–	10	14/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		Dual	SE440	SIG	23	–	2	7	–	4.5	4.0	0.2	2.8	1000	–	F, G	also 0°C to 70°C 15°C to 55°C
		Dual	S8440	SIG	25	–	2	–	7	–	5.0	0.35	3.4	1000	–	F	
		Dual 4-input	578B	AL	35	8	–	–	6	10.4	5	400	3800	1000	–	C	
		Dual 4-input	538B	AL	100	8	–	–	6	4.8	5	250	3800	1000	–	C	
		Dual 4-input	508B	AL	180	8	–	–	8	2	4	250	3800	1000	–	C	
		Dual 4-input	TNG4041-42	TR	–	–	1	–	–	–	–	–	–	1000	0 to 75	D,P,DIP	High speed
		Quad 2-input	TNG4541	TR	–	–	1	–	–	–	–	0.45	3.5	1000	0 to 75	D,P,DIP	High speed
Gate Expanders **F**	1	Quad 2-input	SWG230	SW	2	8	–	–	–	28	4.5-6	–	–	–	–	–	
		Quad 2-input	SWG231	SW	2	8	–	–	–	28	4.5-6	–	–	–	–	–	
		Quad 2-input	SWG232	SW	2	8	–	–	–	28	4.5-6	–	–	–	0 to +75	–	
		Quad 2-input	SWG233	SW	2	8	–	–	–	28	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SWG270	SW	2	8	–	–	–	6.7	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG271	SW	2	8	–	–	–	6.7	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG272	SW	2	8	–	–	–	6.7	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SWG273	SW	2	8	–	–	–	6.7	4.5-6	–	–	–	0 to +75	–	
		Quad 2-input	SG230,231	SY	2	–	–	–	12	28	–	0.25	3.5	1000	–	D, G	
		Quad 2-input	SG232, 233	SY	2	–	–	–	10	28	–	0. 25	3. 5	1000	0 to 75	D, G	
		Dual 4-input	SG270, 271	SY	2	–	–	–	15	6.7	–	0. 25	3.5	1000	–	D, G	
		Dual 4- input	SG272,273	SY	2	–	–	–	12	6.7	–	0. 25	3.5	1000	0 to 75	D, G	
		Dual	SE806	SIG	–	–	4	–	4	5	+5	0.4	2.0	1000	–	F	
		Dual 4-input	S8806	SIG	–	–	4	–	–	–	5.0	0.45	2.4	1000	–	F	
		Dual	SN54H60	TI	–	20	–	–	4	2	5.25	0.4	2.4	1000	–	D	
		Triple	SN54H61	TI	–	3	–	–	–	2	5.5	0.4	2.4	1000	–	D	
		AND-OR	SN54H62	TI	–	10	–	–	–	2	4.5	0.4	2.4	1000	–	D	
		Triple	SN74H61	TI	–	3	–	–	–	2	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		AND-OR	SN74H62	TI	–	10	–	–	–	2	5.25	0.4	2.4	1000	0 to 70	D, DIP	
		Quad	SWG150	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Quad	SWG151	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Quad	SWG152	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
	2	Quad	SWG153	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG170	SW	–	8	–	–	–	5	4.5-6	–	–	–	–	-	
		Dual 4-input	SWG171	SW	–	8	–	–	–	5	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG172	SW	–	8	–	–	–	5	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SWG173	SW	–	8	–	–	–	5	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SWG180	SW	–	8	–	–	–	1	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG181	SW	–	8	–	–	–	1	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG182	SW	–	8	–	–	–	1	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SWG183	SW	–	8	–	–	–	1	4.5-6	–	–	–	0 to +75	–	
		Dual 4-input	SW5460	SW	–	4	–	–	–	5	4.5-5.5	–	–	–	–	–	
		Dual 4-input	SW7460	SW	–	4	–	–	–	5	4.8-5.3	–	–	–	0 to +75	–	
		3-input	SG170,171 SG172,173	SY	–	–	–	–	–	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Dual 3-input	SG180, 181 SG182,183	SY	–	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		Dual 4-input	SN5460	TI	–	–	–	–	4	5/exp	4.5 to 5.5	–	–	1000	–	D	
		Dual 4-input	SN7460	TI	–	–	–	–	4	5/exp	4.75-5.25	–	–	1000	0 to 70	D	
		–	TNG3051	TR	–	–	8	–	–	5	5-6	0.20	3.0	1000	–	A, F	
		–	TNG3251	TR	–	–	4	–	–	5	5-6	0.20	3.0	1000	–	A, F	
Inverters **G**		Quad 2 - input	SN5453	TI	15	–	–	–	10	25	4.5 - 5.5	–	–	1000	–	D	

Temperature range is —55 to 125°C unless otherwise stated.

4. Emitter-Coupled Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Adders **A**		Half	MC303	MO	7	–	–	–	ac 15 dc 25	63	–5.2	–1.55	–0.75	–	–	A, C	
		Half	MC353	MO	7	–	–	–	ac 15 dc 25	63	–5.2	–1.55	–0.75	–	0 to 75	A, C	
		Full	MC1019P	MO	10	–	–	–	ac 15 dc 25	110	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Full	MC1219F	MO	10	–	–	–	ac 15 dc 25	110	–5.2	–1.55	–0.75	–	–	C	
Binary Elements **B**		R-S FF	WC379	WH	6	–	–	4	8	223	–4.0	–0.70	–0.01	150	–	D	
		J-K	MC308	MO	7.5	–	2	–	ac 15 dc 25	87	–5.2	–1.55	–0.75	–	–	A, C	
		J-K	MC358	MO	7.5	–	2	–	ac 15 dc 25	50	–5.2	–1.55	–0.75	–	0 to 75	A, C	
		J-K	MC358A	MO	7.5	–	2	–	ac 15 dc 25	87	–5.2	–1.55	–0.75	–	0 to 75	A, C	
		Set-Reset	MC352	MO	10	–	–	–	25	35	10	1.55	0.75	–	0 to 75	A, C	
		J-K	MC358	MO	10	–	–	–	–	52	10	1.55	0.75	–	0 to 75	A, C	
		JK	SW308	SW	10	–	–	–	25	52	-5.2	–1.55	-0.75	–	–	A, C	
		R-S	MC302	MO	10.5	2	15	–	ac 15 dc 25	42	–5.2	–1.55	–0.75	–	–	A, C	Expandable
		R-S	MC352A	MO	10.5	2	15	–	ac 15 dc 25	42	–5.2	–1.55	–0.75	–	0 to 75	A, C	Expandable
		J-K	MC364	MO	12	–	2	–	ac 15 dc 25	118	–5.2	–1.55	–0.75	–	0 to 75	A, C	
		J-K	MC314	MO	12	–	2	–	ac 15 dc 25	118	-5.2	–1.55	–0.75	–	–	A, C	
		Ac coupled J-K	MC1013P	MO	–	–	–	–	ac 15 dc 25	105	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		J-K	MC1213F	MO	–	–	–	–	ac 15 dc 25	105	–5.2	–1.55	–0.75	–	–	C	
Drivers **C**		Single 6-input	WC378	WH	3	–	6	12	20	100	–4	–0.70	–0.01	150	–	D	
		Line & Capacity	MC315	MO	14	3	15	–	50 Ω line	270	-5.2	–1.55	–0.75	–	–	A, C	Expandable
		Line & Capacity	MC365	MO	14	3	15	–	50 Ω line	270	–5.2	–1.55	–0.75	–	0 to 75	A, C	Expandable
		–	MC304	MO	–	–	–	–	ac 15 dc 25	18	–5.2	–	–	–	–	A, C	
		Lamp	MC316	MO	–	–	3	–	10 mA	135	–5.2	–1.55	–0.75	–	–	C	
		Lamp	MC366	MO	–	–	3	–	10 mA	135	–5.2	–1.55	–0.75	–	0 to 75	A, C	
		–	SW304	SW	–	–	–	5	25	18	–5.2	–	–	–	–	A, C	
		–	MC354	MO	–	–	–	–	ac 15 dc 25	18	–5.2	–	–	–	0 to 75	A, C	
Gates **D**	NOR 1	Quad 2-input	CR2101	RCA	5.6	–	8	–	12	156	5.2	–1.55	–0.75	320	–	F	
		Dual 2-input	MC309	MO	6.5	–	2	–	ac 15 dc 25	54	–5.2	–1.55	–0.75	–	–	A, C	
		Dual 2-input	MC311	MO	6.5	–	2	–	ac 15 dc 25	41	–5.2	–1.55	–0.75	–	–	A, C	
		Dual 3-input	MC312	MO	7.5	–	3	–	ac 15 dc 25	70	–5.2	–1.55	–0.75	–	–	A, C	
		Dual	SW309 SW310 SW311	SW	6	–	2	–	26	49	-5.2	–1.5	-0.75	–	–	A, C	Units Differ in output configuration
	OR/NOR 2	Dual 4-input	WC377	WH	2	–	4	6	10	60/	–4.0	–0.70	–0.01	150	–	D	
		Dual 3-input	WC380	WH	2	–	3	6	10	60/	–4.0	–0.70	–0.01	150	–	D	
		Single 8-input	WC381	WH	2	–	8	6	10	100/	–4.0	–0.70	–0.01	150	–	D	
		Dual 4-input	CD2150	RCA	3.6	–	8	–	12	220	–5	–1.6	–0.76	330	10 to 60	F	
		Dual 4-input	CA2151	RCA	3.6	–	8	–	12	175	–5	–1.6	–0.76	330	10 to 60	F	
		8-input	CA2152	RCA	3.6	–	8	–	12	110	–5	–0.76	–1.6	330	10 to 60	F	
		Dual	SN7000	TI	5	–	–	–	–	40/ gate	+1.25- –3.5	–	–	250	0 to 70	D	4 load resistors
		Dual	SN7001	TI	5	–	–	–	–	40/ gate	+1.25- –3.5	–	–	250	0 to 70	D	2 load resistors
		Dual 4-input	CR2100	RCA	5.6	–	8	–	12	115	–5.2	–1.55	–0.75	320	–	F	
		–	SW301	SW	6	–	5	–	26	35	-5.2	–1.55	-0.75	–	–	A, C	
		–	SW306 SW307	SW	6	3	25	–	26	35	-5.2	-1.55	-0.75	–	–	A, C	Units Differ in Output Configuration
	NOR/NAND 3	Triple 3-input	MC1007P	MO	5	–	–	–	ac 15 dc 25	110	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Triple 3-input	MC1008P	MO	5	–	–	–	ac 15 dc 25	75	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Triple 3-input	MC1009P	MO	5	–	–	–	ac 15 dc 25	60	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Quad 2-input	MC1010P	MO	5	–	–	–	ac 15 dc 25	115	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Quad 2-input	MC1011P	MO	5	–	–	–	ac 15 dc 25	95	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Quad 2-input	MC1012F	MO	5	–	–	–	ac 15 ad 25	115	–5.2	–1.55	–0.75	–	–	C	
		Quad 2-input	MC1012P	MO	5	–	–	–	ac 15 dc 25	65	–5.2	–1.55	–0.75	–	–	C	
		Triple 3-input	MC1207F	MO	5	–	–	–	ac 15 dc 25	110	–5.2	–1.55	–0.75	–	–	C	
		Triple 3-input	MC1208F	MO	5	–	–	–	ac 15 dc 25	75	–5.2	–1.55	–0.75	–	–	C	

Temperature range is —55 to 125°C unless otherwise stated.

4. ECL *(continued)*

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Gates **D**	NOR/NAND	Triple 3-input	MC1209F	MO	5	–	–	–	ac 15 dc 25	60	-5.2	-1.55	-0.75	–	–	C	
		Quad 2-input	MC1211F	MO	5	–	–	–	ac 15 dc 25	95	-5.2	-1.55	-0.75	–	–	C	
		Quad 2-input	MC1212F	MO	5	–	–	–	ac 15 dc 25	65	-5.2	-1.55	-0.75	–	–	C	
		Dual 2-input	MC310	MO	6.5	–	2	–	ac 15 dc 25	54	-5.2	-1.55	-0.75	–	–	A, C	
	4	Quad 2-input	MC313F	MO	6.5	–	2	–	ac 15 dc 25	124	-5.2	-1.55	-0.75	–	–	C	
		Dual 2-input	MC359	MO	6.5	–	2	–	ac 15 dc 25	54	-5.2	-1.55	-0.75	–	0 to 75	A, C	
		Dual 2-input	MC360	MO	6.5	–	2	–	ac 15 dc 25	54	-5.2	-1.55	-0.75	–	0 to 75	A, C	
		Dual 2-input	MC361	MO	6.5	–	2	–	ac 15 dc 25	41	-5.2	-1.55	-0.75	–	0 to 75	A, C	
		Quad 2-input	MC363F	MO	6.5	–	2	–	ac 15 dc 25	124	-5.2	-1.55	-0.75	–	0 to 75	C	
		Dual 3-input	MC362	MO	7.5	–	3	–	ac 15 dc 25	70	-5.2	-1.55	-0.75	–	0 to 75	A, C	
	NAND-AND	Dual 4-input	MC369F	MO	3	–	4	–	ac 15 dc 100	250	-5.2	-1.55	-0.75	–	0 to 75	C	
		Dual 2-input	MC369G	MO	3	–	4	–	ac 15 dc 100	250	-5.2	-1.55	-0.75	–	0 to 75	A	
		Dual 4-input	MC1050	MO	4	–	–	–	10	–	-5.2	-1.55	-0.75	–	0 to 70	C	Comp. out
		Dual 4-input	MC1051	MO	4	–	–	–	10	–	-5.2	-1.55	-0.75	–	0 to 70	C	Wired OR
		8-input	MC1052	MO	4	–	–	–	10	–	-5.2	-1.55	-0.75	–	0 to 70	C	Comp. out
		6-input	MC1001P	MO	5	–	–	–	ac 45 dc 75	115	-5.2	-1.55	-0.75	–	0 to 75	G, DIP	
		6-input	MC1002P	MO	5	–	–	–	ac 45 dc 75	80	-5.2	-1.55	-0.75	–	0 to 75	G, DIP	
		6-input	MC1003P	MO	5	–	–	–	ac 45 dc 75	40	-5.2	-1 55	-0.75	–	0 to 75	G, DIP	
	5	Dual 4-input	MC1004P	MO	5	–	–	–	ac 15 dc 25	95	-5.2	-1 55	-0.75	–	0 to 75	G, DIP	
		Dual 4-input	MC1005P	MO	5	–	–	–	ac 15 dc 25	65	-5.2	-1.55	-0.75	–	0 to 75	G, DIP	
		Dual 4-input	MC1006P	MO	5	–	–	–	ac 15 dc 25	45	-5.2	-1.55	-0.75	–	0 to 75	G, DIP	
		6-input	MC1201F	MO	5	–	–	–	ac 45 dc 75	115	-5.2	-1.55	-0.75	–	–	C	
		6-input	MC1202F	MO	5	–	–	–	ac 45 dc 75	80	-5.2	-1.55	-0.75	–	–	C	
		6-input	MC1203F	MO	5	–	–	–	ac 45 dc 75	40	-5.2	-1.55	-0.75	–	–	C	
		Dual 4-input	MC1204F	MO	5	–	–	–	ac 15 dc 25	95	-5.2	-1.55	-0.75	–	–	C	
		Dual 4-input	MC1205F	MO	5	–	–	–	ac 15 dc 25	65	-5.2	-1.55	-0.75	–	–	C	
		Dual 4-input	MC1206F	MO	5	–	–	–	ac 15 dc 25	45	-5.2	-1.55	-0.75	–	–	C	
		3-input	MC356	MO	6	3	25	–	26	35	10	1.55	0.75	–	0 to 75	A, C	
		3-input	MC306	MO	7.0	3	15	–	ac 15 dc 25	37	-5.2	-1.55	-0.75	–	–	A, C	Expandable
	6	3-input	MC307	MO	7.0	3	15	–	ac 15	15	-5.2	-1.55	-0.75	–	–	A, C	Expandable, Comp. out
		3-input	MC356	MO	7.0	3	15	–	ac 15 dc 25	37	-5.2	-1.55	-0.75	–	0 to 75	A, C	Expandable
		3-input	MC357	MO	7.0	3	15	–	ac 15 dc 25	15	-5.2	-1.55	-0.75	–	0 to 75	A, C	Expandable
		5-input	MC301	MO	7.5	–	5	–	ac 15 dc 25	37	-5.2	-1 55	-0 75	–	–	A, C	
		5-input	MC351	MO	7.5	–	5	–	ac 15 dc 25	37	-5.2	-1.55	-0.75	–	0 to 75	A, C	
Gate Expanders **E**		5-input	MC305	MO	5	–	5	–	–	–	-5.2	–	–	–	–	A, C	
		5-input	MC355	MO	5	–	5	–	–	–	-5.2	–	–	–	0 to 75	A, C	
		–	SW305	SW	6	–	–	–	–	–	-5.2	–	–	–	–	A, C	
Level Translators **F**		DTL to ECL	MC318	MO	17	–	2	–	ac 15 dc 25	105	-52 & +6	-1.55	-0.75	–	–	A, C	
		DTL to ECL	MC368	MO	17	–	2	–	ac 15 dc 25	105	-5.2 &+6	-1.55	-0.75	–	0 to 75	A, C	
		ECL to DTL	MC317	MO	30	–	3	–	7	63	-5.2 &+6	-1.55	-0.75	–	–	A, C	
		ECL to DTL	MC367	MO	30	–	3	–	7 &+6	63	-5.2	-1.55	-0.75	–	0 to 75	A, C	
		DTL to ECL	MC1017P	MO	–	–	–	–	ac 15 dc 25	110	-5.2 & +6	-1.55	-0.75	–	0 to 75	G, DIP	
		MECL to DTL	MC1018P	MO	–	–	–	–	DTL 7	70	-5.2 &+6	-1.55	-0.75	–	0 to 75	G, DIP	
		DTL to ECL	MC1217F	MO	–	–	–	–	ac 15 dc 25	110	-5.2 &+6	-1.55	-0.75	–	–	C	
		MECL to DTL	MC1218F	MO	–	–	–	–	DTL 7	70	-5.2 &+6	-1.55	-0.75	–	–	C	
		DTL to CML	MC1511	MO	–	–	1	–	25	25	–	-1.97	-0.75	400	–	A	
		CML to DTL	MC1512	MO	–	–	25	–	–	80	–	-0.75	2.95	–	–	A	

Temperature range is —55 to 125°C unless otherwise stated.

5. Resistor-Capacitor Transistor Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Binary Elements A		J-K	FF7317E	IN	8	2	2	–	4	96	6	0.2	<6	1500	–	G	TF
		R-S-T	FF8317E	IN	8	3	3	–	4	96	6	0.2	<6	1500	–	G	TF
		Schmitt Trigg	ST2514B	IN	20	1	1	–	6	145	12	0. 2	<12	2500	–	G	TF
		R-S FF/Counter	SN510B	TI	300	–	–	–	4	2@3V	3-6	–	–	200	–	D	
		R-S FF/Counter	SN511B	TI	300	–	–	–	20	2@3V	3-6	–	–	200	–	D	With Emitter Follower
		R-S	SN5101B	TI	300	–	–	–	4	2@3V	3-6	–	–	200	–	D	Dual Presets
		R-S	SN5111	TI	300	–	–	–	20	3@3 v	3-6	–	–	200	–	D	Dual Preset
		Ripple-Counter	SN5112	TI	300	–	–	–	16	3@3V	3-6	–	–	200	–	D	
		Ripple-Counter	SN5113	TI	300	–	–	–	16	4@4 v	3-6	–	–	200	–	D	
		–	USO100A	SPR	–	–	–	–	4	2-7	3-6	2.5	0.3	–	–	–	
		–	USO101A	SPR	–	–	–	–	20	2-7	3-6	2.5	0.3	–	–	–	USO101A
Clock Driver B		–	SN517B	TI	–	–	–	–	20	3@3V	3-6	–	–	200	–	D	
Gates C	NAND/NOR	Dual 3-input	GG3317	IN	4	3	3	–	5	96	6	0.2	<6	1500	–	G	TF
		Dual	GG3317C	IN	6	3	–	–	5	96	6	0.2	<6	1000	–	G	
		R-S-J-K	FF0451B	IN	12	4	–	–	5	60	7	0.2	<7	1.5	–	G	
		R-S-T	FF6451B	IN	12	3	–	–	5	60	7	0.2	<7	1.5	–	G	
		Dual	GG3714C	IN	50	3	–	–	6	5	9	0.2	<9	2.5	–	G	
		6-input	SN512B	TI	65@6V	–	–	–	5	2@3V	3-6	–	–	200	–	D	
		6-input	SN513B	TI	65@6V	–	–	–	25	3@3V	3-6	–	–	200	–	D	With Emitter Follower
		Dual 3-input	SN514B	TI	65@6V	–	–	–	5	2@3V	3-6	–	–	200	–	D	
		Dual 2-input	SN516B	TI	65@6 V	–	–	–	25	2@3V	3-6	–	–	200	–	D	
		Triple 2-input	SN5161B	TI	65@6V	–	–	–	5	2/ gate	3-6	–	–	200	–	D	
		Triple 2-input	SN5162B	TI	65@6V	–	–	–	25	2/ gate	3-6	–	–	200	–	D	Emitter Follower
		–	USO102A	SPR	100	–	6	–	5	2-7	3-6	2.5	0.3	–	–	–	
		–	USO103A	SPR	100	–	6	–	25	2-7	3-6	2.5	0.3	–	–	–	
		Exclusive OR	SN515B	TI	100@6V	–	–	–	5	3@3V	3-6	–	–	200	–	D	
		Pulse Exclusive OR	SN5191	TI	–	–	–	–	5	6@3V	3-6	–	–	200	–	D	
Multivibrators D		Medium Delay	DM3510B	IN	–	1	1	–	5	96	12	0. 2	<12	2500	–	G	TF
		One-shot	SN518B	TI	–	–	–	–	5	2@3V	3-6	–	–	200	–	D	

Temperature range is —55 to 125°C unless otherwise stated.

6. Complementary Transistor Logic

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Binary Elements A	–	Dual-rank	CTμL951	FA	15-20	–	–	15	–	150	4.5,-2	0.36	2.25	400	15 to 55	G	
		Dual Rank	9957	FA	15	–	–	–	15	150	4.5-2	–0.5	2.5	1100	15 to 55	G	
Buffers B		–	CTμL956	FA	12	–	–	–	25	125	4.5,-2	0.36	2.25	400	15 to 55	G	
		Dual 2-input	9956	FA	12	–	–	–	25	125	4.5-2	–0.5	2.5	1100	15 to 55	G	
		J-K Master Slave	9967	FA	20	–	–	–	12	170	4.5-2	–0.5	2.5	1100	15 to 55	G	
		R-S Master Slave	9973	FA	20	–	–	–	12	150	4.5-2	–0.5	2.5	1100	15 to 55	G	
		Dual Latch	9968	FA	20	–	–	–	11	190	4.5-2	–0.5	2.5	1400	15 to 55	G	
Gates C	AND 1	2,2,3 input	CTμL953	FA	3	8	–	12	–	–	4.5,-2	0.36	2.25	400	15 to 55	G	
		Dual 4-input	CTμL954	FA	3	8	–	12	–	–	4.5,-2	0.36		400	15 to 55	G	
		Single 8-input	CTμL955	FA	3	8	–	12	–	–	4.5,-2	0.36		400	15 to 55	G	
	NOR 2	–	CTμL952	FA	9	–	–	10	–	55	4.5,-2	0.36	2.25	400	15 to 55	G	
		Dual 2-input	9952	–	9	–	–	–	12	55	4.5-2	–0.5	2.5	1100	15 to 55	G	
	AND/OR 3	2, 2, 3 input	9953	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	
		Dual 4-input	9954	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	
		Single 8-input	9955	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	
		3, 1, 3 input	9964	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	
		1, 1, 1, 1 input	9965	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	
		2, 2, 2, 2 input	9966	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	3 inputs
		2, 2, 2, 2 input	9971	FA	3	–	–	–	11	35/	4.5-2	–5	2.5	–	15 to 55	G	2 outputs

Temperature range is —55 to 125°C unless otherwise stated.

7. MOS Arrays

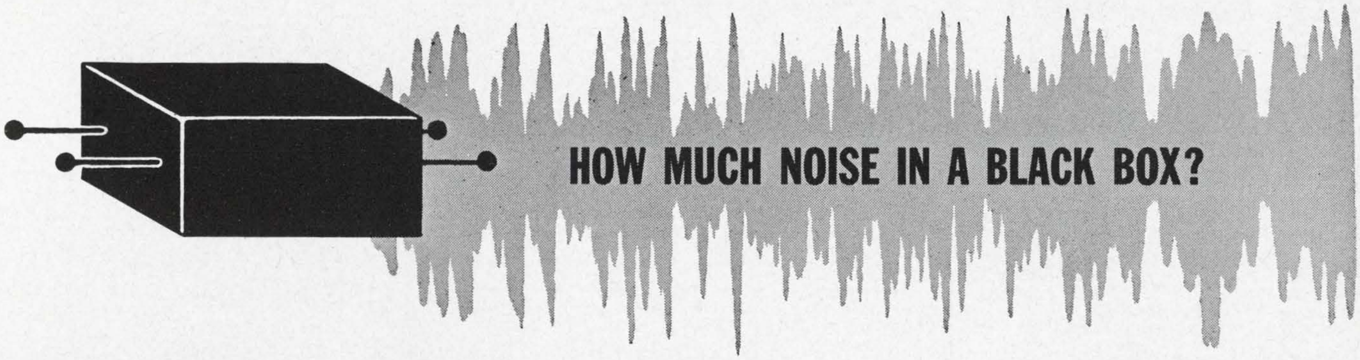
	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
	Gates A	Quad	MC1020P	MO	5	–	–	–	ac15 dc25	115	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Quad	MC1220F	MO	5	–	–	–	ac15 dc25	115	–5.2	–1.55	–0.75	–	–	C	
		Quad	MC1221F	MO	10	–	–	–	ac15 dc25	110	–5.2	–1.55	–0.75	–	–	C	
		Quad	MC1021P	MO	10	–	–	–	ac15 dc25	110	–5.2	–1.55	–0.75	–	0 to 75	G, DIP	
		Dual	SC126	SI	40	–	1	–	10	100	5 & 12	adj	adj	adj	–	D	
		Dual	SC426	SI	40	–	1	–	10	100	5 & 12	adj	adj	adj	0 -75	D	
		Dual	MEM1000	GI	500	1	–	5	–	56	–13±1V –26±1V	–2.0	–10.0	1000	–55 to 85	F	
		Dual 3-input	MEM1002	GI	330	1	–	5	–	36	–27±1V	–2.0	–10.0	1000	–55 to 85	–	
		–	MEM5014	GI	–	1	–	5	–	150	–27±1V	–2.0	–10.0	1000	–55 to 85	–	
		Dual	MEM1008	GI	500	1	–	5	–	42	–27±1V	–2.0	–10.0	1000	–55 to 85	G	
		9-bit	MEM1022	GI	1000	1	–	5	–	50	–27±1V	–2.0	–10.0	1000	–55 to 85	F	
		4-bit	MEM1050	GI	3200	1	–	5	–	240	–27±1V	–2.0	–10.0	1000	–55 to 85	–	
		Ternary	MEM5021	GI	500	1	–	5	–	78	13±1V	–2.0	–10.0	1000	–55 to 85	–	
		Binary to Decimal	9960	FA	50	–	–	–	–	30	3.3-5.0	1.0	60.0	250	0 to 75	G	Nixie Driver
		Resistence	TEBR-2	BR	10	–	–	–	–	>60	>28	AR	AR	–	–	G	TF, ±5PPM
	NAND/NOR B	Dual 4-input	PL4G01	GME	1000	–	–	–	–	20	-12, -24	–3	–9	1000	–	G	–24v clock
		Dual	9302	FA	18	–	–	–	10	100	4.5-5.5	0.2	2.7	1000	–	C, G	
		2-Channel	D111F Series	SI	550	–	–	–	–	180	30	–	–	–	–	D	Buffer/Level Shifter
		6-Channel	G116F	SI	–	–	–	–	–	–	–30	–	–	–	–	D	
	Flip-Flop C	Dual J-K	PL4M01	GME	2500	–	–	–	–	100	-12, -24	–3		1000	–	G	
		R-S-T F/F	MEM1005	GI	950	1	–	5	–	72	–27±1V	–2.0	–10.0	1000	–55 to 85	G	
	Analog Switch D	4-channel	PL4S01	GME	–	–	–	–	–	150	-15-30+ 10	10	0	1000	–	G	
		6-Channel	D/123F Series	SI	550	–	–	–	–	180	30	–	–	–	–	D	Buffer/Level Shifter
	Converter E	BCD to Decimal	PL4G02	GME	–	–	–	–	–	100	-12, -24	–3	–9	1000	–	G	
		BCD to Binary	PL4G03	GME	–	–	–	–	–	50	–24	–3	–9	1000	–	G	
		D to A	PL4S02	GME	–	–	–	–	–	75	-12, -24	–3	–9	1000	–	G	
	Counter F	BCD Decade	PL4C01	GME	2500	–	–	–	–	75	-12, -24	–3	–9	1000	–	G	
		Binary to BCD	SN7441	TI	–	–	–	–	–	90	5.25	–	–	–	0 to 70	DIP	
		Binary to Decimal	9301	FA	20	–	–	–	8	80	4.5-5.5	0.2	2.8	800	–	G	
	Shift Reg. G	9-bit	PL4R01	GME	–	–	–	–	–	75	-12, -24	–3	–9	1000	–	G	
		9-bit	PL4R07	GME	–	–	–	–	–	75	-12, -24	–3		1000	–	G	
		–	PL5200	GME	–	–	–	–	–	2.5/ bit	–20	–3	–9	1000	–	A	

Temperature range is —55 to 125°C unless otherwise stated.

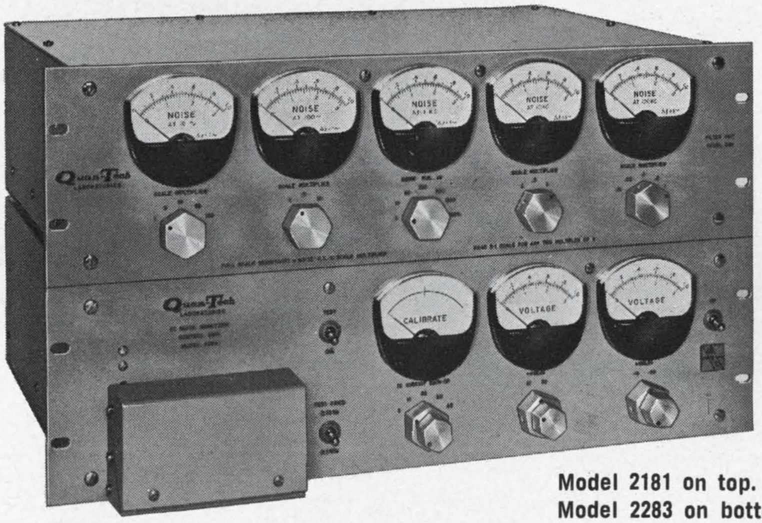
8. Miscellaneous Digital Circuits

	Logic Function	Type	Model	Mfr.	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. mW (/ = per gate)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)	Package Type	Remarks
						Typ.	Max.	Typ.	Max.			"0"	"1"				
Counter A		BCD decade	SN5490	TI	†12 MHz	–	–	–	–	150	4.5 - 5.5	–	–	1000	–	D	† Count freq.
		BCD decade	SN7490	TI	†12 MHz	–	–	–	–	150	4.75 to 5.25	–	–	1000	0 - 70	D	† Count freq.
		Decade BCD	9075	FA	80	–	–	4	–	120	3.6-5.5	0.25	2.5	250	–	G	Preset from 0-9
		Modulo 16	9076	FA	80	–	–	4	–	120	3.6-5.5	0.25	2.5	250	–	G	Preset from 0-9
		Modulo 16	9989	FA	160	–	–	6	–	140	3.6-5.5	0.25	2.0	250	0 to 75	A, G	
		Decade BCD	9958	FA	300	–	–	6	–	140	3.6-5.5	0.25	2.0	250	0 to 75	A, G	
Diode Matrix B		–	*	RAD	†10	–	–	–	–	450	40	–	–	–	–	D, G	†Reverse Recovery Time
			*20 matrix sizes, from 4 x 10 to 15 x 15 in RM series.														
		–	MC1116	MO	–	–	–	–	–	–	40(max)	–	–	–	–	A	
		–	MC1117	MO	–	–	–	–	–	–	40(max)	–	–	–	–	A	
		–	MC1118	MO	–	–	–	–	–	–	40(max)	–	–	–	–	A	
		Dual 3-input	MC217	MO	–	–	–	–	–	–	–	4	.3	–	–	A, C	
		Dual 3-input	MC267	MO	–	–	–	–	–	–	–	4	.3	–	0 to 75	A, C	
		Dual	WC217	WH	–	–	7	–	–	–	–	–	–	–	–	A	
		Triple	WC227	WH	–	–	10	–	–	–	–	–	–	–	–	D	
Level Detector	C	–	WM208T	WH	1 MHz	–	–	–	–	–	6	–	–	–	–	A, C, D	
Memory D		16 - bit	SN5481	TI	Read: 25 Write: 25	–	–	–	–	150	4.5 - 5.5	–	–	1000	–	D	
		16 - bit	SN7481	TI	Read: 25 Write: 25	–	–	–	–	150	4.75 to 5.25	–	–	1000	0 - 70	D, J	
		8-bit	9030	FA	–	–	–	–	10	100	4.5-5.5	0.2	2.7	1000	–	C, G	
		16-bit	9033	FA	18	–	–	–	10	160	4.5-5.5	0.2	2.7	1000	–	G	
		4-bit	9959	FA	80	–	–	6	–	125	3.3-5.0	0.25	2.5	250	–	G	Buffer
		16-bit	TMC3162-64	TR	20	–	1	–	40mA	250	5	0.45	3.5	1000	0 to 75	D,P,DIP	
Pulse Source E			NM4002	NOR	25	–	–	–	–	590	+20	0	+3	–	–	A, B	Apollo pre core driver
Schmitt Trigger F		–	NC/PC17	GI	8	–	1	–	5	200	12, 4.2, -3	0	5	–	–	A, E	MC RCT
		–	WC208	WH	–	–	–	–	4	15	5.7-6.3	–	–	–	0 to 75	A, D	
Shift Register G		22-bit	TEBR-1	BR	50	–	–	–	–	160	5	0.2	2.4	1000	–	G	MC; TF; 1″x1″ FP
		4-bit	9300	FA	17	–	–	–	10	100	4.5-5.5	0.2	27	1000	–	C, G	S/P, P/S
		4-bit	9303	FA	17	–	–	–	10	100	4.5-5.5	0.2	2.7	1000	–	C	S/P, P/S
		4-bit	9997	FA	40	–	–	–	7	110	3.6-5.5	0.25	2.5	250	–	C, G	S/P, P/S
		4-bit	9998	FA	40	–	–	–	7	110	3.6-5.5	0.25	2.5	250	–	C, G	Complementary Outputs
		5-bit Parallel in/ Parallel out	MEM 3005PP	GI	–	1	–	5	–	15	–13±1V	–2.0	–10.0	1000	–55 to 85	F	
		8 - bit	SN5491	TI	†15 MHz	–	–	–	–	190	4.5 - 5.5	–	–	1000	–	D	† Shift freq.
		8 - bit	SN7491	TI	† 15 MHz	–	–	–	–	190	4.75 to	–	–	1000	0 - 70	D	† Shift freq.
		8-bit Parallel in/ Serial out	MEM 3008PS	GI	–	1	–	5	–	24	–13±1V –27±1V	–2.0	–10.0	1000	–55 to 85	F	
		12-bit Serial in/ Parallel out	MEM 3012SP	GI	–	1	–	5	–	170	–27±1V	–2.0	–10.0	1000	–55 to 85	C	
		Dual 16-bit	MEM 3016-2	GI	–	1	–	5	–	100	–13±1V –27±1V	–2.0	–10.0	1000	–55 to 85	G	
		Dual 16-bit	MEM 3016-2D	GI	–	1	–	5	–	40	–27±1V	–2.0	–10.0	1000	–55 to 85	G	
		20-bit	MEM3020	GI	–	1	–	5	–	50	–13±1V –27±1V	–2.0	–10.0	1000	–55 to 85	G	
		1-bit, 4-bit, 16-bit	MEM3021	GI	–	1	–	5	–	150	–27±1V	–2.0	–10.0	1000	–55 to 85	G	
		Dual 25-bit	MEM3050	GI	–	1	–	5	–	30	–27±1V	–2.0	–10.0	1000	–55 to 85	G	
		Serial Accumulator	MEM3064	GI	–	1	–	5	–	40	–27±1V 5.25	–2.0	–10.0	1000	–55 to 85	F	
Steering Gate	H	–	NC/PC9	GI	–	–	–	–	–	–	–	–	–	–	–	A, E	MC RCDT
Utilogic I	AND Gate	Single	SU305	SIG	15	–	6	–	10	5	+4.5	–	–	–	–20, +85	A, C	
	AND Gate	Dual	SU306	SIG	15	–	3	–	10	5	+4.5	–	–	–	–20, +85	A, C	
	NOR Gate	Single	SU314	SIG	20	–	7	–	17	18	+4.5	0.6	3.3	1200	–20, +85	A, C	
	NOR Gate	Dual	SU315	SIG	20	–	3	–	17	18	+4.5	0.6	3.3	1200	–20, +85	A, C	
	NOR Gate	Dual	SU316	SIG	20	–	2	–	17	18	+4.5	0.6	3.3	1200	–20, +85	A, C	
	OR Gate	Dual	SU331	SIG	20	–	2	–	17	36	+4.5	0.6	3.3	1200	–20, +85	A, C	
	OR Gate	Dual	SU332	SIG	20	–	3	–	17	36	+4.5	0.6	3.3	1200	–20, +85	A, C	
	Expander	Dual	SU300	SIG	–	–	–	–	–	5	+4.5	–	–	–	–20, +85	A, C	
	J-K Binary	Single	SU320	SIG	65	–	–	–	17	90	+4.5	0.6	3.3	1200	–20, +85	A, C	

Temperature range is —55 to 125°C unless otherwise stated.



HOW MUCH NOISE IN A BLACK BOX?



Model 2181 on top.
Model 2283 on bottom.

Now you can measure noise in Linear IC's, Operational Amplifiers, and other "Black Boxes" SIMPLY, RAPIDLY, and EFFICIENTLY with

Quan-Tech's new

Model 2283-2181 Integrated Circuit Noise Analyzer

Perhaps we should have called this instrument a Black Box Noise Analyzer — it's that versatile. Basically, it will measure anything from the thermal noise of a 10K ohm resistor up to a complete amplifier with 50db or more gain, or any combination of things in between. The Model 2283 Control Unit consists of a pair of extremely low-noise power supplies, one plus and one minus, each independently variable from zero to 30 volts at 100 milliamperes for biasing IC's and Op Amps. Included in the control unit is an amplifier having a voltage gain of 10,000 and a bandwidth of 5Hz to 125KHz. A 50db variable-plus-step attenuator compensates for the gain of the device under test, and a 1KHz calibrating signal is provided for standardizing overall gain.

Printed circuit cards that plug into the test jig provide almost unlimited versatility in the types of devices that can be tested. We have available standard cards with test sockets for the more commonly used linear IC's, or we'll design and build one for your pet devices, whether they be zener diodes, FET's, bi-polars or what. If you're the do-it-yourself type, be our guest and make your own.

The Model 2181 Filter Unit, when used with the Control Unit, permits noise measurements to be made at five frequencies simultaneously from 10Hz to 100KHz. If you don't need the simplicity and multiple frequency readout of the Model 2181, the Model 2283 Control Unit can be used with a wave analyzer to measure noise. Naturally, we recommend either our Model 303, 304, or 305, which have bandwidths and time constants especially suited for noise measurements. Whatever your requirements, this instrument can solve many noise measuring problems in connection with the new devices now becoming available.

Price: Model 2283 Control Unit $1450.
Model 2181 Filter Unit $2500.

Quan-Tech LABORATORIES, INC.

10

43 SOUTH JEFFERSON ROAD, WHIPPANY, NEW JERSEY 07981 • PHONE (201) 887-5508 • TWX 710-986-8251

ON READER-SERVICE CARD CIRCLE 89

9. Linear Circuits

Function	Model	Mfr.	Frequency Range	Input (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks
Analog switch	E16-501	AL	Ton <500 ns Toff <600 ns	±5	†40	–	–	–	40	–	A	†hFE
A	45P912	GE	100 MHz	0.0006	–	–	–	–	20	–	A	
	4JP913	GE	100 MHz	0.0006	–	–	–	–	20	–	A	
	PC402H	GI	200	3	–	–	10 k/3.9 k	–	+45, +28	–	E	
	PC401H	GI	200	3	–	–	10 k/3.9 k	–	+45, +28	–	E	
	NM2017	NOR	200	5	–	–	10 k	–	10	–	D	
	2107B	AL	350 ns	5.6	–	*5.6	†0.4 nA	100	±12	–	A	
	2108B	AL	350 ns	6.5	–	*6.5	†0.4 nA	50	+18	–	A	
	2109B	AL	350 ns	8.5	–	*8.5	†0.4 nA	100	±12	–	A	†Cut-off current
	2110B	AL	350 ns	10	–	*10	0.4 nA	50	†18	–	A	
	8502	VAR	10 Hz – 100	0-20	46	10	10 k	1000	10 to 20	10	–	
	2114B	AL	900	9	–	*9	1.0	100	±15	–	G	
Audio Amp.	AMC101	AMP	dc-20	–	80	.002	–	–	5	6	G	
B	TAA310	AMP	15+	–	90	–	–	–	7	4	A	
	μA702	FA	dc to 30 MHz	‡1-2 mV	67-70	*10	25-30 k	200	+12-6/+6-3	–	A, C	‡Offset Voltage
	μA716C	FA	0 to 200	0-20	‡	175	10 k	10	12 to 24	–70 dBm	A	‡Selectable
	PA222	GE	70-14 k	–	–	1000	–	–	22-24	–60	DIP	
	NS7558	NA	dc-500	–	56	50	1 k	–	12	–	G	
	CA3000	RCA	1000	1.4	37	–	195	8000	+6, –6	–	A	
	CA3007	RCA	1000	0.57	22	–	4000	60	6, –6	–	A	
	CA3020	RCA	1000	–	58	550	40,000	–	+9	–	A	
	TAA111	SA	0.08-150	–	65	–	3000 (min)	–	7	–	5	
	TAA121	SA	0.05-150	–	65	–	3000 (min)	–	7	–	–	
	TAA131	SA	up to 20	–	64	–	–	–	5	–	–	Sub Min Case
	WC183	WH	.5-10	–	94	45	40 k	1 k	9	*3	A, D	
Broadband Amp.	4JP108	GE	6 MHz	–	*20	–	50 k	1 k	15	–	A	
C	HX610	HX	dc-150 MHz	±3V	52	32	300 k	300	±12	–	TO-100	
	PA7600	PH	0-200 MHz	–	†43	2.5	–	–	6	5	A	†MHz Video Bandwidth
	CA3011	RCA	4500	–	70	–	3000	31.5	7.5	8.7	A	
	CA3012	RCA	4500	–	65	–	3000	31.5	7.5	8.7	A	
	CA3013	RCA	100 to 20,00	–	75	–	3000	31.5	7.5	8.7	A	
	CA3014	RCA	100 to 20,000	–	75	–	3000	31.5	7.5	8.7	A	
	SE501	SIG	40	–	28	–	1.3 k	–	6.0	4 db	A, C	
	WM1146Q	WH	dc-100 MHz	–	16	–	–	–	12	4	C	
D/A Switch D	4JP380	GE	250 MHz	–	–	–	–	20	5	–	A	
Demodulator Chopper E	NM2024	NOR	5	26	–	–	–	–	28	–	D	
Differential Amp.	D13-000	AL	400	–	45	6-V	20 k	5 k	±12	–	A, C	
F	D13-001	AL	400	–	45	6 V	10 k	5.5 k	±12	–	A, C	
	D13-002	AL	400	–	45	5 V	5 k	5.5 k	±12	–	A, C	
	831A	AL	dc-400	*2.5 mV	66	*6 k	40 k	5 k	±12	–	A, C	* Offset Voltage
	831B	AL	dc-400	*8 mV	66	*6	20 k	5.5 k	±12	–	A, C	* Offset Voltage
	831C	AL	dc-400	*20 mV	63.5	*5	20 k	5.5 k	±12	–	A, C	* Offset Voltage
	831D	AL	dc-400	*10 mV	63.5	*6	20 k	6V	±12	–	A	* Offset Voltage
	μA711	FA	40 ns	† 1 mV	63	*+4.5, –0.5		200	+12, –6	–	A	dual input †offset voltage
	PC200	GI	0-20	–	73	–	100 k Diff.	200	±2 to ±22	5μV	E	
	PC201	GI	0-20	–	73	–	200 k Diff.	200	±6 to ±22	5μV	F	
	MC1429	MO	250 kHz @ 3dB BW	±5	38	*±6	40 k	17 k	±12	–	A	
	MC1519	MO	1 MHz	±5	73/45 †	–	2.6 k/1.2 k†	2.7 k/ 48 †	±14	–	A	†CE/CC
	MC1525	MO	1400	±5	140	–	2 k	11 k	±14	–	A	
	MC1526	MO	500	±5	65	–	60 k	11 k	±14	–	A	Darlington (npn)
	MC1529	MO	300 kHz @ 3dB BW	±5	38	*±6	50 k	15 k	±12	–	A	
	NM1005	NOR	300	†2mV	75	*16	3.2 k	100	†12, -6	*2.5 mV	A, D	†Offset Voltage
	NM1006	NOR	1 MHz	†8m V	66	*8	250 k	100	10	*2mV	D	†Offset Voltage
	NM1021	NOR	1 MHz	†4mV	60	*6	1.5 M	5 k	†12; -25	–	–	†Offset Voltage
	SE505	SIG	1000	–	1500 Open Loop	–	4 k	–	+6, –3	–	A, C	
	203	SSD	500	±3	40	150	75,000	300	25	2 μV*	C	
	SN523A	TI	dc–3 MHz	±5	66	4	10 k	10 k	±12	–	A, D	
	SN525A	TI	dc–1 MHz	±5	88	4	100 k	10 k	±12	–	D	
	SN723	TI	dc–3 MHz	±5	64	4	10 k	10 k	±12	–	A, D	
	SN725	TI	dc-45	†2 mV	86	*16	140 k	10 k	±12	–	D	†Offset voltage
	SN5231L	TI	dc-3 MHz	±5	66	*±12	15 k	200	±12	–	G	
	SN5510	TI	dc–300 MHz	±4	40	0.4	3.5 k	35	±6	–	D	
	SNX1312	TI	50	†1 mV	58	*±10	100 k	45	±12	–	G	†Offset voltage
	WC115T	WH	0-300	240M	60V/V	*5	150 k	8 k	±12	–	A	
	WC750T	WH	dc-2 MHz	–	2000 V/V	72	32 k	1 k	±15	–	A	Two circuits/pkg.
Differential Comparator	μA710	FA	40 ns	†2 mV	63	*+3.2, –0.5		200	+12, –6	–	A, C	† offset voltage
G	μA710C	FA	40 ns	†2 mV	63	*+3.2, –0.5		200	+12, –6	–	A, C	† offset voltage
	μA711C	FA	40 ns	†1 mV	63	*+4.5, –0.5		200	+12, –6	–	A	dual input †offset voltage
	NM1037	NOR	100	±10	*1000	*6	–	3 k	30	–	A	Min-Max Limit Detector
	PA710	PH	40 ns	†2mV	64	* +3.2 –0.5	–	200	+12 –6	–	A, C	†Offset
	SE560	SIG	10 MHz	–	1700 Open Loop	–	–	–	–	–	A, C	
	SN52710	TI	40 ns	‡2 mV	63	*+3.2, –0.5	–	200	+12, –6	–	D, G	†Offset voltage
	SN52711	TI	40 ns	†1 mV	63	*+4.5, –0.5	–	200	+12, –6	–	D, G	†Offset voltage
	SN72710	TI	40 ns	†2 mV	63	*+3.2, –0.5	–	200	†12, –6	–	D, G	†Offset Voltage
	SN72711	TI	40 ns	†1 mV	63	*+4.5, –0.5	–	200	+12, –6	–	D, G	†Offset voltage

9. Linear Circuits *(continued)*

Function	Model	Mfr.	Frequency Range	Input (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks
Driver Switch **H**	NM1038	NOR	50	±10	–	–	11 k	–	34, 6, -6	–	D	
Emitter Coupled Amp. **I**	MC1110	MO	dc-300 MHz	0.114	26	10	2 k	5 k	±12	6	A	
	TAA293	AMP	0-600	–	80	–	–	–	7	5	A	
	12X218	GE	10-100	–	–	–	50 M	250	25	B	E	
	4JPA113	GE	100	–	85	50	20 k	50	15	–	A	
	4JP114	GE	1 MHz	–	†3,000	45	1.5 k	10 k	6	–	A	†Current gain
	NM1032	NOR	dc – 190	–	45	–	34 k	2 k	6, -12	–	D	
	NM1033	NOR	dc – 190	–	66	–	3.4 k	2 k	12, 6, -12	–	D	
	PA7602	PH	0-100	–	76	*6	†>25 k	†<50	12	–	A	†Gain of 40dB
	UC1501A	SPR	3 – 250	–	84	500	2 k	150	15	–	–	
	UC1503A	SPR	200 Hz – 3 MHz	–	60	600	20 k	150	15	–	–	
	UC1505A	SPR	30 Hz – 11 MHz	–	40	600	47 k	150	15	–	–	
	UC1507A	SPR	10 Hz – 10 MHz	–	34	600	47 k	150	15	–	–	
	WC-934	WH	0-1500	30 mV	32	–	180 k	100	±9	4	D	
General Purpose Amp. **J**	12X207	GE	10-100	0.0001	*600	–	10 k	1 M	30	10 m V rms	A	
Limiter **K**	UC1508A	SPR	50 Hz – 12 kHz	2	40	16	40 k	15	15	–	–	
Operational Amp. **L**	A13-251	AL	10 MHz	–	86	*10	250 k	1 k	± 12	–	A	
	800B	AL	dc-10 MHz	†5 mV	86	*±10	1 M	400	±12	–	A	†Offset voltage
	800D	AL	dc-10 MHz	†10 mV	86	*±9	500 k	400	±12	–	A	†Offset voltage
	801B	AL	dc-10 MHz	*5 mV	86	*±10	1M	400	±12	–	A	* Offset Voltage
	801D	AL	dc-10 MHz	*10 mV	86	*±9	500 k	400	±12	–	A	* Offset Voltage
	805B	AL	dc-10 MHz	*3 mV	94	*±13	1M	150	±15	–	A, C	* Offset Voltage
	805C	AL	dc-10 MHz	*3 mV	94	*±13	1M	150	±15	–	A	* Offset Voltage
	806B	AL	dc-10 MHz	*3 mV	94	*±10	1M	150	±12	–	A	* Offset Voltage
	806C	AL	dc-10 MHz	*3 mV	94	*±10	1M	150	±12	–	A	* Offset Voltage
	807B	AL	dc-10 MHz	*1 mV	94	*±13	1M	150	±15	–	A C	* Offset Voltage
1	2404B	AL	dc-10 MHz	*3 mV	100	±11	10^{11}	500	±15	–	G	* Offset Voltage
	2405B	AL	dc-10 MHz	*3 mV	100	±25	10^{11}	500	±30	–	G	* Offset Voltage
	ATF401	AMP	dc to 2 MHz	4-10	88	25	200 k	–	±15	–	–	
	TEBR-3	BR	dc-500	0.001	93	*±14	10 k	0 1	±15	–	G	TF; multi-gain
	805-3	CDC	1 MHz	100 µV	96	90	1000 k	24	±15	–	A	
	805-4	CDC	1 MHz	100 µV	96	90 dB	1000 kΩ	150	±15	–	A	
	806-3	CDC	1 MHz	100 µV	96	90 dB	1000 kΩ	150	±15	–	A	
	806-4	CDC	1 MHz	100µV	96	90 dB	1000 KΩ	150	±15	–	A	–
	807-4	CDC	1 MHz	50µV	96	90 dB	1000 KΩ	150	±15	–	A	–
	µA702A	FA	dc-30MHz	† 2 mV	68	*± 53	25 k	200	+12,–6	–	A, C	RA, ITT
	µA702C	FA	dc-30 MHz	†5 mV	68	*±5.3	20 k	200	+12,–6	–	A, C	RA, ITT
	µA709	FA	0 to 1 MHz	‡1 mV	96	*24	500 k	150	±15,±9	–	A, C	RA, ITT
	µA709C	FA	0 to 1 MHz	‡2 mV	93	*27	300 k	150	±15,±9	–	A, C	RA, ITT
	4JPA107	GE	200	–	70	±10	750 k	100	±12	–	A	
	4JPA135	GE	200	–	70	*±4	1 M	100	±6	–	A	
	TMC40006	MEP	100	–	60	–	100 k	5 k	±12	–	G	
	MC1430	MO	1 MHz @ 3dB BW	±5	74	*±5	15 k	25	±6	–	A, C	2 mV noise voltage
	MC1431	MO	150 kHz @ 3dB BW	±5	71	*±5	600 k	25	±6	–	A, C	5 mV noise voltage
	MC1433	MO	200 kHz @ 3dB BW	±10	†60,000	*±13	600 k	100	±15	–	A, C	† V/V,0.3µV noise voltage
	MC1530	MO	1.2 MHz	±5	74	10	10 k	25	±9	–	A	
	MC1531	MO	400	±5	71	10	1 M	25	±9	–	A	Darlington Input
	MC1533	MO	200 kHz @3dB BW	±10	†60,000	*±13	1 M	100	±15	–	–	†V/V,0.3µ V noise voltage
	MC1709	MO	200 kHz @ 3 dB BW	±5	†45,000	*±14	400 k	150	±15	0.8µV	A	†V/V
2	NS7560	NA	dc-10 MHz	5	63	–	2 5M	70	+12,–12	–	G	† Offset Voltage
	NS7560A	NA	dc-10 MHz	1	74	–	2.5M	70	+12,–12	–	G	† Offset Voltage
	PA702A/ 712	PH	0.8 MHz	†2 mV	68	*±5.3	25 k	200	12-6, 6-3	–	A, C	†Offset Voltage
	PA7026	PH	0-8 MHz	†7 mV	68	*±5.3	20 k	200	12-6	–	A, C	†Offset Voltage
	Q25AH	PR	0–2	±10	86-116	24	10^{12}	100 k	±15	0.5	G	FETs
	Q82AH	PR	dc-70 MHz	±10	86-92	100	2M	150 (Open Loop)	±15	4	G	
	Q85AH	PR	0–2000	±11	86-116	24	10^{8}	100 k	±15	2	G	
	RA-238	RAD	7000	±12	68	*21	250,000	250	-15,+25	–	D	Offset Voltage Adjustable
	RA-239	RAD	dc-15,000	±12	68	*21	100,000	150	-15,+25	–	D	Offset Voltage Adjustable
	RA-240	RAD	dc-6000	±6	84	*9.6	150,000	100	-15,+25	–	D	Offset Voltage Adjustable
	RA-335	RAD	7000	±12	68	*21	250,000	250	-15,+25	–	D	Offset Voltage Adjustable
	RA-338	RAD	7000	±12	68	*21	250,000	250	-15,+25	–	D	Offset Voltage Adjustable
	RA-339	RAD	dc-15,000	±12	68	*21	150,000	150	-15,+25	–	D	Offset Voltage Adjustable
	RA-339	RAD	dc-15,000	±12	68	*21	100,000	150	-15,+25	–	D	Offset Voltage Adjustable
3	RA-340	RAD	dc-6000	±6	84	*9.6	150,000	100	-15,+25	–	D	Offset Voltage Adjustable
	RA-340	RAD	dc-6000	±6	84	*9.6	150,000	100	-15,+25	–	D	Offset Voltage Adjustable
	RA-538	RAD	dc-7000	±12	68	*21	250,000	250	-15,+25	–	D	Offset Voltage Adjustable
	RA-539	RAD	dc-15,000	±12	68	*21	100,000	150	-15,+25	–	D	Offset Voltage Adjustable
	RA-540	RAD	0-6000	±6	84	*9.6	150,000	100	-15 +25	–	0	Offset Voltage Adjustable
	CA3008	RCA	300	-4 to +1	60	–	14K	200	+6,–6	–	A, F	
	CA3015,6	RCA	320	-8,+1	70	–	7.8 k	92	+12, –12	–	A, F	
	CA3029	RCA	1000	1	60	–	14,000	200	+6,–6	–	A	

9. Linear Circuits *(continued)*

Function	Model	Mfr.	Frequency Range	Input (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks
Operational Amp.	CA3031	RCA	–	–8,+1.5	85	–	25 k	130	+12,–6	–	A	
L	CA3032	RCA	–	–8,+1.5	85	–	20 k	200	+12,–6	–	A	
	SE506	SIG	300	–	13,000 Open Loop	–	200 k	–	+15,–15	–	A, C	
	SN521A	TI	dc – 50	±4	62	–	12 k - 100 k	10 k	10, 6, -9	–	D	
	SN522A	TI	dc – 50	±4	62	–	12 k- 100 k	160	10, 6, -9	–	D	Emitter follower
	SN524A	TI	dc–3 MHz	±5	60	4	1 M	75	±12	–	A, D	
	SN526A	TI	dc–1 MHz	±5	88	70	1000 k	12 k	±12	–	D	
	SN724	TI	dc–3 MHz	±5	54	4	750 k	75	±12	–	A, D	
	SN726	TI	dc-1 MHz	±5	56	*±5	†200 k	–	±12	–	D	†RL = 0.6 kΩ
. 4	SN52702	TI	dc-30 MHz	†2 mV	67	*±5.3	25 k	200	+12 –6	–	D G	†Offset voltage
	SN52709	TI	dc-500	†1 mV	93	*±14	400K	150	±15	–	D, G	†Offset voltage
	SN72702	TI	dc-30 MHz	†5 mV	67	*±5.3	20 k	200	+12, –6	–	D G	†Offset voltage
	SN72709	TI	dc-500	+2 mV	93	*±14	250 k	150	±15	–	D, G	†Offset voltage
	UC4000	UC	1500	±10	86	20	1.5M	30	±15	–	101	
	UC4001	UC	1500	±10	86	20	1 5M	30	±15	–	101	
	UC4002	UC	1500	±10	86	20	1.5M	30	±15	–	101	
	WC161Q	WH	500	±6.25	*2200	50	300 k	40	±12	–	C	Single & Diff Output
	PC-210H	GI	1.5 MHz	±8	70	*±15	30 k	50	±18	4 μV	E	
	PC212H	GI	1.2 MHz	±8	64	*±10	100 k	50	±12	4μV	E	
	PC250	GI	30	±20	50	–	10^{14}	150	±12	–	E	
	PC-251	GI	30	±20	50	–	10^{14}	150	±12	–	E	Short-circuit proof
Phase Splitter Amp.	UC1502A	SPR	3 – 250	–	84	160	2 k	100	15	–	–	
M	UC1504A	SPR	200 Hz – 3 MHz	–	58	230	20 k	100	15	–	–	
	UC1506A	SPR	30 Hz – 11 MHz	–	39	230	20 k	100	15	–	–	
Power Amp.	MC1524	MO	300	±5	*10/20/40	1000	8.5 k	0.58	±12	–	A	
N	NM1003	NOR	dc – 20	0-60	54	8000	10 k	500	36	–	G	Modified To-53
	NM1008	NOR	dc – 20	0-60	46	8000	10 k	300	36	–	G	Modified To-53
Pulse Amp.	UC1509A	SPR	–	5	22	–	20 k	100, 10	15	–	–	
O	UC1510A	SPR	–	6.7	0	–	40 k	100, 10	15	–	–	
	12X264	GE	10 MHz	–	25	–	–	–	15	–	A	
RF/IF Amp.	903B	AL	dc-110 MHz	–	15	*4	25 pF/10 mμ	7 pf/0.5 mμ	+12, –6	–	A	
P	903C	AL	dc-110 MHz	–	15	*4	25 pF/10 mμ	7 pf/0.6 mμ	+12, –6	–	A	
	MC1550	MO	22 MHz	±5	26	*4.2	1800	100 k	+6	<5	A	
	PA7602	PH	10-200 MHz	–	18	*1	90	95	±6	–	A	
	PA713	PH	0-200 MHz	–	†33	–	450	900	6	7	A-C	†12 MHz Video Bandwidth
	CA3002	RCA	11,000	2.2	20	–	100,000	70	6,–6	4	A	
	CA3004	RCA	100,000	–2.5, +3.5	12	–	1.2 k	2200	+6,-6	6.3	A	
	CA3005	RCA	100,000	–2.5 +3.5	16	–	1.4 k	200	+6,-6	7.8	A	
	CA3006	RCA	100,000	0.8	16	–	1.4k	2000	+6,–6	7.8	A	
	CA3028	RCA	100,000	–	16	–	–	–	–	6.8	A	
Sense Amp.	MC1540	MO	0-40 MHz	17 mV	39	*5.9	–	–	±6	–	A	Core Memory Appl
Q	NM2012	NOR	0-1 MHz	†1 mV	49	*4	–	–	13	–	A, D	†Offset Voltage
	NM2016	NOR	0-1 MHz	†4 mV	54	*4	–	–	30	–	A, D	†Offset Voltage Temp. Compensated
	SE500	SIG	0-3 MHz	–	31	–	–	–	+13, +4, +1.5	–	A, C	
	SE504	SIG	3000	–	30	–	–	–	13.0	–	A, C	
	SA10 SA11	SY	7 MHz	17 mV	–	–	240	–	-25, 12, +5	–	D, G	Digital Output 0-5V
	SN5500	TI	†125 ns	6	–	–	–	–	±6	–	A, D	† Prop. delay
	SN7500	TI	†125 ns	6	–	–	–	–	±6	–	D	†Prop. delay
	SN7501	TI	0.7μs-cycle time	†12-20mV	–	*0.4, 2.6	5 k	–	±5	–	D	†Adjustable range
	SN7502	TI	1 5 μs-cycle time	†14-24mV	–	*0.4, 2.6	5 k	–	–	±5	D	†Adjustable range
Summing Amp. R	4JP116	GE	100 MHz	–	1×10^5	–	1	1	±25	–	A	
Video Amp.	E13-511	AL	50 MHz	0.26	22	–	520	520	+12	–	A	
S	901B	AL	dc-60 MHz	*260 mV	24	*7	550	500	±12	–	A	* Offset Voltage
	901C	AL	dc-60 MHz	260 mV	24	*7	550	500	±12	–	A	
	NC/PC101	GI	40 MHz	0.2	20	4.5	1 k	500	6	3	A, E	
	MC1552	MO	40 MHz	+1,-5	40	*2.9	10 k	50	+6	5 @ 30 MHz	A	
	MC1553	MO	35 MHz	+1,-5	52	*2.9	10 k	50	+6	5 @ 30 MHz	A	
	NS7512A	NA	dc-100 MHz	–	25	–	500	500	+12	–	G	
	CA3001	RCA	11,700	1.5	19	–	50,000	70	–	–	A	
	CA3021	RCA	56,000	1.8	56	–	550	300	–	–	A	
	CA3022	RCA	2500	2	57	–	360	120	–	–	A	
	CA3023	RCA	5000	1	53	–	180	98,000	–	–	A	
	SA20	SY	up to 100 MHz	–	45	–	2.6 k	>5	24	15	A	
	SN7510	TI	dc-40 MHz	–	39	–	6 k	35	±6	*5 μV	D, G	
	WC1146	WH	0-45,000	–	23	–	90	2000	12	4	A, C	
	WM1146	WH	0-35 MHz	–	20	–	100	2 k	12	4	C	
Voltage Reg.	2802B	AL	–	+20,+14	60	†*12	–	.5	–	–	G	†0.2%
T	2803B	AL	–	–20,–14	60	†*–12	–	.5	–	–	G	†0.2%
	BR-801	BR	100	±10 to ±40	–	*1.5 to ±38	–	2	±10 to ±40	–	G	MC; TF; up to 1 amp.
	NC511/ PC511H	GI	100	+15 to +24	–	150mA	–	0.1	+12	0.4 mV	A or E	
1	NC512/ PC512H	GI	100	+27 to +36	–	140mA	–	0.2	+24	1 mV	E	
	NC513/ PC513H	GI	100	-15 to -24	–	150mA	–	0.1	-12	0.4 mV	A or E	
	NC514/ PC514H	GI	100	-27 to -36	–	140mA	–	0.2	-24	1 mV	E	

Reader-Service cards are good all year.

9. Linear Circuits *(continued)*

Function	Model	Mfr.	Frequency Range	Input (Volts)	Gain (db) or *(Volts)	Output (mW) or *(Volts)	Input Impedance (ohms)	Output Impedance (ohms)	Supply Voltage (Volts)	Noise Figure (db) or *(Volts)	Package Type	Remarks
Voltage Reg. T	NC521/ PC521H	GI	100	+28	–	*+6	–	0.05	–	–	E	Imax=200 mA
	NC523/ PC523H	GI	–	–28	–	*–6	–	0.05	–	–	E	Imax=200 mA
	NCS-675A	GI	–	+28	–	*+5	–	0.1	–	–	A	Imax=200mA
	PC501H	GI	100	+16to+24		150mA		0.2	+12	0.4 mV	E	
	PC502H	GI	100	-16 to -24	–	150mA	–	0.2	-12	0.4 mV	E	
	PC503H	GI	100	+28 to +36	–	140mA	–	0.4	+24	1 mV	E	
	PC504H	GI	100	-28 to -36	–	140 mA	–	0.4	-24	1 mV	E	
	NM1004	NOR	–	>20, >30		†1.25mA	-	–	715	1 mV		†Drive Current
	1APU6	TRI	dc	10-31	–	*6	–	0.06	–	–	G	1A
2	1APU12	TRI	dc	16-37	–	*12	–	0.12	–	–	G	1A
	1APU18	TRI	dc	22-40	–	*18	–	0.18	–	–	G	1A
	1APU24	TRI	dc	28-40	–	*24	–	0.24	–	–	G	1A
	3APL2	TRI	–	4-15	80	*2	–	0.006	–	–	G	3A
	3APL3	TRI	–	5-15	80	*3	–	0.008	–	–	G	3A
	3APL4	TRI	–	6-15	75	*4	–	0.010	–	–	G	3A
	3APL5	TRI	–	7-18	75	*5	–	0.012	–	–	G	3A
	3APL6	TRI	–	8-20	70	*6	–	0.014	–	–	G	3A
	3APL8	TRI	–	10-20	70	*8	–	0.016	–	–	G	3A
	3APL10	TRI	–	12-25	80	*10	–	0.005	–	–	G	3A
	3APL12	TRI	–	14-30	80	*12	–	0.006	–	–	–	3A
	3APL15	TRI	–	17-35	75	*15	–	0.008	–	–	G	3A
	3APL18	TRI	–	20-35	75	*18	–	0.010	–	–	G	3
	3APL22	TRI	dc	24-40	70	*22	–	0.012	–	–	G	3A
	3APL27	TRI	dc	29-45	70	*27	–	0.014	–	–	G	3A
	3APL33	TRI	dc	35-50	70	*33	–	0.016	–	–	G	3A
	75TE3.9	TRI	dc	>out	–	*3.9	–	0.006	–	–	G	3A or 75W
	75TE4.7	TRI	dc	>out	–	*4.7	–	0.008	–	–	G	3A or 75W
	75TE5.6	TRI	dc	>out	–	*5.6	–	0.010	–	–	G	3A or 75W
	75TE6.8	TRI	dc	>out	–	*6.8	–	0.012	–	–	G	3A or 75W
	75TE8.2	TRI	dc	>out	–	*8.2	–	0.015	–	–	G	3A or 75W
	75TE10	TRI	dc	>out	–	*10	–	0.005	–	–	G	3A or 75W
	75TE12	TRI	dc	>out	–	*12	–	0.006	–	–	G	3A or 75W
	75TE15	TRI	dc	>out	–	*15	–	0.008	–	–	G	3A or 75W
	75TE18	TRI	dc	>out	–	*18	–	0.009	–	–	G	3A or 75W
3	75TE22	TRI	dc	>out	–	*22	–	0.011	–	–	G	3A or 75W
	75TE27	TRI	dc	>out	–	*27	–	0.013	–	–	G	3A or 75W
	75TE33	TRI	dc	>out	-	*33	–	0.015	–	–	G	3A or 75W
	75TE39	TRI	dc	>out	–	*39	–	0.018	–	–	G	3A or 75W
	75TE47	TRI	dc	>out	–	*47	–	0.021	–	–	G	3A or 75W
	75TE56	TRI	dc	>out	–	*56	–	0.025	–	–	–	3A or 75W
	80TF3.9	TRI	dc	>out	–	*3.9	–	0.006	–	–	G	3A or 80W
	80TF4.7	TRI	dc	>out	–	4.7	–	0.008	–	–	G	3A or 80W
	80TF5.6	TRI	dc	>out	–	5.6	–	0.010	–	–	G	3A or 80W
	80TF6.8	TRI	dc	>out	–	*6.8	–	0.012	–	–	G	3A or 80W
	80TF8.2	TRI	dc	>out	–	*8.2	–	0.015	–	–	G	3A or 80W
	80TF10	TRI	dc	>out	–	*10	–	0.005	–	–	G	3A or 80W
	80TF12	TRI	dc	>out	–	*12	–	0.006	–	–	G	3A or 80W
	80TF15	TRI	dc	>out	–	*15	–	0.008	–	–	–	3A or 80W
	80TF18	TRI	dc	>out	–	*18	–	0.009	–	–	G	3A or 80W
	80TF22	TRI	dc	>out	–	*22	–	0.011	–	–	G	3A or 80W
	80TF27	TRI	dc	>out	–	*27	–	0.013	–	–	–	3A or 80W
4	80TF33	TRI	dc	>out	–	*33	–	0.015	–	–	–	3A or 80W
	80TF39	TRI	dc	>out	–	*39	–	0.018	–	–	G	3A or 80W
	80TF47	TRI	dc	>out	dc	*47	–	0.021	–	–	G	3A or 80W
	80TF56	TRI	dc	>out	–	*56	–	0.025	–	–	G	3A or 80W
	WC110T	WH	100	10-50	–	2A	–	0 004	–	–	TO-3	

Complete listing of semiconductor manufacturers starts on page 86.

Circle as many numbers on the reader-service card as you like.

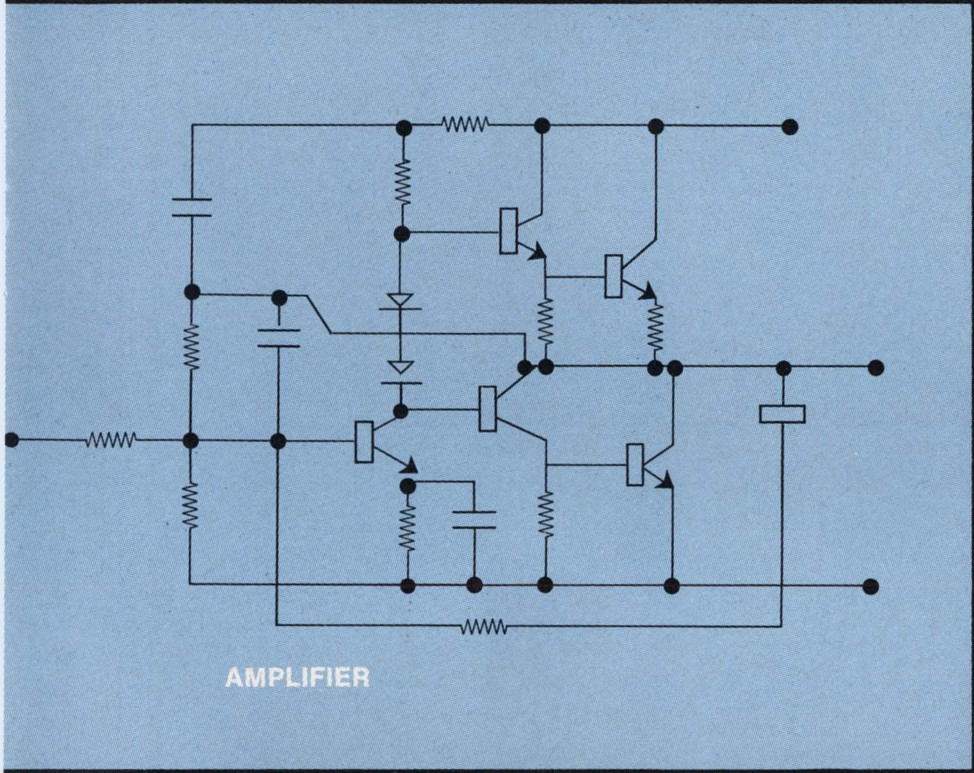
Valuable reprints are FREE if you circle them on the reader-service card.

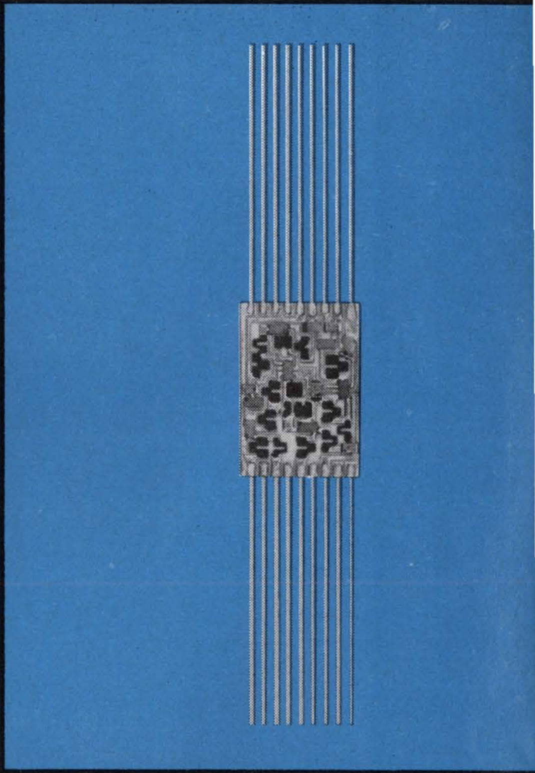
Microelectronic Cross-Index

This cross-index helps you locate any microelectronic circuit quickly and easily. The first digit indicates the type of logic. The letter indicates the location of the circuit in the logic family. The last digit pinpoints the location of the circuit.

For example, to look up the DTμL930, turn to letter "D" and find the entry DTμL930. The cross-index directs you to 1D12. The number "1" refers to the first microelectronic category, "1. Diode Transistor Logic." "D" is the function category (in the case "gates"). Number 12 pinpoints the DTμL930 in the gate table.

HYBRIDIZATION . . . the fine art of converting your discrete component circuit to a microcircuit.





Volume microcircuit production of your analog or digital circuit is accomplished at Mepco by HYBRIDIZATION. The ability to manufacture precision passive film components is complemented by a wide variety of semiconductor attachment techniques. These capabilities provide the required flexibility to microminiaturize your circuit at the lowest possible cost. Consider these exceptional performance characteristics.

- Matched semiconductor parameters
- Ratio match of resistance values to .1%
- Power dissipation — 10 watts per sq. inch
- Temperature coefficient tracking of ±20ppm maximum

Write or call today for complete details.
Mepco, Inc., Columbia Road, Morristown, N.J. 07960
(201) 539-2000 TWX: 710-986-7437
O.E.M. Sales Offices from Coast to Coast

MEPCO

MANUFACTURERS OF **PRECISION ELECTRONIC DEVICES**

A Heritage of Reliability

Resistors . . . Potentiometers . . . Microcircuits . . . Capacitors

Learn why

Please send me a FREE copy of "Circuit Considerations in VHF/UHF Power Transistor Amplifier Design," along with detailed specifications on ITT VHF transistors.

NAME ____________________ TITLE ____________

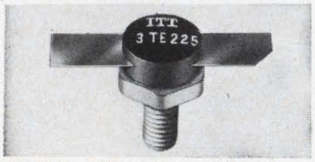
COMPANY ________________________________

ADDRESS ________________________________

CITY ______________ STATE __________ ZIP ________

VHF transistors from ITT make circuit optimization easier

2N4130 — 50 watts at 70 MHz in a TO-3 package.



3TE225 — 50 watts at 150 MHz in strip line configuration.

There's no question about it — ITT's "Predictables" will simplify your amplifier circuit design job. Performance is exceptional . . . and it's predictable. Here are two examples:

2N4130 — delivers 50 watts at 70 MHz. This transistor is resistor-stabilized for increased efficiency, and its grounded emitter minimizes capacitance. It's unusually easy to work with in Class B and C circuits and in single sideband applications.

3TE225 — offering 50 watts at 150 MHz, in the jumbo-sized 11/16″ strip line package. Almost perfect stability makes tune-up easier, while low inductance adds bandwidth and simplifies matching to driver stages.

Don't make circuit optimization tougher than it has to be. Get full details on the Predictables today. Use the coupon above for information; call your ITT distributor or factory representative for immediate delivery. ITT Semiconductors is a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida.

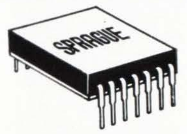
transistors ITT

FACTORIES IN WEST PALM BEACH, FLORIDA; PALO ALTO, CALIFORNIA; LAWRENCE, MASSACHUSETTS; HARLOW AND FOOTSCRAY, ENGLAND; FREIBURG AND NURENBERG, GERMANY

ON READER-SERVICE CARD CIRCLE 91

Did you know Sprague makes...?

MODULINE® MICROCIRCUITS

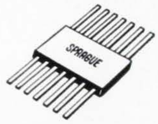


A new concept in technology integration, with compatible 14-pin DIP mounting. Four standard circuits are available now:

UM1000—4-bit D to A Converter
UC1518—Video Amplifier
UC1519—Sense Amplifier
UC1522—Operational Amplifier

On Reader Service Card Circle 821

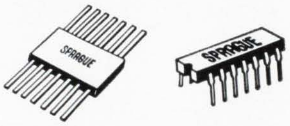
*SERIES SE100, NE100, US700 (Signetics CS700) DTL INTEGRATED CIRCUITS



Two operating temperature ranges: —55 C to +125 C and 0 C to +70 C. NAND/NOR gates, clock and line drivers, gate expanders, RS/T and J-K binaries, one-shot multivibrator.

On Reader Service Card Circle 822

*SERIES 400 low-power TTL INTEGRATED CIRCUITS



All dual or quad function devices . . . reduces can count and minimizes equipment size. Available in two package styles, three temperature ranges.

On Reader Service Card Circle 823

*SERIES 600 DTL INTEGRATED CIRCUITS for minimum cost

Two temperature ranges: 0 to +70 C and +15 to +55 C. Low power consumption: 20 mW/gate maximum. High system speed: 3 to 10 MHz. Low gate delay: 30 to 45 nsec maximum. High noise immunity: 800 mV to 2.0 V.

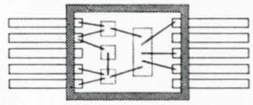
On Reader Service Card Circle 824

UNICIRCUIT® mW RTL INTEGRATED CIRCUITS

Types US-0908 through US-0921 . . . Fully interchangeable mW digital building blocks featuring power consumption of 4 mW/node and propagation delay of 40 nsec

On Reader Service Card Circle 825

UNICIRCUIT® CUSTOM HYBRID CIRCUITS



Combine monolithic silicon circuits with tantalum or Ni-Cr alloy resistors. Close resistance tolerances, low temperature coefficient. Resistor matching, ±½%.

On Reader Service Card Circle 826

D to A CONVERTER CIRCUITS

Expandable to 12 bits with < ½ bit error

	4-BIT SERIES	5-BIT SERIES
Ladder Network	UT-1000	UT-1001
Ladder Switch	UD-4001	UD-4036
Buffer Amplifier	UD-4024	UD-4037

On Reader Service Card Circle 827

MULTIPLE TRANSISTORS (NPN-PNP PAIRS/QUADS)

AMPLIFIERS SWITCHES CHOPPERS

Pairs	Quads
2 NPN	4 NPN
2 PNP	4 PNP
1 NPN—1 PNP	2 NPN—2 PNP

On Reader Service Card Circle 828

ECONOLINE★ PLASTIC TRANSISTORS

56 popular types, including the 2N4952 . . . the 2N2222 replacement that can cut your costs 40%. Write for new catalog CN200A.

★Trademark

On Reader Service Card Circle 829

*Available from Sprague Electric under technology interchange with Signetics Corp.

For complete technical data on any of these products, write to:

Technical Literature Service
Sprague Electric Company
509 Marshall Street
North Adams, Mass. 01247

SPRAGUE COMPONENTS

INTEGRATED CIRCUITS
THIN-FILM MICROCIRCUITS
TRANSISTORS
CAPACITORS
RESISTORS

PULSE TRANSFORMERS
INTERFERENCE FILTERS
PULSE-FORMING NETWORKS
TOROIDAL INDUCTORS
ELECTRIC WAVE FILTERS

CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
BOBBIN and TAPE WOUND MAGNETIC CORES
SILICON RECTIFIER GATE CONTROLS
FUNCTIONAL DIGITAL CIRCUITS

4SS-7111

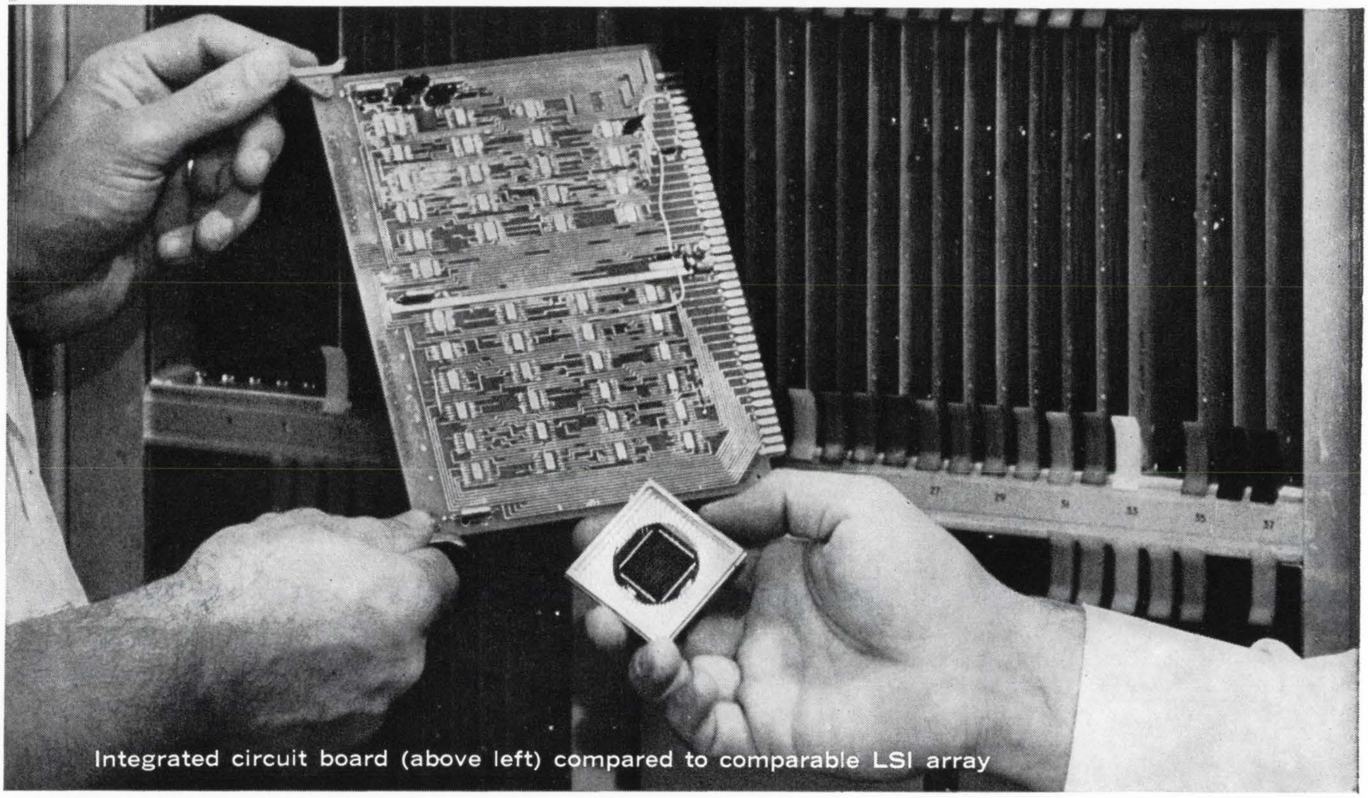
SPRAGUE®

THE MARK OF RELIABILITY

Sprague' and '②' are registered trademarks of the Sprague Electric Co.

Big opportunities.

Small packages: LSI



Integrated circuit board (above left) compared to comparable LSI array

From the transistor to LSI — quite a breakthrough. TI engineers don't rest on their laurels. TI-invented integrated circuits made possible an airborne computer as small as a portable television. A significant achievement. (Yesterday such a computer with discrete components would fill a room). IC techniques are now revolutionizing solid-state radar by eliminating moving parts and high power sources. And this is just the beginning.

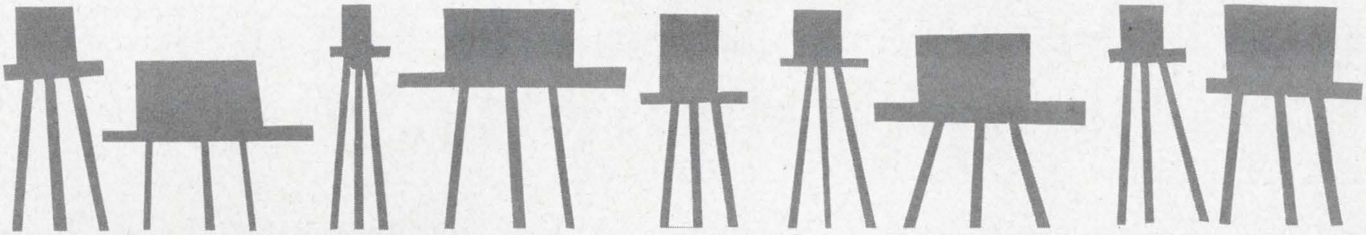
Today, with LSI (large-scale integration of component functions), TI scientists are further reducing component densities several hundred times greater than with IC's. What's next may be up to you.

If you're an engineer, chemist or physicist with ideas for tomorrow, you'll find unique opportunities at TI for creative exploration into such areas as integrated circuits, radar and microwave, data processing systems, materials development, laser applications, and many other technologies. Your opportunities are as big as your ideas, even though our products may be small. Talk tomorrow with TI today. Send your confidential resume to Tom Dudley, Dept. C-497, P. O. Box 5474, Dallas, Texas 75222. *An equal opportunity employer.*

TEXAS INSTRUMENTS
INCORPORATED

ON READER-SERVICE CARD CIRCLE 92

Looking for a book on Semiconductors? Here's a shelf-full from Hayden:



TRANSISTORS FOR AUDIOFREQUENCY

Guy Fontaine

The companion volume to Fontaine's DIODES AND TRANSISTORS offers highly detailed treatment of the practical aspects of semiconductors in the audiofrequency range. The book provides thorough explanation of the parameters and characteristics furnished by the manufacturer, and their various applications in the design of an audiofrequency stage. #5641. 384 pages, illustrated, clothbound. $7.95

TRANSISTOR CIRCUITS IN ELECTRONICS

S. S. Hakim and R. Barrett

This indispensable sourcebook introduces the working principles of transistors in both amplifiers and oscillators, and linear and switching circuits. The book begins by discussing transistor characteristics and the functions performed by various types, then goes on to consider the transistor as a switch and to discuss regenerative switching circuits. In addition, the book shows how Boolean Algebra, the algebra of sets and binary arithmetic are applied in the study of computer and other logical circuits. #5034. 341 pages, illustrated, cloth. $9.50

DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS

Abraham I. Pressman

Here is a book that provides the design engineer with a firm grasp of the principles and practices. Primarily concerned with the design of computer building blocks using transistors, the book employs "worst case" design calculations throughout. Circuit analysis and all aspects of output wave forms are calculated by treating the transistor as a current switch. #0215. 328 pages, illustrated, cloth. $9.95

PRINCIPLES OF TRANSISTOR CIRCUITS

S. W. Amos

Keeping pace with this rapidly advancing field, the updated Third Edition offers fifty per cent more information than its distinguished predecessor. The book includes new material on dc stabilization of amplifiers by direct-coupled feedback, phase shift and Weinbridge oscillators, blocking oscillators and transistor sawtooth generators. New appendices of transistor parameters and transistor manufacturers add to the completeness of this definitive work. #5649. 293 pages, illustrated, cloth. $7.95

ELECTRONICS FOUR: SEMICONDUCTORS

This self-contained unit-volume from Hayden's new ELECTRONICS 1-7 course, Harry Mileaf, Editor-in-Chief, was designed to meet the requirements of modern technical education. From first response it will be a standard text in schools teaching electronics. With unparalleled 2-color illustrations, review, and reinforcement, it promotes a complete understanding of the theory, operation, design, and functions of semiconductors, providing a concise background in atomic and electron theory. Equally valid for classroom use or as a self-study text for technicians, engineers will find it valuable also for updating themselves and as a convenient reference. #5556. 118 pages, illustrated, paper. $3.45

MICROELECTRONIC DESIGN

Edited by Howard Bierman

Almost 90 authoritative discussions of all aspects of microelectronics have been selected from **Electronic Design** and organized into a compact, convenient, and comprehensive reference. Each topic has been approached in practical and useful terms to provide a working overview of the field. #5762, 312 pp., Illustrated, $11.50

DIODES AND TRANSISTORS

Guy Fontaine

Written to teach the language of semiconductors and its applications in all kinds of circuits, this popular work is divided into three comprehensive parts. The first section provides a thorough review of the principles underlying all semiconductor devices; section two covers diodes, the fundamental properties of point contact and PN junction diodes, plus an analysis of the performance characteristics of both; the balance of the book is devoted to transistors and gives a detailed presentation of all the parameters that could interest engineers. A final section deals with methods of designing circuits using transistors. #5500. 480 pages, illustrated, cloth. $7.95

TRANSISTOR AND DIODE NETWORK PROBLEMS AND SOLUTIONS

Harry E. Stockman

This two-way reference demonstrates the practical application of theory and serves as sourcebook of step-by-step mathematical solutions to practical problems. With schematic situations covering the entire field of transistor and diode networks, the reader develops effective techniques by comparing his own solution methods with the author's. #5694, 332 pp., Illustrated, $9.95

TRANSISTOR BASICS: A SHORT COURSE

George C. Stanley, Jr.

For your own review, or for training technicians, here is a fast way to gain a practical understanding of transistors. Its simplified approach to transistor circuit analysis will enable the reader to determine desired values to an accuracy adequate for almost any practical situation. Includes material on working with and handling transistors and transistor troubleshooting techniques. #5819, 112 pp., Illustrated, $2.75

Examine these outstanding new books for 10 full days... with no obligation!

HAYDEN BOOK COMPANY, INC., 116 W. 14 St., New York, N.Y. 10011

Send me the books circled below for a free ten-day examination. At the end of that time I will remit payment (plus postage) for those I wish to keep and return the rest.

5649	5500	5034	5556	5819
5762	5641	0215	5694	

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________________ State ____________ Zip ________

☐ Check here if payment enclosed. Publisher pays postage with same return guarantee. (On all foreign orders except Canada, payment in $US must be enclosed.)

Check the 0-TC point in your FETs.

Experiments show that theoretical values of bias current for 0-TC are not accurate.

A zero-temperature-coefficient (0-TC) point that is inherently present in junction- and MOS-FETs is the devices' ideal operating point because no changes due to temperature take place there.

The theoretical explanation of this phenomenon is already well documented.[1,2,3,4,5] Experience shows, however, that theoretical expressions cannot be relied on for detailed circuit design. In fact, to use the 0-TC point in practical circuits, a designer must determine it for every FET type, and, quite often, for each FET of the same type.

The purpose of this article, then, is to describe the 0-TC measuring techniques, to present test data for several commercially available FETs, and to review briefly applications where the 0-TC point can be used advantageously.

Theoretical model may give imprecise results

The temperature variation of drain current in J-FETs is largely due to two opposing factors. The first is the change in width of the thermally generated depletion layer at the gate-channel junction. The second is the majority-carrier mobility between the source and drain.

In the references cited above it is shown that the first factor tends to increase the drain current at a rate equivalent to a change of 2.2 mV/°C at the gate. The second factor tends to decrease the gate current at a rate of approximately 0.7%/°C.

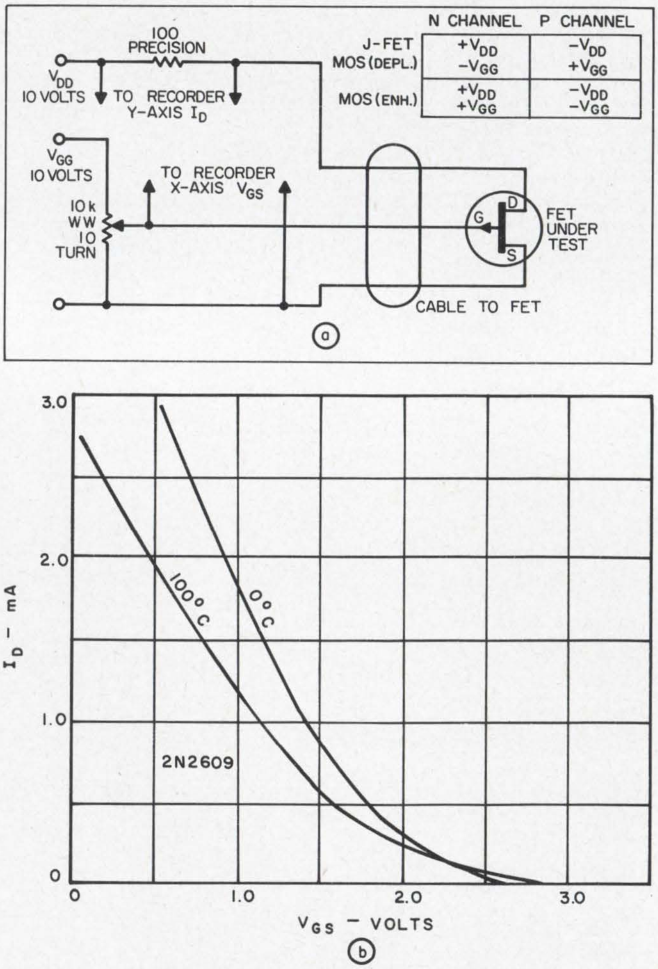
These two factors combined result in the following equations:[1]

$$I_{DZ}=0.4\,I_{DSS}/V_p^2=\textit{drain current for zero TC} \qquad (1)$$

$$V_{GSZ}=V_p-0.63=\textit{gate-source voltage for zero TC} \qquad (2)$$

These equations, having been developed from a theoretical model, often do not give correct results in practice. The semiconductor doping and diffusion account for most of the differences between the actual and theoretical results. Of the two foregoing equations, the first is the more meaningful because the result, I_{DZ}, is independent of the drain-to-source voltage. V_{GSZ}, on the other hand, is dependent on the drain-to-source voltage, a variable known only in the final circuit configuration.

From practical considerations, therefore, the best way to establish the 0-TC point is experimentally. I_{DZ}, being a unique value, should be determined first. A second test should then be performed to determine V_{GSZ} at I_{DZ} and the proper drain-to-source voltage. The 0-TC point can be determined easily by making a plot of V_{GS} vs I_D for various temperatures, using the circuit shown in Fig. 1a. The equipment needed is an X-Y recorder, two



1. **0-TC point of a FET** can be quickly determined using a simple test setup (a). A sample curve (b) has been obtained for the 2N2609 FET.

Thomas H. Lynch, Systems Engineer, Perkin Elmer Aerospace Systems, Pomona, Calif.

low-voltage dc supplies, and an environmental oven. A ten-turn potentiometer is used to control the gate-to-source voltage so that a smooth curve is produced on the X-Y recorder. A sample V_{GS}-vs-I_D plot of a p-channel FET is shown in Fig. 1b. In lieu of using an oven, a simpler and possibly quicker method would be the use of ice water and boiling water. This method would produce both an accurate temperature reference and a very good heat sink.

It is frequently impractical to bias the FET at exactly I_{DZ}. In order to determine the temperature drift errors at other drain currents, a plot similar to that of Fig. 2 can be used. It was developed by determining graphically the drift at various drain currents with the V_{GS}-vs-I_D plot of Fig. 1b. It can be seen that for moderate drift requirements (less than 1 mV/°C) the J-FET is well behaved over a wide range of currents.

A large spread in I_{DZ} values often occurs from one sample to the next of a particular type of J-FET. This is a result of the many device conditions that affect I_{DZ}. When production requirements necessitate a specific I_{DZ}, the J-FETs can usually be specially ordered from a manufacturer.

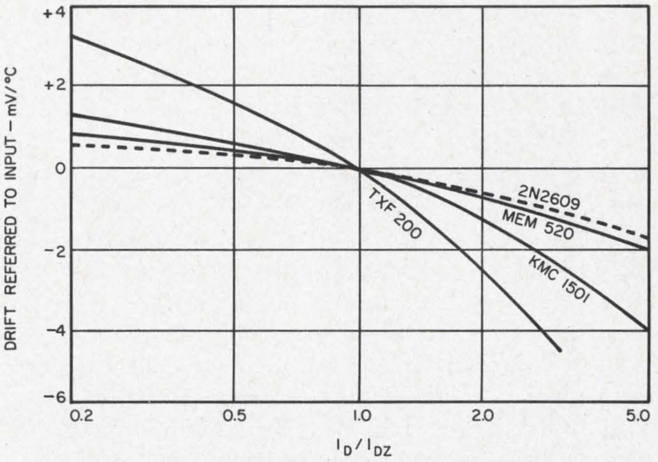
MOS-FET characteristics are hard to determine

The temperature dependence of MOS-FET characteristics is much more difficult to define than that of J-FETs'. For this reason, an easily handled mathematical model has not as yet been developed. One of the most difficult factors to control in MOS-FET fabrication is the interface structure between the silicon drain-source channel and the silicon dioxide gate insulator. Large changes in the surface properties of the transistor are to be expected as a result of variations in cooling rate, in atmospheric purity, and in general cleanliness during the formation of the gate insulator.

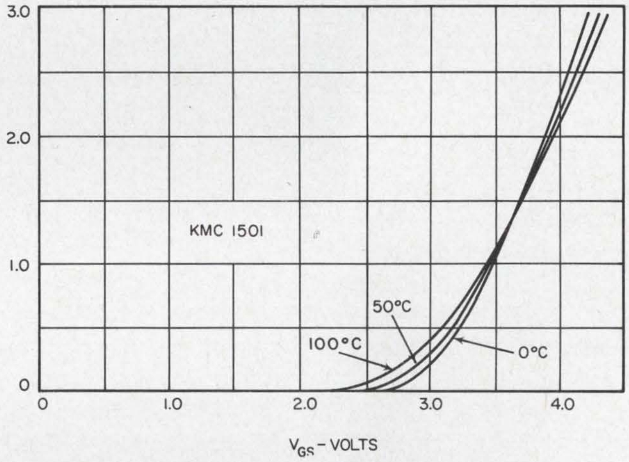
A theoretical explanation of the temperature-dependent properties can, however, be made.[2] It can be theorized that there is a particular drain current for which a 0-TC exists. But in practice, this drain current, I_{DZ}, is impossible to predict and requires experimental determination.

The same method outlined for J-FETs can be used to determine the 0-TC point of MOS-FETs experimentally. Fig. 3 shows the results of a temperature-dependent V_{GS}-vs-I_D plot for a p-channel enhancement-mode MOS-FET. For a closer analysis of the 0-TC point, it is advantageous to use zero suppression in the X-Y recorder. This quickly demonstrates nonlinearities (Fig. 4).

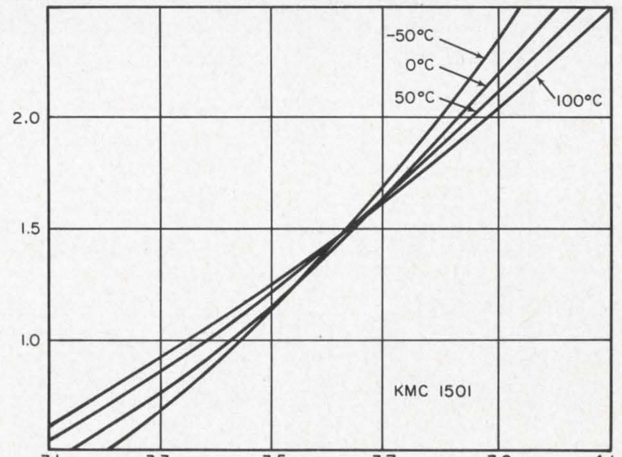
One problem seldom admitted, yet sometimes encountered, is sodium ion drift.[3] This can complicate the search for a 0-TC point because the gate voltage may not be a true indication of drain current. The ion drift rate is very temperature-



2. **Maximum allowable drift** for condition when a FET must be biased at an I_D different from I_{DZ} can be determined from the data of Fig. 1b. Devices of four manufacturers were used for this photo.



3. **MOS-FETs also possess a 0-TC point,** as can be seen from the plot above. Yet it is more difficult to predict and may vary from unit to unit. The existing theoretical models are not accurate.



4. **A blown-up view of the 0-TC** shown in Fig. 3, obtained through zero suppression in the X-Y recorder, demonstrates the nonlinearities in the V_{GS}-vs-I_D plot. Note the large variations in I_D.

dependent. At 100°C the mobility of sodium ions through the silicon dioxide gate insulator is many times greater than at room temperature. The magnitude of the drift is vividly portrayed in Fig. 5, a plot of the drain current versus time. This defect is present in varying degrees in all MOS-FETs presently manufactured and depends on the purity of the manufacturing conditions. The problem can be alleviated by first making the V_{GS}-vs-I_D plot at the highest temperature after the drift has gone to its limit under biased conditions; then, while maintaining the gate bias voltage, cooling the device down for its lower-temperature runs. The result will be a true indication of I_{DZ} alone, if a significant drift is present.

Most MOS-FETs that were tested possessed a 0-TC point. Several units checked are listed below with their approximate I_{DZ}:

Sprague	TXF200	50 μA
Fairchild	FI100	100 μA
General	MEM520	0.5 mA
Instrument	MEM551	0.5 mA
KMC	1501	1.5 mA
TRW	2N4308	2.5 mA
Siliconix	2N3631	4.0 mA

Because of variations in the manufacturing conditions, however, these approximate values must not be relied on as constant.

MOS-FETs, as a rule, will not perform as well as J-FETs under wide ranges of temperature because of the complex temperature compensation present at the 0-TC point. Of the types tested, the General Instrument MEM520, MEM 551 and the KMC 1501 exhibited the most stable 0-TC point over a temperature range of 0°C to 100°C.

Where to use FETs

J-FETs offer the widest latitude in design because of the diversity of the types available. Since the transconductance, g_m, of a FET is proportional to the drain current, high gain in conventional circuitry requires the J-FET's I_{DZ} to be near its I_{DSS}. From Eq. 2, V_p must be about 0.63 volt if I_{DZ} is to equal I_{DSS}. Devices such as the Union Carbide 2N3687 and 2N3698 satisfy this requirement. Equation 1 shows that low I_{DZ} operation can be obtained from J-FETs that have a V_p of 4 to 6 volts. However, the stage gain will suffer unless techniques like that shown in Fig. 6 are used. In this application, a constant-current load at I_{DZ} is used to give the highest possible stage gain. A temperature-compensated power supply regulator combination (*Q1* and *CR1*) and *R1* comprise the current source. The composite stage gain can easily exceed several thousand.

The use of MOS-FETs in dc amplifiers, because of the difficulties involved, is usually limited to high-input-impedance applications. The small number of different types available often limits the circuit design. Some of the problems that have to be considered are:

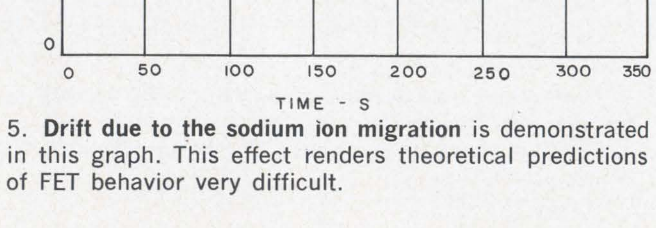
- The unpredictability of the 0-TC point.
- The 0-TC point variability with the temperature range.
- Gate voltage drift due to ion migration.

It is therefore necessary to design the circuit around the device once the MOS-FET's limitations have been thoroughly investigated.

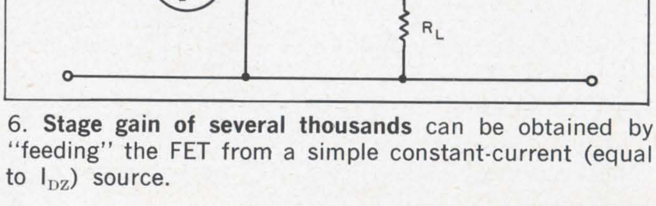
Large-swing open-loop dc amplifiers should be avoided. This is to prevent drift errors when a signal causes operation at a point far removed from the I_{DZ} value. The magnitude of this drift error can be calculated with a curve similar to those in Fig. 2. The effects of drift can be reduced by limiting 0-TC biased FET stages to low signal levels or by going to closed-loop operation. Closed-loop amplifiers are the best approach since they have the advantage of reducing the drift error by the loop gain.

FETs for amplifiers and current sources

The FET version of the differential amplifier poses a problem (absent with transistors) because



5. **Drift due to the sodium ion migration** is demonstrated in this graph. This effect renders theoretical predictions of FET behavior very difficult.

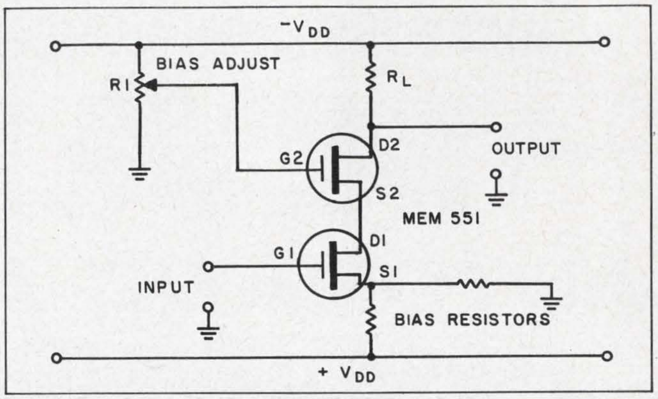


6. **Stage gain of several thousands** can be obtained by "feeding" the FET from a simple constant-current (equal to I_{DZ}) source.

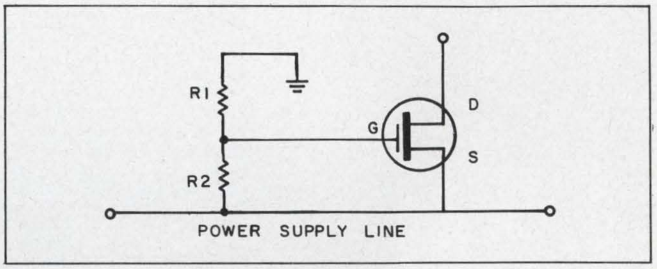
of the 0-TC point. When a dc signal is applied to a 0-TC biased differential FET stage, differential drift errors will occur. These drift errors, which appear only when a signal is applied, are caused by one FET operating above, and the other operating below, the 0-TC bias point. To reduce dynamic-differential drift errors, the bias points should be a little below the 0-TC values, depending on the signal swing. This can be deduced from an analysis of the curves of Fig. 2. If high input impedances are not required, a good differential transistor such as the 2N4044 should be used instead of a FET.

It has been implied that the operating point of a FET preceding a transistor can be adjusted to compensate for the drift in the transistor. A circuit of this nature should not be designed for production-line fabrication, however, because of the setup time required. Each circuit has to be individually trimmed to minimize drift, since drift rates of the FET and transistor vary from unit to unit.

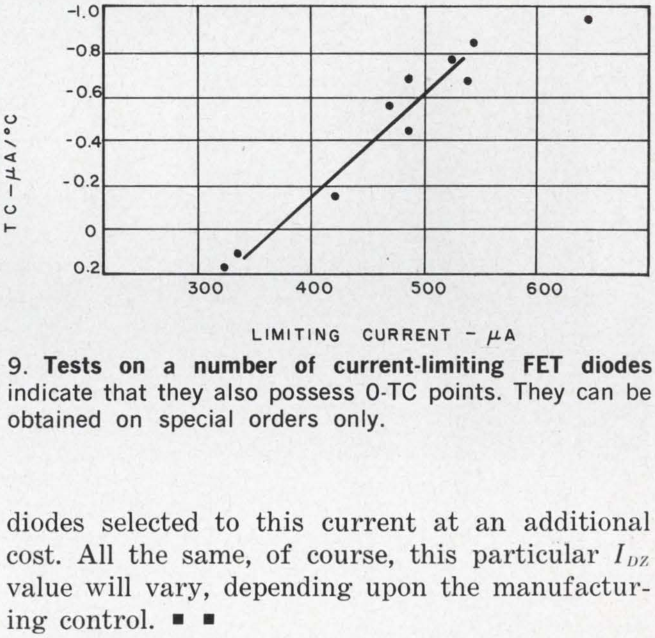
MOS-FETs can easily be adapted for use in a dc-coupled cascode amplifier. Because of the compound connection, both MOS-FETs should have nearly the same 0-TC point. Rather than match two units that have the same 0-TC point, use a dual-monolithic MOS-FET. Tests were performed on a General Instrument MEM551 dual unit to verify the similarity between the 0-TC points of each MOS-FET. On the whole, they were virtually identical. When properly biased in the circuit, as shown in Fig. 7, the result is an exceptionally stable dc-input amplifier.



7. **Stable single-ended dc amplifier** results when a dual MOS-FET unit is used.



8. **Enhancement-mode MOS-FET** can be used to build a simple constant-current source.



9. **Tests on a number of current-limiting FET diodes** indicate that they also possess 0-TC points. They can be obtained on special orders only.

Due to the constant-current nature of FETs in the pinch-off region, they lend themselves to use as simple current sources. When using J-FETs for this application, a low V_p is desirable. This will minimize the voltage drop for current-limiting in the circuit of Fig. 7. *R1* can be adjusted to produce the I_{DZ} current. Enhancement-mode MOS-FETs make simple current sources in the circuit of Fig. 8. The ratio of *R1* and *R2* can be adjusted to give the proper current level. The big advantage of FET current sources over conventional transistor-Zener combinations is their low minimum voltage drop for current-limiting.

Motorola is producing a series of current-limiting diodes (type number MCL 1300) that are actually J-FETs with gate and source shorted. When FETs are used in this configuration, I_{DSS} current is limited. If these current-limiting diodes are to have a 0-TC current level, the J-FET used must have a V_p of about 0.63 volt. Since no data on temperature stability were supplied, tests were run on enough diodes to verify the possible existence of I_{DZ} current level. The results, shown in Fig. 9, indicate that the I_{DZ} current level exists at approximaely 0.37 mA. Motorola can supply diodes selected to this current at an additional cost. All the same, of course, this particular I_{DZ} value will vary, depending upon the manufacturing control. ■ ■

References:

1. James S. Sherwin, "The Fet as an Amplifier," *1966 WESCON Convention Record* (New York: IEEE, 1966), Session 11/2.

2. F. P. Heiman and H. S. Miller, "Temperature Dependence of n-Type MOS Transistors," *IEEE Trans. on Electron Devices*, Vol. ED-12, No. 3 (March, 1965), 142.

3. A. S. Grove, P. Lamond *et al.*, "Stable MOS Transistors," *Electro Technology*, LXXVI, No. 6 (Dec., 1965), 40.

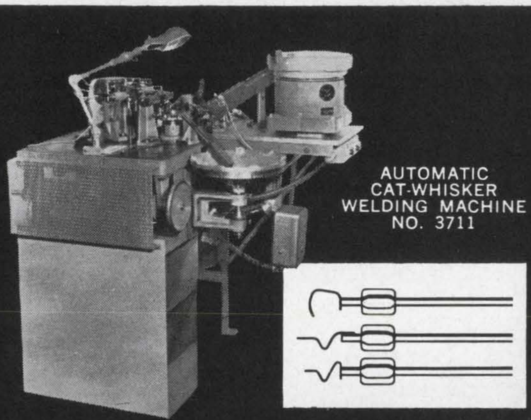
4. Lee L. Evans, "Biasing FETs for Zero dc Drift," *Electro Technology*, LXXIV, No. 2 (Aug., 1964).

5. James S. Sherwin, "Take the Fog out of Field-Effect Design," ELECTRONIC DESIGN, XIV, No. 13 (May 24, 1966), 38-44; "Gain Insight into FET Amplifiers," *Op. cit.*, No. 14 (June 7, 1966), 40-45; "Simplify Low Frequency FET Designs," *Op. cit.*, No. 15 (June 21, 1966), 86-90.

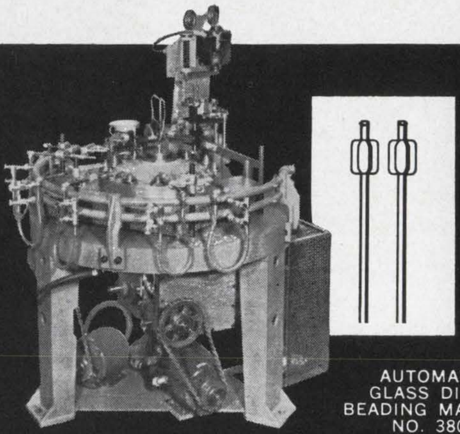
Increase Production...Lower Your Costs!

—with KAHLE

AUTOMATIC ASSEMBLY and PRODUCTION MACHINES



AUTOMATIC
CAT-WHISKER
WELDING MACHINE
NO. 3711

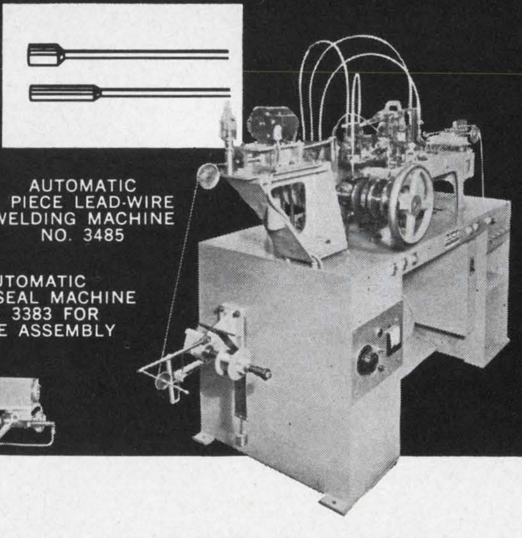


AUTOMATIC
GLASS DIODE
BEADING MACHINE
NO. 3808

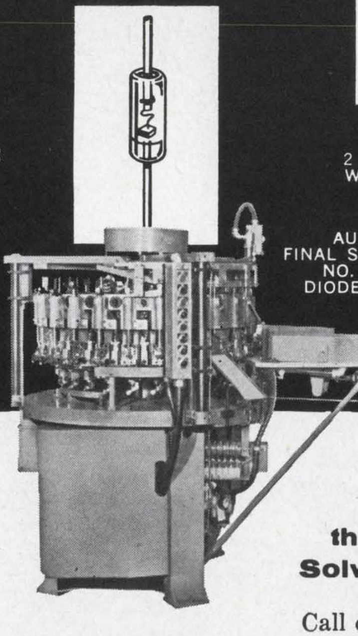
Complete Design,
Development and
Machine Building
Services on
Precision Equipment
for —

CRYSTAL DIODES:

- TUBE CUTTING
- LEAD BEADING
- CRYSTAL GROWING
- CRYSTAL REFINING
- CRYSTAL MOUNTING
- BODY FORMING
- WELDING



AUTOMATIC
2 PIECE LEAD-WIRE
WELDING MACHINE
NO. 3485



AUTOMATIC
FINAL SEAL MACHINE
NO. 3383 FOR
DIODE ASSEMBLY

TRANSISTORS:

- HEADER FORMING
- CRYSTAL MOUNTING
- WELDING
- EXHAUSTING
- SEALING

— and other production operations

KAHLE Engineers have the Experience and Facilities to Solve Your Production Problems!

Call or write KAHLE for recommendations on your specific electronic and related manufacturing operations. KAHLE Automatic assembly and production machines are in use by hundreds of leading manufacturers where they have earned an industry-wide reputation for high efficiency and dependable performance!

KAHLE
ENGINEERING COMPANY

3332 HUDSON AVE., UNION CITY, N. J. 07087
Telephone: UNion 7-6500 (Area Code 201)
EUROPEA S.p.A.—Via Spartaco, 16, Caravaggio (Bergamo), Italy

DESIGNERS AND BUILDERS OF AUTOMATIC ASSEMBLY AND PRODUCTION MACHINES FOR ELECTRONICS MANUFACTURING

ON READER-SERVICE CARD CIRCLE 94

Name your failure rate

this G-E sealed relay will give it to you

But you have to let us establish:

- level of confidence
- operating conditions
- what constitutes a failure

By varying these conditions, we can give you any failure rate you want.

Doesn't make sense, does it? You're supposed to set the conditions. Not us.

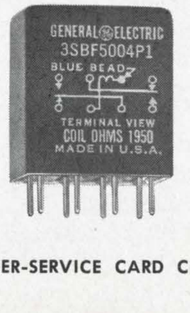
That's why we don't establish failure rates till you give us application information.

If we did, we'd hurt you. And us.

You, because you might buy the wrong relay.

Us, because we might hurt our reputation and lose you—a valued customer.

Want realistic failure rate data and the best relay for your next project? Contact your G-E Electronic Components Sales Engineer. Or for latest catalog information, write General Electric Company, Section 792-40, Schenectady, New York 12305.



GENERAL ELECTRIC

ON READER-SERVICE CARD CIRCLE 95

Stagger-tune the IC amplifier stages

in an IF or RF strip design. It will have just the right gain and selectivity curve.

Stagger tuning—tuning each stage of an amplifier at slightly different frequencies—can achieve:

- A gain-bandwidth product greater than that of synchronously tuned cascade stages.
- A selectivity curve of prescribed response.

It is possible to stagger-tune *n* single stages to attain a flat band pass, an equal-ripple (Chebyshev) band pass, or many other selectivity curves with very good gain.[1]

The stagger-tuned circuit can be implemented with discrete transistors, but the availability of high-performance, integrated high-frequency amplifiers at prices comparable to those of single transistors offers an attractive alternative. One such amplifier, with characteristics that are particularly suited to stagger-tuned circuits, is the Motorola MC1550.*

The simplified schematic in Fig. 1 serves to explain the ac and dc operation of the MC1550. Considering dc operation first, voltage V_S and resistor R_S establish current I_{D1} in diode *D1*. Since this diode is on the same silicon die as transistor *Q1* and they are laid out very close to each other, the emitter current of *Q1* will be within 5% of the diode current. This biasing technique exploits the matching characteristics that are available with integrated circuits and illustrates a method that would be difficult to accomplish with discrete components but is easy with integrated circuits. The current established in the emitter of *Q1* will be shared between *Q2* and *Q3*, depending on the relationship between V_{agc} and V_R. Where V_{agc} is at least 114 mV greater than V_R, *Q3* is turned off and all the collector current of *Q2* is transferred to *Q1*. Since *Q3* is off, the ac gain will be at its minimum point. If, on the other hand, V_{agc} is less than V_R by 114 mV or more, all the collector current present in *Q1* will flow through *Q3*. This, then, is the operating point for maximum ac gain.

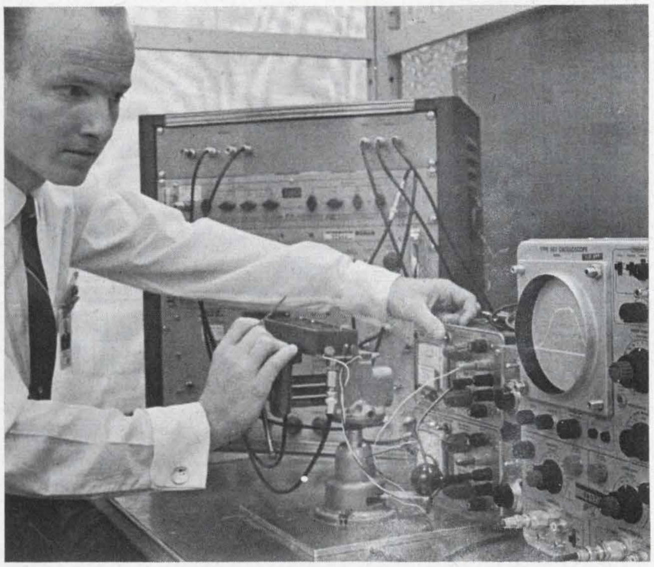
In ac operation, the input is applied to the base of *Q1* and the output taken from the collector of *Q3*. Thus, the combination of *Q1*-*Q3* acts as a common-emitter, common-base pair. This pair offers the distinct performance advantage of reducing internal feedback (y_{12}) two orders of magnitude in comparison with a single transistor. With a General Radio 1607-A immittance bridge, y_{12} was too small to measure up to frequencies of 300 MHz. This indicates that the magnitude of y_{12} is less than 0.001 mmhos over the useful frequencies of operation of the amplifier, and can, for all practical purposes, be neglected. This property of the integrated amplifier is particularly important to its tuning.

Basic two-port theory gives the expressions for input and output admittances of a discrete-component amplifier as:

$$Y_{in} = y_{11} - [y_{21} y_{12}/(y_{22} + Y_L)]; \quad (1)$$

$$Y_{out} = y_{22} - [y_{21} y_{12}/(y_{11} + Y_S)]. \quad (2)$$

Equations 1 and 2 show that a change in the load



Author Brent Welling checks the pass band of a stagger-tuned, integrated-circuit IF strip of his own design. The integrated-circuit amplifiers simplify final tuning.

*Similar integrated amplifiers are Fairchild's μA703C and RCA's CA3028.

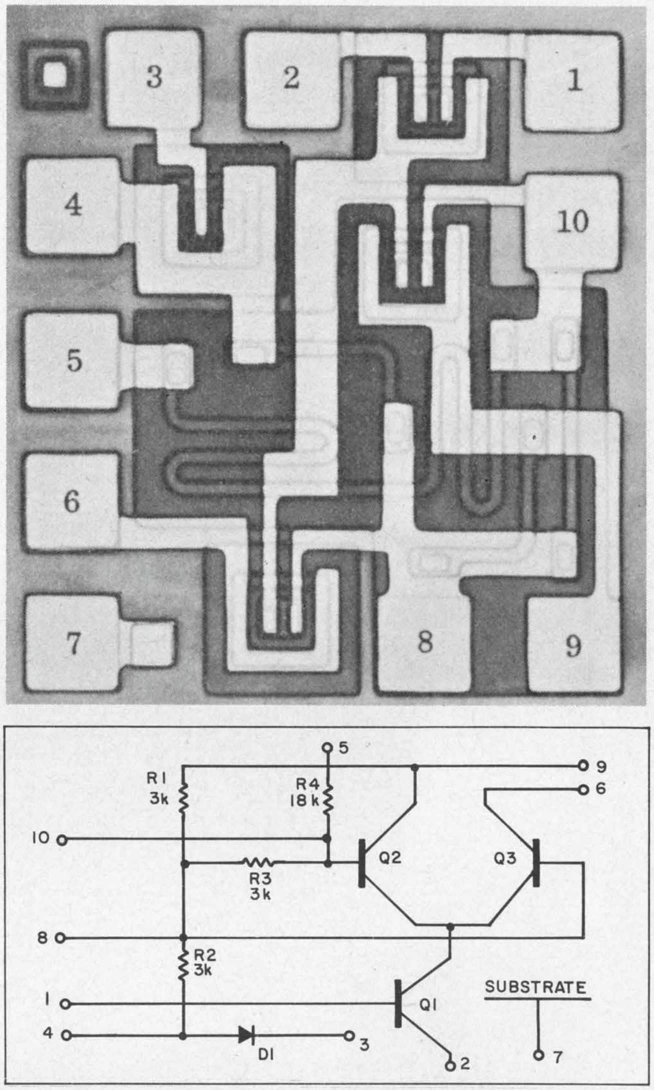
Brent Welling, IC Applications Engineer, Motorola Semiconductor Products, Inc., Phoenix, Ariz.

due to tuning of the output circuitry changes the input admittance and hence the input tuned circuit. The output tuned circuit is likewise changed when the input tuned circuitry is altered. As a result the input and outpot tuned circuitry must be alternately juggled until some degree of accuracy is obtained. With the integrated amplifier this is not the case. Since $y_{12} \approx 0$, Eqs. 1 and 2 above reduce to $Y_{in} \approx y_{11}$ and $Y_{out} \approx y_{22}$. Hence, the input and output admittances remain constant and each tuned circuit may be tuned individually with little effect on the other. This minimizes the time needed for tuning alignment.[2]

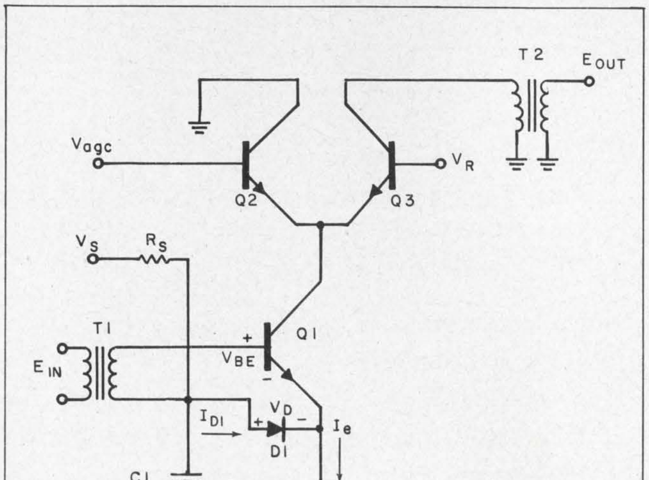
The gain of this circuit can be varied—a performance advantage over a single transistor. A dc analysis of the amplifier shows that for full agc operation the change in emitter current of transistor *Q1* (see Fig. 2) is very small ($\approx 2\%$). Because I_{e1} varies only slightly, the input impedance variation, which depends on $r_e = KT/qI_e$, is very small. As a result there is no detuning of the input circuitry with agc.

Figure 3 shows how the input resistance, R_{in}, and input capacitance, C_{in}, vary with applied agc voltage at 60 MHz when $V_{CC} = 6$ volts. As can be seen, the input impedance of the amplifier is relatively unaffected by variations in agc voltage.

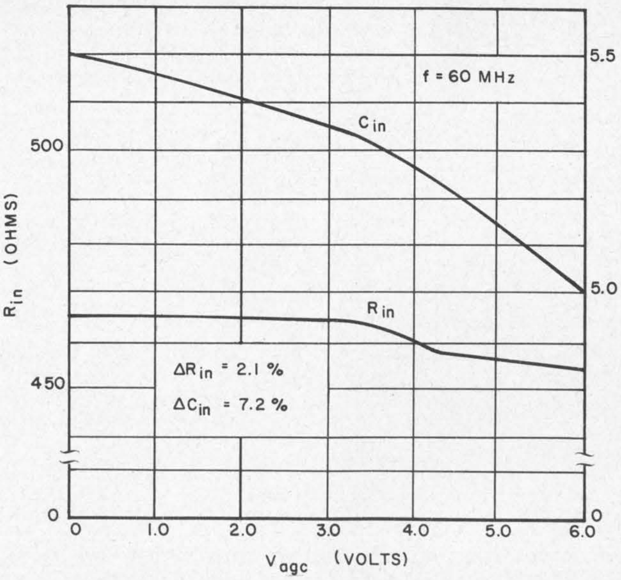
A schematic of the MC1550 amplifier including biasing resistors is shown in Fig. 2 with a picture of the monolithic die. The circuit is constructed on a 30-by-32-mil die using 200 ohm/square sheet resistance material and 1-by-0.5-mil emitters in the box geometry transistors. Resistors *R1* and *R2* bias the diode *D1* and also establish a base voltage for transistor *Q3*. Resistors *R3* and *R4* serve to widen the agc voltage range from 114 mV to about 0.86 volt. This is necessary if the agc line is to be less susceptible to external noise.



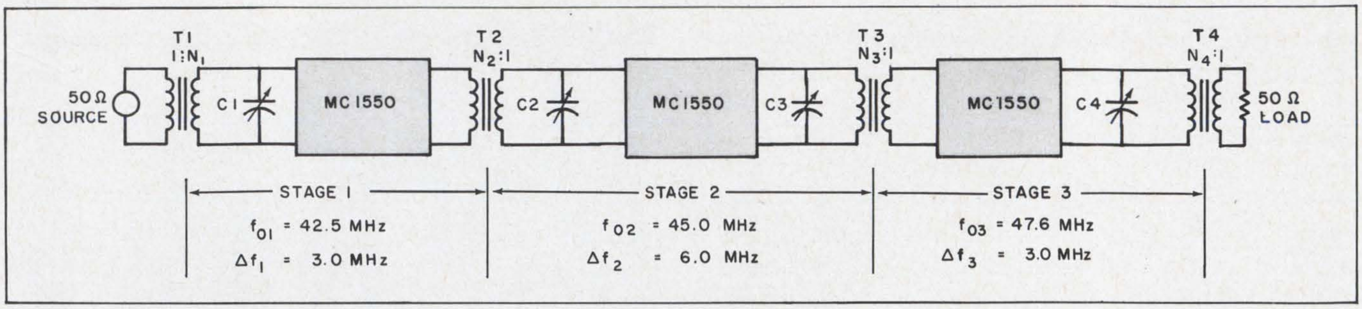
2. **Diode D1 lies right near transistor** Q1; hence, the emitter current and diode current are within 5% of each other. The matching characteristics obtainable with integrated amplifiers are hard to match with their discrete-circuit equivalents.



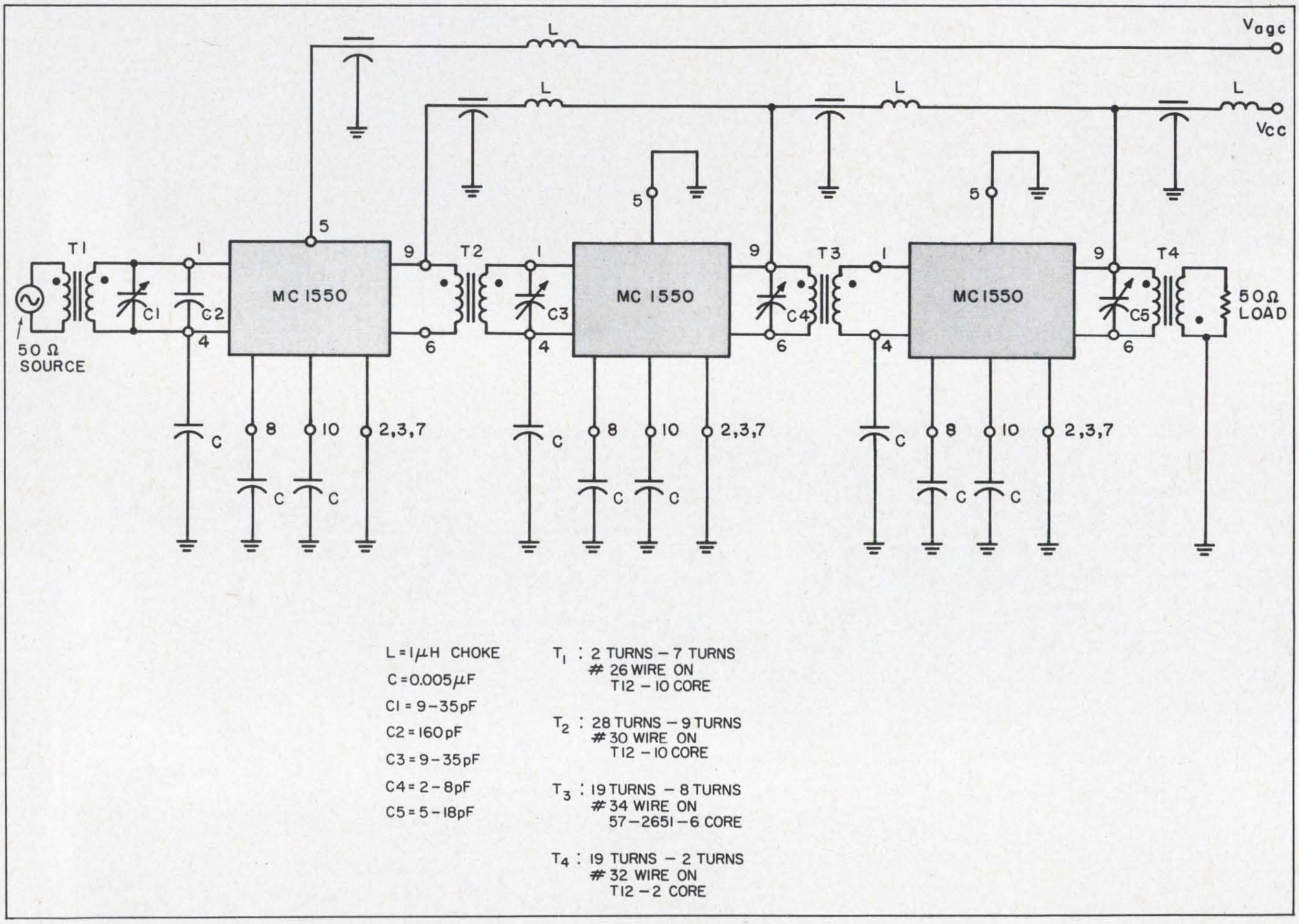
1. **This simplified schematic** shows how voltage V_{agc}, controls the gain of the amplifier by controlling the flow of current through Q3.



3. **Input impedance** $\mathbf{R_{in}}$ is relatively unaffected by changes in the agc voltage.



4. **This cascaded tuned amplifier** is for operation at a center frequency of 45 MHz with a 6-MHz bandwidth.



5. **Final schematic of the 45-MHz tuned amplifier** shows all pin connections and component values.

Design steps illustrate the technique

Consider the following hypothetical design for an IF amplifier:

Center frequency (f_0) = 45 MHz.
Bandwidth (Δf) = 6 MHz.
Power gain (G_T) = 70 dB.
Agc control > 50 dB.
Source impedance = 50 Ω.
Load impedance = 50 Ω.

A typical circuit for this application with transformer interstage coupling appears in Fig. 4. The individual stage requirements of this flat, staggered amplifier are as follows:[3]

One stage tuned to f_0 with bandwidth Δf.
One stage tuned to $f_0\,\alpha$ with $Q = 2.0/\delta$.
One stage tuned to f_0/α with $Q = 2.0/\delta$.
($\delta = \Delta f / f_0$ and $\alpha = 1 + 0.433\delta$)

With these amplifier specifications, the following results are obtained:

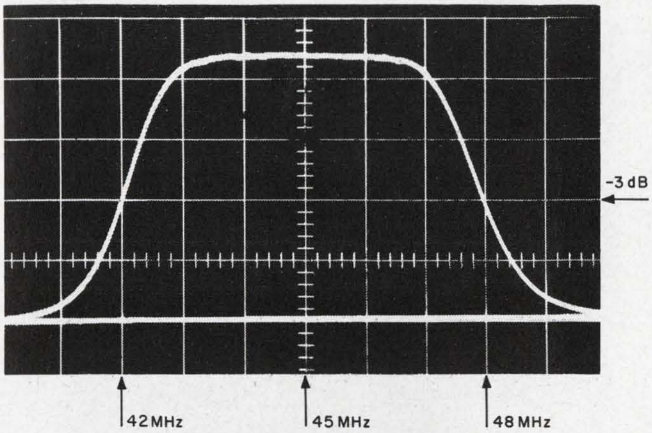
$\delta = 0.1333$ $\alpha = 1.0578$

One stage tuned to 45 MHz with a 6-MHz bandwidth.

One stage tuned to 47.60 MHz with a 3-MHz bandwidth.

One stage tuned to 42.50 MHz with a 3-MHz bandwidth.

There is nothing new or tricky involved in the



6. **Scope trace shows frequency response** of 45-MHz stagger-tuned circuit.

interstage design. The most expedient procedure is to assume that the coupling transformers are ideal, form equivalent models with one side of the transformer referred to the other side, then compute the band and center frequency from Eqs. 3 and 4 for the parallel tuned circuits:

$$\Delta f = 1/2\,\pi R_T\,C_T, \qquad (3)$$

$$f = 1/2\,\pi(L_T\,C_T)^{1/2}, \qquad (4)$$

where

R_T = total parallel resistance,
C_T = total parallel capacitance,
L_T = total parallel inductance.

Because there are two tuned circuits associated with each stage, there will, however, be an over-all bandwidth shrinkage of each stage. This is easily handled by broadbanding the output tuned circuit of stage 1 while achieving the desired selectivity and bandwidth with the input tuned circuit and vice versa with stage 3. The same procedure could be followed in the design of stage 2, broadbanding the output tuned circuit while achieving the desired bandwidth and selectivity with the input tuned circuit. In this particular instance, however, the procedure adopted was to tune synchronously both the input and the output circuits of stage 2 and take the shrinkage factor into account. A schematic of the final design showing all the pin connections is given in Fig. 5.

A first prototype circuit was tuned in the following manner. Each stage was disconnected from the other stages and loading applied to each stage to simulate the actual circuitry in cascade. Each stage was then tuned to the desired center frequency with the correct bandwidth. Once each stage was tuned, the circuits were connected in cascade and final fine tuning adjustments made. With the experience gained in tuning the first prototype, a second prototype was tuned merely by sweeping the amplifier with a Jerrold 890 sweep generator and tuning while observing the output on an oscilloscope. A photograph of the sweep is shown in Fig. 6. The final results were:

Agc voltage	Power gain dB	Center frequency MHz	Bandwidth MHz
0.0	70.0	45.0	6.0
0.5	70.0	45.0	6.0
1.0	70.0	45.0	6.0
1.5	70.2	45.0	6.0
2.0	70.2	45.0	6.0
2.5	63.5	45.0	5.9
3.0	58.4	45.0	5.8
3.5	46.1	45.0	5.8
4.0	28.7	45.0	5.8
4.5	6.2	45.0	5.7

7. **The agc voltage of the first stage** controls the gain of the strip without severely affecting the bandwidth.

Center frequency	= 45 MHz.
Bandwidth	= 6 MHz.
Power gain	= 70.0 dB.

The choice of which stage or stages to apply agc to is more or less arbitrary. Various agc combinations of the three stages were tried to study their effectiveness. With agc applied only to the first stage, 64 dB of agc control were obtained with a maximum deviation from flatness in the pass band of 0.7 dB. With agc applied to all three stages, 90 dB of agc control were obtained with a maximum deviation from flatness in the pass band of 1 dB. These represent the two extremes. When combinations of the three stages taken two at a time were tried, they all fell within this range. Thus, for the design specification, it was sufficient to apply agc only to the first stage. The variation of bandwidth and center frequency were measured and the results are given in Fig. 7. These data indicate a maximum of 5% bandwidth deviation occurring at the low-gain (maximum agc) condition, with full agc occurring over a 2.5-volt range. With an input of 50 μV rms, the output signal into 50 ohms is 156 mV with a noise level of 6.8 mV.

The results of this design strongly indicate that the MC1550, and similar integrated amplifiers, have good potential for use in both the RF and IF stages of television, radio, radar, and communications gear where high gain, wide agc, and low cost are of prime importance.

The use of an integrated-circuit, high-frequency amplifier has been considered only in a stagger-tuned IF strip with a design frequency of 45 MHz. The design and tuning procedure is similar, however, for designs throughout its full range of operation—dc to 300 MHz. ■ ■

References:

1. H. Wallman, *Stagger-Tuned IF Amplifiers* (MIT Radiation Laboratory Report 524, Feb., 1944).

2. Robertson-Welling, *An Integrated-Circuit RF-IF Amplifier* (Motorola Semiconductor Products, Inc., Application Note AN247).

3. D. G. Fink, *Television Engineering Handbook* (1st ed.; New York: McGraw-Hill Book Co., Inc., 1957).

sometimes the best things get taken for granted

ask your wife.

Ask Sprague Electric.

Our forty-year history of steady growth and diversification is based on the reliability and high quality of our components. Our customers tend to take these qualities for granted in Sprague Electric products, and we're proud of it.

Within Sprague Electric, however, establishing and maintaining this superiority isn't taken for granted. It requires exceptionally qualified research scientists, development engineers, technical managers and related personnel.

To attract and hold the career-long interest of these individuals, Sprague Electric has to be an exceptional organization. It is.

Our research and engineering activities employ more than 600 people.

We have an unblemished record of employment stability, together with an engineering turnover rate that is perhaps the lowest in the industry.

We are one of the nation's largest, most diversified and fastest-growing manufacturers of electronic components, with 25 plants in the U.S. (including a new 130,000 sq. ft. microelectronics facility in Worcester, Mass. and a new facility to be constructed in Wichita Falls, Texas).

Have you been taking Sprague Electric for granted?

Opportunities exist for the following:

ELECTRICAL/ELECTRONIC ENGINEERS

Solid State Circuit Product Development • Digital Circuit Design • Pulse Forming Networks • Component Test Equipment Design • Integrated Circuit Design • Component Q.C. • Linear Circuits Design • Microcircuits Development • Manufacturing Engineering • Interference Control • Instrumentation • Miniature High Voltage Fabrication • Regulator Design • Semiconductor Reliability • Product Marketing • Magnetic Components Design • Electrical Standards Engineering • QAR Engineering • Integrated Circuits • Production Engineering •

CHEMISTS/PHYSICISTS/CHEMICAL ENGINEERS

Paper, Film, Ceramic, Electrolytic or Tantalum Capacitor Development • Microcircuit Product and Process Development • Organic Finishes and Molding Compounds • Hybrid Microcircuit Process Formulation • Electronic Component Process Development • Pilot Plant Supervision • Evaporation Techniques • Materials Processing Engineering •

MECHANICAL/INDUSTRIAL ENGINEERS

Automatic and Semi-Automatic Manufacturing Equipment Design • MIL SPEC Electronics Assembly Production • Materials, Methods and Processes Engineering • Machine Design • Production Control (Manager) • QAR Engineering • Capacitor Production Equipment Planning •

For prompt consideration of your qualifications, forward your resume to Mr. John Miller, Corporate Manager Recruitment and Staffing, Sprague Electric Company, 1025 Marshall Street, North Adams, Massachusetts 01247.

An equal opportunity employer.

SPRAGUE ELECTRIC COMPANY

SPRAGUE®
THE MARK OF RELIABILITY

ON READER-SERVICE CARD CIRCLE CAREER NUMBER 901

MOS-FET and bipolar form RC phase-shift oscillator

An RC phase-shift oscillator which effectively exploits the unique characteristics of bipolar and MOS transistors is shown in the figure. This circuit configuration has several distinct advantages over other phase-shift oscillators.

The feedback network is a three-section, low-pass filter. This simultaneously provides a dc bias path for the MOS transistor and an ac phase-shift network. Because of the extremely high input impedance of the MOS transistor and the low output impedance of the bipolar transistor, the filter is subjected to near ideal drive and load conditions, thus simplifying design calculations. Large resistors may be used, making very low-frequency operation practical without the necessity of large capacitors.

Thus the circuit is simple to design, uses few components, and is suitable for a wide range of frequencies.

R_L controls the total loop gain and should be adjusted for best output waveform. Once set, the oscillator is very stable because of its "self-bias" arrangement. The choice of a low-pass feedback network results in improved harmonic rejection. If the output is taken by another MOS-FET to prevent loading, an exceptionally pure sine wave can be obtained.

The output dc level is approximately $V_{CC} - V_{Gth}$. For identical RC sections the frequency of oscillation is:

$$f_0 = 1/(2\pi 6^{1/2} RC).$$

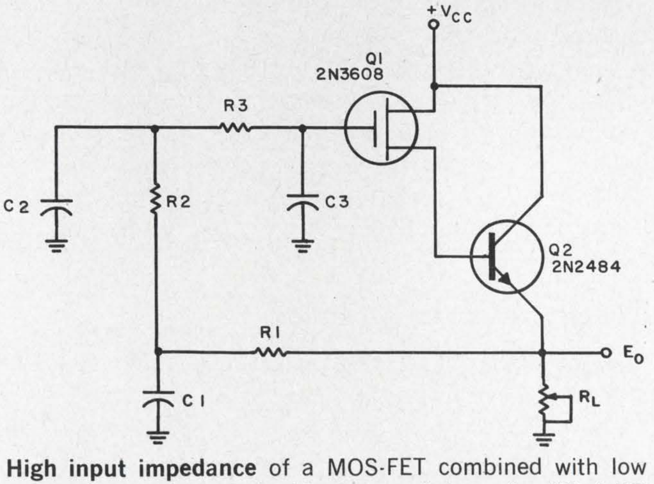
If the time constant of each section is the same, but $R3 >> R2 >> R1$ and $C1 >> C2 >> C3$, each stage will contribute very close to 60° of phase shift and the frequency of oscillation is:

$$f_0 = 3^{1/2}/(2\pi RC),$$

where RC is any filter section.

Charles R. Bond, Design Engineer, Electromec Design and Development Co., Santa Clara, Calif.

VOTE FOR 110



High input impedance of a MOS-FET combined with low output impedance of the bipolar result in a simplified RC phase-shift oscillator.

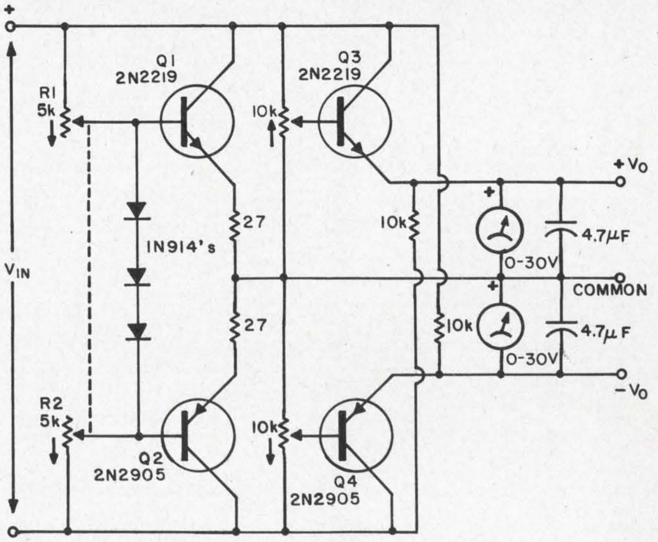
VOTE! Circle the Reader-Service-Card number corresponding to what you think is the best Idea-for-Design in this issue.

SEND US YOUR IDEAS FOR DESIGN. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component, or a cost-saving design tip to our Ideas-for-Design editor. If your idea is published, you will receive $20 and become eligible for an additional $30 (awarded for the best-of-issue Idea) and the grand prize of $1000 for the Idea of the Year.

One power supply does the work of two

A common problem in a development laboratory is that of keeping several bench power supplies available. Most circuit development work requires at least two different supply voltages, but an engineer will all too often find only one power supply.

The circuit shows a "little black box" that can be plugged into a single, ungrounded power supply to furnish both a positive and a negative



Negative and positive voltages can be obtained from one power supply with the circuit shown.

voltage, each individually adjustable. The dual control, *R1* and *R2*, together with dual emitter follower *Q1* and *Q2*, sets the ratio of maximum available positive to negative outputs. The other two potentiometers, with their emitter followers, allow individual control of the positive and negative outputs.

If the input voltage is varied, both outputs will vary by approximately the same percentage, thus simplifying certain circuit tests. The values shown were selected to allow an input voltage of up to 40 volts. Maximum output current depends on the setting of the controls, but may be up to 50 mA.

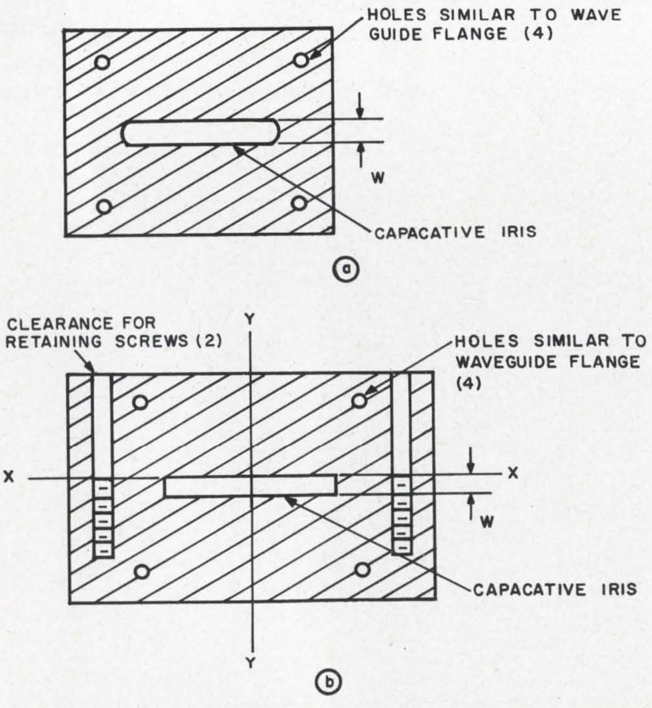
Acknowledgment:
This work was performed under the auspices of the U.S. Atomic Energy Commission.

Curtis Sewell, Jr., Electronic Engineer, Lawrence Radiation Laboratory, Livermore, Calif.

VOTE FOR 111

Modified capacitive iris provides design flexibility

The capacitive iris is a transverse shunt discontinuity in rectangular waveguides that is occasonally used in certain impedance matching and filter design problems. This iris is usually described quantitatively by a normalized susceptance. In standard construction (see Fig. 1a), larger values of normalized susceptance can be realized by decreasing the iris width, *W*. This can become quite difficult when large values of normalized susceptance are desired.



1. **Increased susceptance** is possible when a standard capacitive iris (a) is made out of two pieces (b). This allows greater flexibility in machining the opening.

In a standard X-band waveguide (RG-52/U), a 0.031-inch iris width (with rounded corners) with a 0.031-inch iris thickness provides a measured normalized susceptance of only 3.0 at 9.0 GHz. This can be increased to 8.5 by increasing the iris thickness to 0.187 inch. Further increases in iris thickness are usually not desirable for a simple shunt susceptance. Further decreases in iris width are not feasible, because end mill cutters smaller than 0.031 inch are not available.

Use of the thick iris (0.187-inch thickness) makes possible iris widths smaller than 0.031 inch by constructing the iris from two pieces. This modified iris (see Fig. 1b) consists of two pieces joined together at plane *X-X* by two retaining screws. With a 0.187-inch iris thickness, No. 4-40 retaining screws can be used. A standard 1/16-inch end mill cutter can be used to cut irises of any width (with square corners) in the lower piece prior to assembly. In the RD-52/U waveguide, at 9.0 GHz, the following data were obtained for the modified thick irises:

Iris Width (Inches)	Normalized Susceptance
0.020	12
0.010	19
0.005	40

Another advantage of the thick iris is the possibility of providing a means to adjust the normalized susceptance of the iris. For the RG-52/U waveguide and an iris thickness of 0.187 inch, a No. 4-40 capacitive trimming screw can be used at plane *Y-Y* parallel to the retaining screws. At 9.0 GHz, with an iris width of 0.031 inch, a 0.025-inch insertion of the trimming screw increased the normalized susceptance from 8.5 to 11.0.

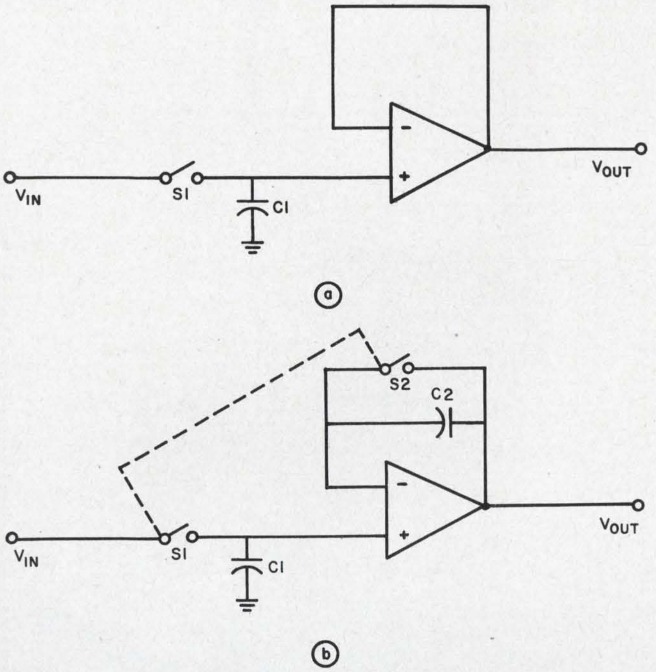
Richard M. Kurzrok, Consulting Engineer, New York. (Work performed while the author was employed at the Advanced Communications Laboratory, Radio Corporation of America, New York.)

VOTE FOR 112

Capacitor improves sample-and-hold circuit

Conventional sample-and-hold circuits using operational amplifiers have the general form of Fig. 1a. The voltage to be held is sampled through switch *S1* and stored on capacitor *C1*. The amplifier functions as a high-input-impedance, unity-gain buffer between the voltage on the capacitor and the outside world. The charge on the storage capacitor leaks off at a rate determined by the amplifier input bias current and the shunt resistance to ground.

The addition of capacitor *C2*, equal to *C1*,



Marked improvement in voltage-holding ability of a sample-and-hold circuit is possible when a capacitor is added (b) to the conventional circuit (a).

between the output and the inverting input of the amplifier (see Fig. 1b) improves the decay time of the circuit by better than a factor of ten. The circuit operates as before, except that leakage across *C1* is now compensated for by an equivalent leakage across *C2* such that the output voltage remains almost constant, depending on the degree of match between the two input bias currents and the capacitors. The output drift can even be adjusted to zero by trimming one of the capacitors to compensate for the small difference in bias currents.

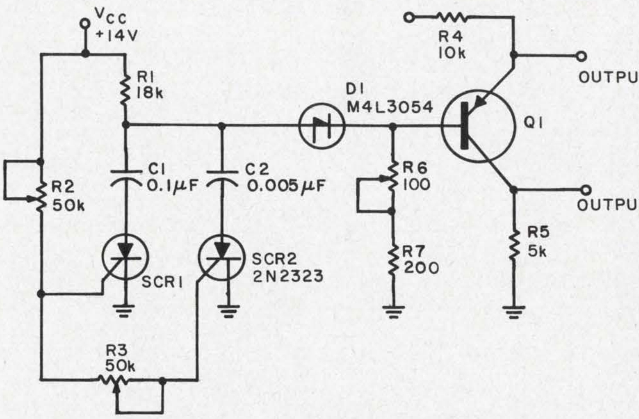
J. N. Giles, Fairchild Semiconductor, Mountain View, Calif.

VOTE FOR 113

A four-layer diode forms double-pulse generator

A combination of a four-layer diode and two SCRs can be used to form a single, double, triple or even burst pulse generator.

This circuit (see figure) performs all these functions with a minimum of components. The cost of this unit is low and the stability is quite high. *R1* and *C1, C2* are RC time constants selected by the gating of *SCR1* or *SCR2* to ground. *R2* and *R3* are the gate threshold controls. *R3* is used primarily to effect the mode change of the generator (single, double, triple pulse). *R6* controls the pulse width of the unit by changing the discharge time of the selected RC component through *D1*. *R7* functions as a current limiter for



Versatile pulse generator can be built quickly with the few components shown above.

D1. *Q1* serves as an isolation stage and an inverter.

R3 is adjusted for maximum resistance. *R2* is adjusted for single pulse. *R3* is adjusted for double- or triple-pulse groups. If the range of *R3* is increased, double pulse with a 4-μs delay adjust can be made. The circuit develops 5-volt pulses with a rise time of 200 ns. The cost is about $20.00. The frequencies available are approximately 400 Hz to 15 kHz.

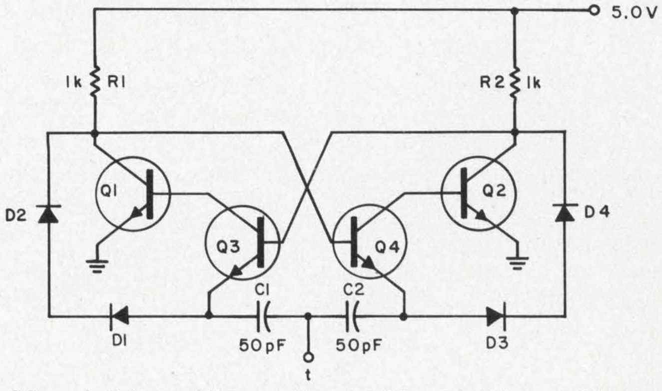
Gerald Lawson, PRD Electronics, Inc., Jericho, N. Y.

VOTE FOR 114

Simple trigger circuit controls flip-flop

This circuit uses transistors *Q3* and *Q4* to provide coupling to *Q1* and *Q2* of the flip-flop and to trigger the flip-flop.

Prior to a trigger pulse, the circuit is stable with *Q1* on and *Q2* off, or vice versa. *Q1* is held on with base drive current from *R2* and the forward-biased collector-base diode of *Q3*. With *Q1* saturated, *Q4* and *Q2* are held off. On arrival of a positive trigger pulse, *C1* charges through *D1*, *D2*



Q3 and Q4 provide coupling to Q1 and Q2 and trigger the flip-flop.

and *Q1*. As the trigger pulse falls back to zero, the potential at the emitter of *Q3* goes negative, which forward-biases the emitter-base diode and pulls the collector down to a saturation voltage. This has the effect of removing base charge from *Q1*, thus turning it off. The current through *R1* is then directed through the collector-base diode of *Q4* and forward-biases the emitter-base diode of *Q2*, turning *Q2* on. This turns *Q3* and *Q1* off. The cycle is now repeated on the opposite side with initiation by another positive trigger pulse. Note that the basic trigger scheme may be used with any multivibrator which turns off the normally on transistor.

Randy Brandt, Design Engineer, Raytheon Co., Mountain View, Calif.

VOTE FOR 115

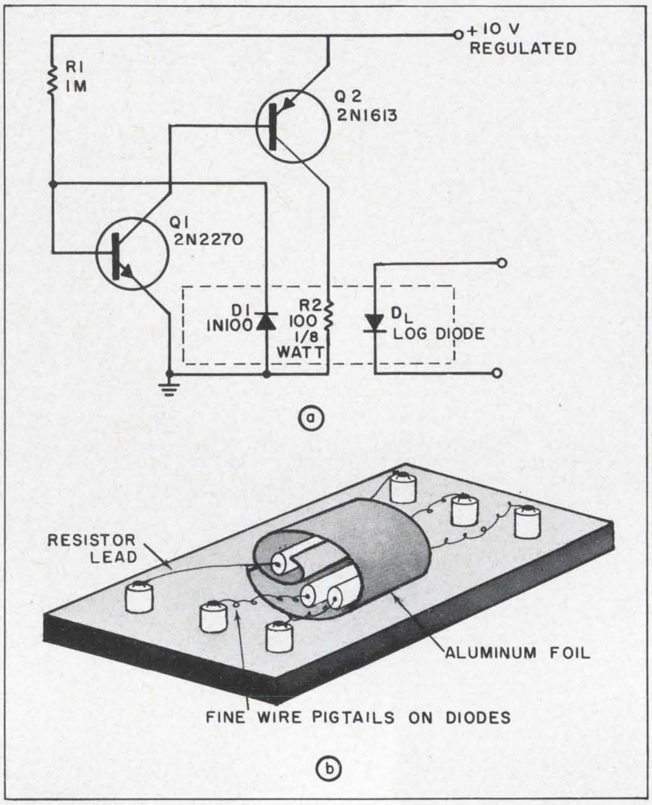
Temperature regulator circuit stabilizes log converter

The forward-biased semiconductor diode characteristic is useful in many applications where a logarithmic data conversion is desired. The diode voltage and current have the general form: $V = A \log I$. However, the constant A in this characteristic is highly temperature-dependent, giving rise to conversion errors as high as 1 dB/° C. The coefficient of the diode temperature is indispensable for converter accuracy and repeatability.

The circuit shown is a simple temperature feedback control system which uses reverse-biased germanium diode *D1* as a temperature sensor. The two transistors form a direct-coupled current amplifier. Resistor *R2* heats diodes *D1* and D_L by thermal conduction in response to current from the amplifier. As *D1* heats, its saturation current increases; this in turn reduces the base current of *Q1*. Consequently, the heating current through *R2* is reduced until system equilibrium is established. The value of *R1* is adjusted so that about half the supply voltage is dropped across *R2* at equilibrium.

Diodes *D1* and D_L should have good thermal coupling to *R2* and be isolated as much as possible from other environmental changes. To achieve this, resistor *R2* and the diodes are coated with heat-conducting silicone grease and wrapped in a narrow strip of aluminum foil. In addition, the diode leads are cut short and fine wire pigtails attached with low-temperature solder.

The system reduces output errors due to ambient-temperature changes by a factor greater than five. The system time constant is about 30 seconds, making warm-up time less than 5 minutes. Component types and values are not critical, except that diode *D1* should be germanium and transistor *Q1* should be silicon.



Temperature of a diode (D_L) is maintained constant with the circuit (a). Packaging of the components enclosed by the dashed lines is shown in (b).

Alex Klooster, Jr., Willow Run Laboratories, Institute of Science and Technology, University of Michigan, Ann Arbor, Mich.

VOTE FOR 116

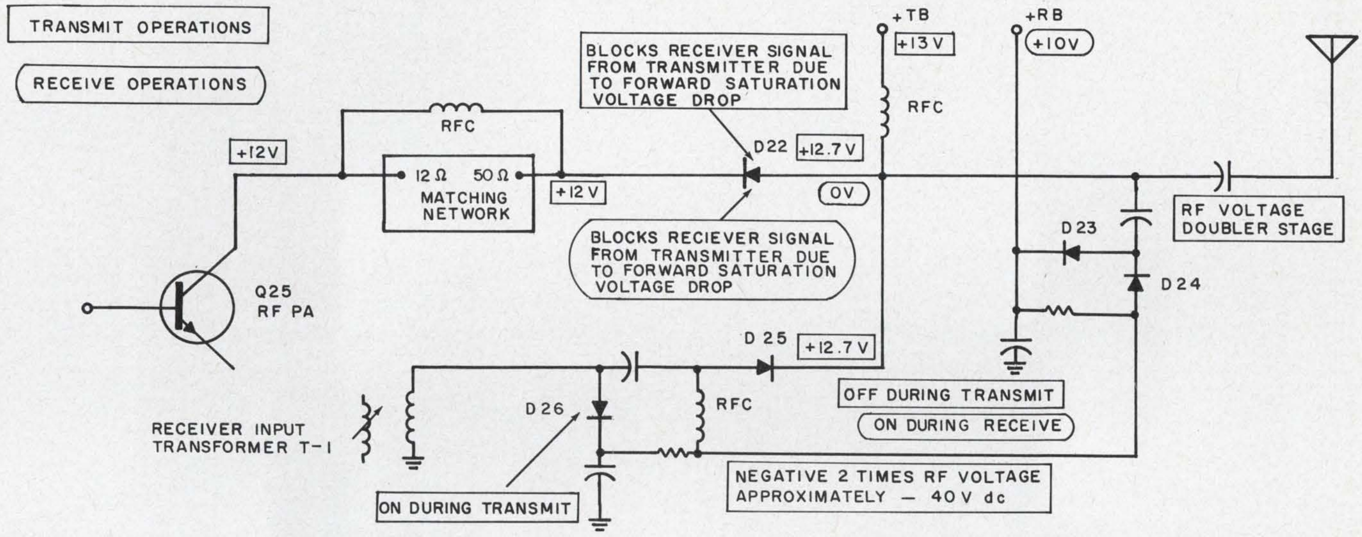
RF voltage blocks receiver during transmit

This circuit provides antenna switching between transmit and receive modes. With 5 watts of transmit signal, upwards of 35 volts of RF must be controlled by a 12-volt power source. The relay is operated by applying these 12 volts to either *TB+* or *RB+* terminals. The opposite terminal will be grounded.

The basic requirement is to conduct a transmitted signal from the transmitter power amplifier stage to the antenna while keeping high RF voltage out of the receiver. The approach is to connect the power amplifier stage to the antenna through diode *D22*, which is turned on by *TB+* current flowing through it to the transmitter. Since this diode will not conduct with less than 0.5-volt forward bias, it also disconnects the transmitter during receive. Diode *D25*, which connects the receiver to the antenna, is turned on during receive by *RB+* and is reversed-biased during transmit by the sum of *TB+* and twice the peak RF voltage. This RF-derived voltage is developed by a half-wave voltage doubler, composed of *D23* and *D24* and connected in the RF line from the transmitter. Diode *D26* provides a low-impedance circuit across the receiver terminals during transmit.

Arleigh B. Baker, Development Engineer, E. F. Johnson Co., Waseca, Minn.

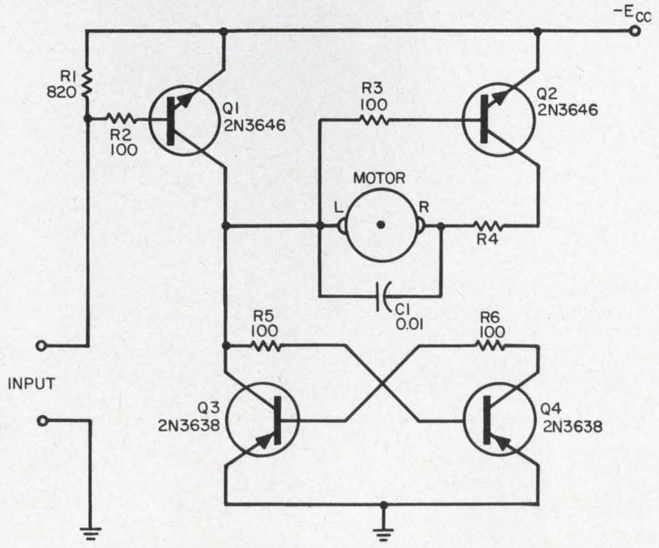
VOTE FOR 117



Solid-state antenna relay employs RF voltage to block receiver during transmitting mode.

Spst switch reverses PM dc motor rotation

The circuit operates as follows: with input open, *Q1* is in the nonconducting state, *Q2* and *Q3* are conducting. *L* is positive with respect to *R*. The voltage across the motor terminals will cause the motor to rotate.



Any switch, spst or a transistor, placed across the input terminals will control the PM dc motor.

With input closed (either by switch or transistor) *Q1* conducts and causes *Q4* to conduct also. The decreasing collector voltage at *Q1* and *Q4* causes *Q2* and *Q3* to turn off. *R* will now be positive with respect to *L*. The voltage across the motor terminals will then cause the motor to reverse direction.

R4 is a current-limiting resistor and speed control. *C1* is used to reduce arcing.

The circuit shown was used in a miniature pulse control system, but could have many applications, such as battery-powered tape recorders and strip-chart recorders.

C. B. Smith, Specialist, Assembly Processes, General Electric Co., Memory Equipment Dept., Oklahoma City, Okla.

VOTE FOR 118

IFD Winner for Jan. 18, 1967

J. C. Rich, Engineer, Test Equipment Engineering Quality Control, General Electric, St. Petersburg, Fla.

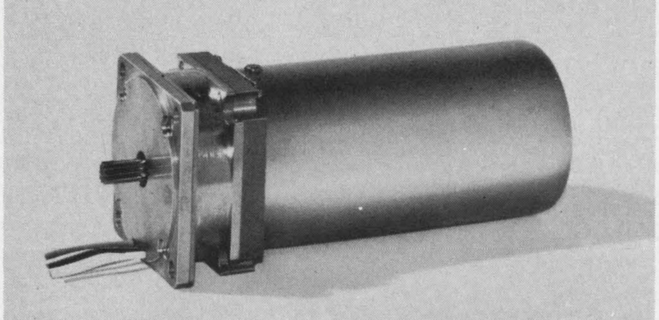
His Idea, "UJT and ac current source used to divide frequency," has been voted the $50 Most Valuable of Issue Award.

Cast Your Vote for the Best Idea in this Issue.

high performance motors

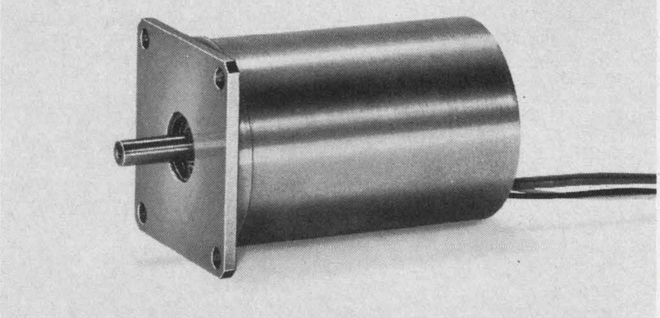
By Wright Division of Sperry Rand Corporation

High Density DC Motors with clutch-brake



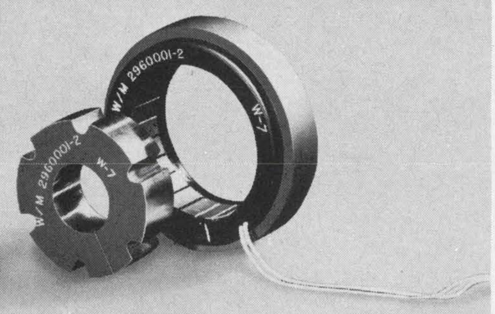
Enormous power is provided in small packages 2″ to 4″ in diameter. Offered in shunt, series, compound, and permanent magnet types.

Synchronous Motors



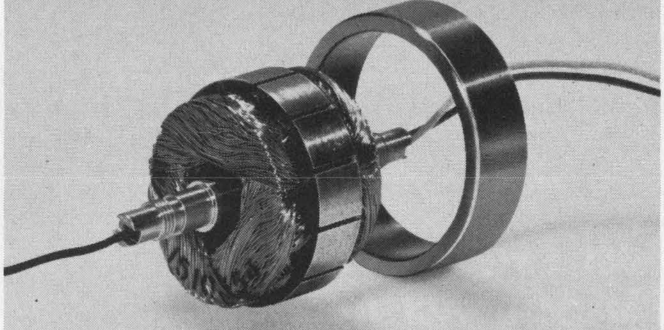
High efficiency designs available in single phase and polyphase types. They feature low noise and flutter. Six different speeds available in one unit.

Brushless DC Torque Motors



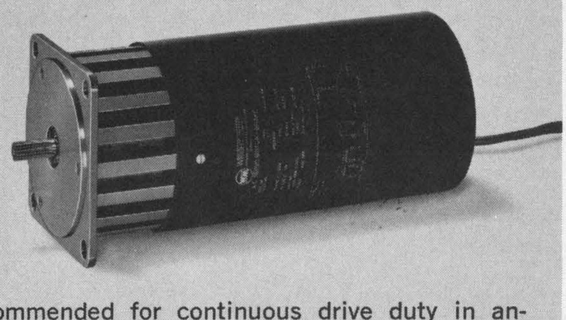
Torque motors with a response of four hundred millionths of a second for incremental rotation. Diameter 1 inch to 10 inches.

Gyro Motors



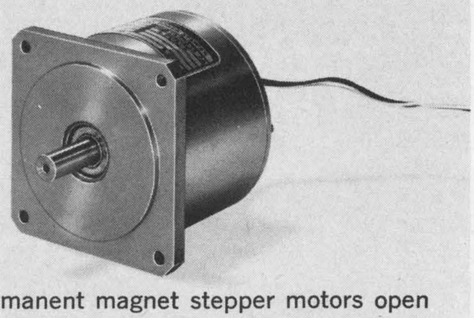
This new type of gyro motor features low power, high torque, and fast acceleration. Synchronous and induction. Half inch to seven inches in diameter.

AC Drive Motors



Recommended for continuous drive duty in antenna, optical, stabilizing systems. Available with synchronous or servo characteristics. Inverted or conventional. Wide variety of windings and sizes.

Power Stepper Motors



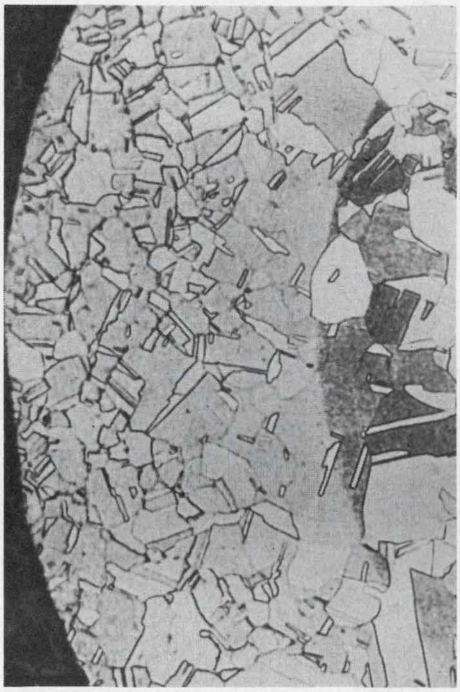
Powerful, permanent magnet stepper motors open whole new fields of application for the direct drive of all types of mechanical systems. Up to 600 ounce-inches torque at 15° step angle.

WRIGHT WM
Division of Sperry Rand Corporation

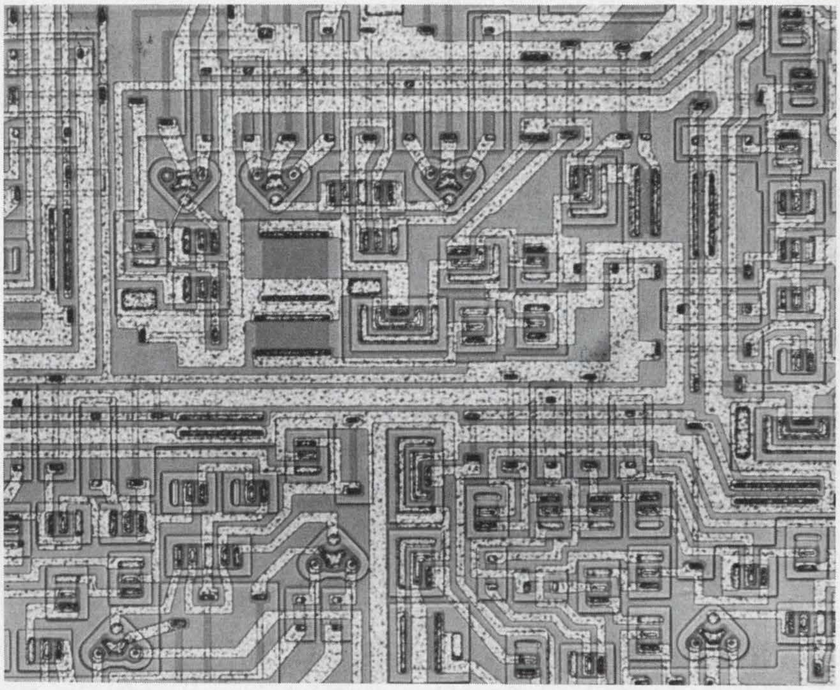
DURHAM, NORTH CAROLINA ☐ TELEPHONE 919/682-8161 ☐ TWX 919/682-8931

ON READER-SERVICE CARD CIRCLE 96

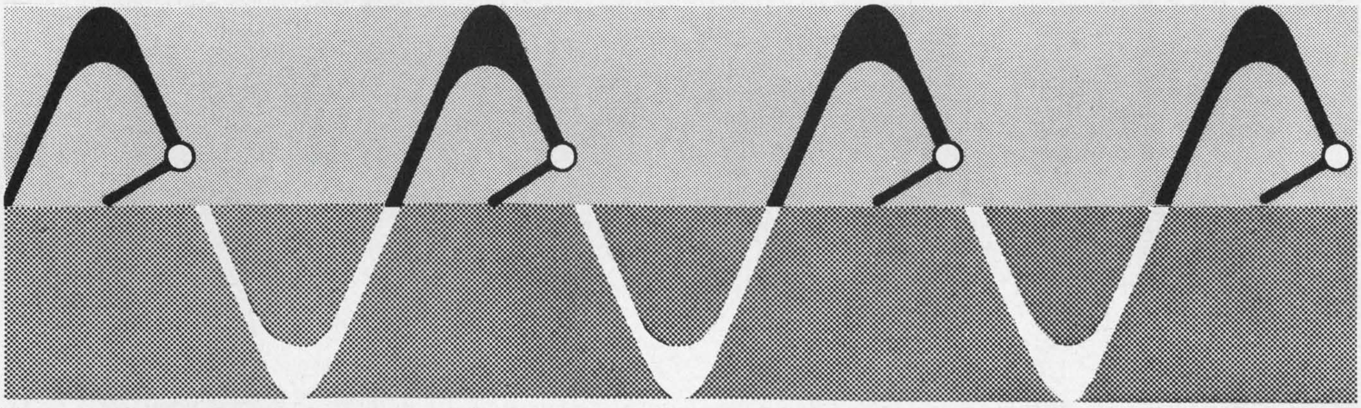
Products



Oxide won't penetrate boron deoxidized copper wire. Page 254



Bipolar LSI array shifts left or right, parallel or serial, at shift frequencies greater than 25 MHz. Page 253



Zero-voltage switching of resistive loads to 3600 watts is provided by a tiny module. A monolithic IC triggers the Triac for full-wave ac power control with less RFI. Page 248

Also in this section:

Silicon FETs are quiet down to sub-audio frequencies. Page 248

Teflon-tipped probe treats tiny chips gently. Page 257

Design Aids, Page 268 . . . . **Application Notes,** Page 266 . . . . **New Literature,** Page 269

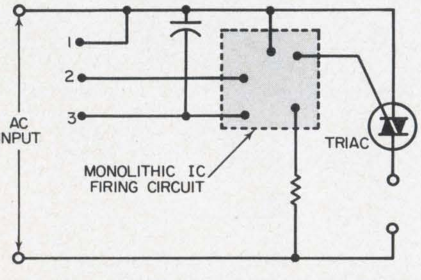
IC triggers Triac for zero-voltage switching

General Electric, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y. Phone: (518) 374-2211. Price: $10 to $20 (100 lots).

An ac power control module, (a Triac triggered by a monolithic IC) is a high-gain threshold and power control switch for resistance heater or tungsten lamp loads and resistance sensors. The modules are basically on-off controllers. The power switching is done by the Triac which is triggered by the monolithic integrated control circuit only at line voltage zero crossings. This mode of operation produces less RFI than mechanical switching elements.

The integrated control circuit, in addition to generating the proper triggering signals for the Triac. provides its own power supply and uses a differential amplifier to sense offset of a resistance bridge. The bridge consists of a user-supplied sensor resistance and reference resistance on one side. and a matched pair of resistors in the IC on the other. The usable range of sensor resistance is 5 to 50 kΩ or up to 100 kΩ at slightly less accuracy.

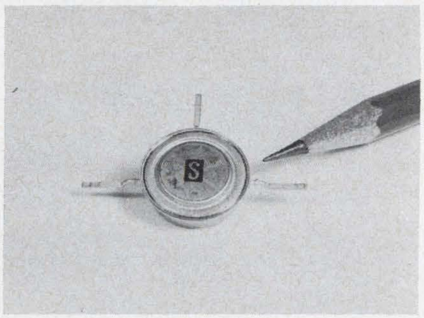
Models are available in ratings of 10 and 15 A rms at 120 and 240 V rms, 50 and 60 Hz, for controlling resistive loads from 500 to 3600 watts. All forms of the module have an extruded aluminum heat sink. electrically isolated from all current-carrying components.



IC triggers Triac for zero-voltage switching. It uses a diff-amp to sense offset of the resistance bridge formed by a sensor and reference resistance across points 1 and 3 and a matched pair of resistors in the IC. When sensor resistance is less than the reference resistance, trigger pulses are generated. Ten volts are developed across points 1 and 3.

CIRCLE NO. 420

Darlington amplifier available in flatpack



Solitron Devices, Inc., Riviera Beach, Fla. Phone: (305) 848-4311.

Ten-ampere silicon Darlington amplifiers are packaged in a 3/4-inch flatpack. The devices have a minimum gain of 2000 at a collector current of 5 A with V_{CE} of 5 volts. Under the same conditions, V_{BE} is 2 volts. Saturation voltage (V_{CE}) is 1.5 volts at a collector current of 5 A and a circuit gain of 500. Leakage currents are typically in the nanoampere range for both I_{CBO} and I_{EBO}. Typical gain is 50 at 5 MHz.

CIRCLE NO. 421

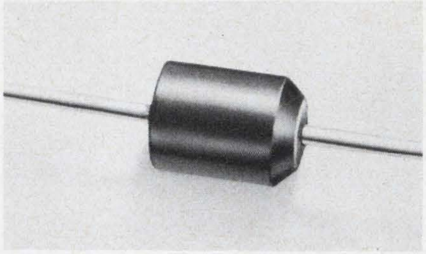
Silicon FETs are quiet even at sub-audio

Siliconix, Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif. Phone: (408) 245-1000. Price: $11.75, $10, $9.40 (100 lots).

The 2N4867, 68 and 69 FET series is designed for minimum noise audio and sub-audio frequency applications. Equivalent short-circuit input noise voltage is 20 $\text{nV}/\sqrt{\text{Hz}}$ at 10 Hz and 1 kHz. Thus, the FETs contribute less than the equivalent thermal noise of the signal source from 100 Hz to 10 kHz for generator resistance of 5 kΩ to 10 MΩ. Even at 20 Hz equivalent noise resistance is less than 20 kΩ. Excess noise at 10 Hz rises at 2 dB/octave. The FETs exhibit less noise than vacuum tubes, and are quieter than bipolars when generator resistance exceeds 2 kΩ. Other specifications on the 2N4867. 68 and 69 include 700, 1000 and 1300-μmho minimum transconductance, 3-to-1 spread in I_{DSS}, and 40-V breakdown voltage. They are packaged in the TO-72 case.

CIRCLE NO. 422

Three-amp rectifier recovers in 300 ns



Electronic Devices, Inc., 21 Gray Oaks Ave., Yonkers, N. Y. Phone: (914) 965-4400. P&A: $3.37; stock.

An axial-lead silicon rectifier has a forward current rating of 3 A, a surge rating of 300 A and recovery time of 300 ns from 1 A forward to 250 mA reverse. In addition to units with standard voltages of 50 to 600 PIV, 800- and 100-PIV rectifiers are available. The series is designed for use with square wave inputs of 5 to 40 kHz and sine wave inputs up to 300 kHz.

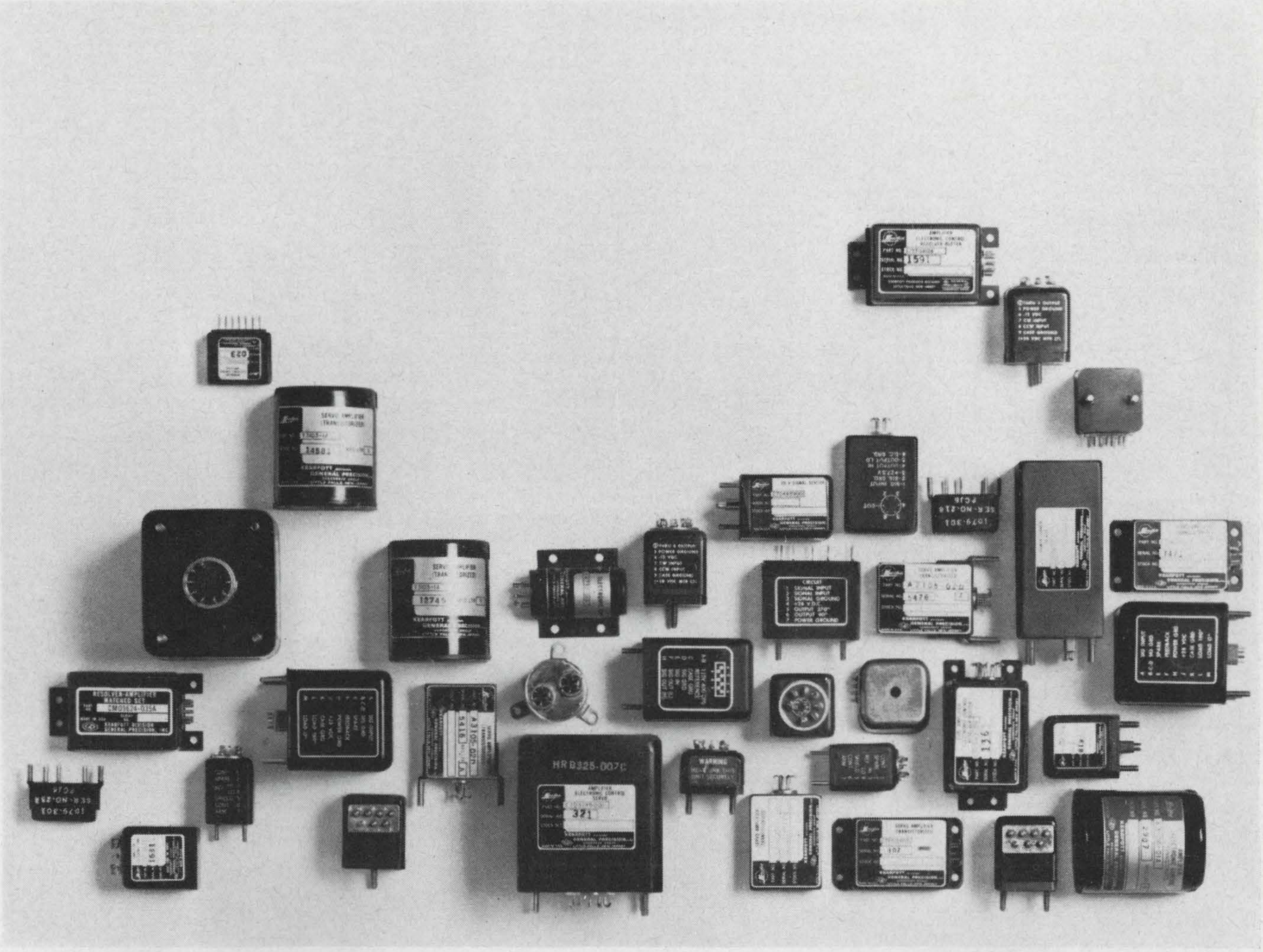
CIRCLE NO. 423

Npns, pnps, stacked 4 to a TO-5 can

Industro Transistor Corp., 35-10 36th Ave., Long Island City, N. Y. Phone: (212) 392-8000.

Four pnp and npn high-voltage transistors stacked in one TO-5 package represent the only multicomponent transistor package in the high-voltage field, according to the manufacturer, Industro Transistor Corp. The units are designed to be used for high-voltage switches and solid-state relay circuits. The space savings offers an advantage over series-stacking conventional transistors to reach a required voltage. V_{CEO} up to 2000 volts is obtainable or 1000 volts for the pnp and 1000 volts for the npn. Four npns or four pnps can also be built into one unit. The 10-pin units can be customized to specific voltage requirements compatible with standard hybrid microcircuit components. To manufacture the four-in-one transistors, one metallizing pattern is used on a ceramic disc. Each disc could accommodate two transistors in the Darlington amplifier configuration. Each base lead is accessible to outside connections.

CIRCLE NO. 424



We make a pile of electronic assemblies at

KEARFOTT

SERVO AMPLIFIERS, PREAMPLIFIERS QUADRATURE REJECTION CIRCUITS, SOLID STATE CHOPPERS, MODULATOR/DEMODULATORS, AMPLIFIER-DEMODULATORS, BUFFER AMPLIFIERS, ISOLATION AMPLIFIERS, SUMMING ISOLATION AMPLIFIERS, AC-DC AMPLIFIERS, SIGNAL SENSORS, COMPARATOR AMPLIFIERS, MAGNETIC AMPLIFIERS, STEPPER MOTOR DRIVERS AND LOGIC.

In fact, we have just added another 24 new units in our latest catalog on electronic assemblies bringing the total to over 115 miniature solid state problem solvers. Among the units added is a 50-watt-output, 90°-phase-shift servo amplifier that weighs only 14 ounces. We also have a 16-watt unit for less demanding applications. We've been producing solid state half-wave and full-wave choppers for some time, and to these we've now added DC-to-AC modulators and AC-to-DC demodulators featuring full-wave modulation or demodulation at frequencies from 50-5000 Hz. Major new additions to the product line are fourteen new stepper motor driver/logic assemblies to satisfy almost every size 8, 11, or 15 stepper motor. Like all our electronic modules, these are transistorized, lightweight, potted in high-strength epoxy and can operate over a wide temperature range. Typically, these driver/logic assemblies consist of sequential logic controlled by CW or CCW input pulse commands and output drivers to control motor-winding current. Operating in the switching mode, these drivers minimize internal power dissipation.

We'd like to send you the new catalog, describing all 115 units. Just write to Kearfott Products Division, General Precision, Inc., Aerospace Group, Dept. 1450, 1150 McBride Avenue, Little Falls, New Jersey 07424.

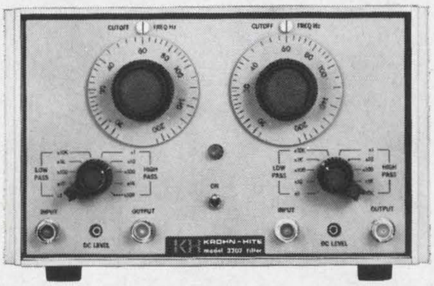
KEARFOTT PRODUCTS DIVISION

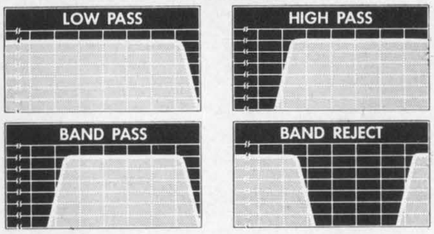
GP GENERAL PRECISION INC.

AEROSPACE GROUP

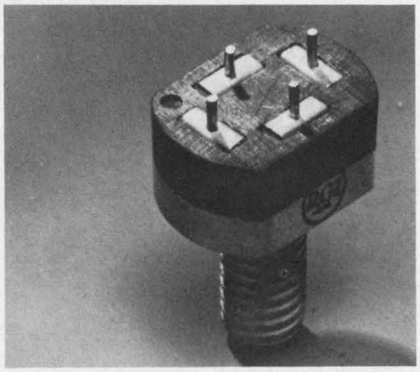
General Precision, Inc. is a subsidiary of General Precision Equipment Corporation.

ON READER-SERVICE CARD CIRCLE 97





Versatile RF overlay packaged in plastic



RCA, Electronic Components & Devices, 415 S. Fifth, Harrison, N. J. Phone: (201) 485-3900. P&A: $40; stock.

The first plastic stud package for RCA's RF overlay transistor utilizes a terminal block structure that permits a choice of stripline, bottom-mounted printed-circuit board or lumped circuit mounting. The 2N5017 overlay transistor is suited for class B and class C RF amplifier applications in military and industrial uhf communications equipment.

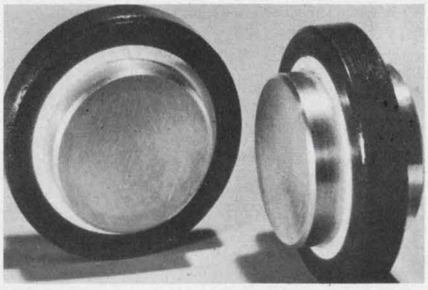
It provides outputs of 23 watts (typical), at 225 MHz and 15 watts (minimum) at 400 MHz, operating from a 28-volt power source. Performance is reportedly improved because of low emitter and base inductances which optimize power and gain. The low base lead inductance is of particular importance in wideband equipment applications. The use of an isolated package technique eliminates circuit restrictions associated with grounded-emitter designs.

The package has all electrodes embedded in the top of the case, permitting circuit components to be placed as close to the chip as possible. Small pins are placed in the electrodes to provide mechanical support to the attached components. A reduction in lead length, with a corresponding reduction in emitter lead inductance, has been achieved by bringing the leads directly out of the top of the case.

CIRCLE NO. 425

Remember to return your **ELECTRONIC DESIGN** renewal card. Don't miss any issues in '67.

Silicon rectifiers withstand 7000-A surges

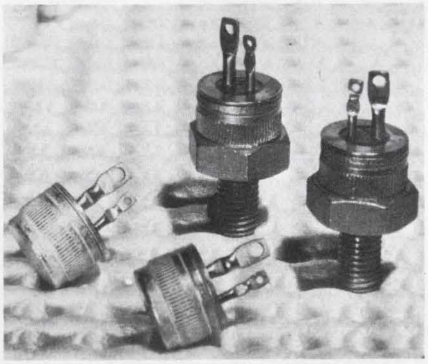


Cogenel, Inc., 50 Rockefeller Plaza, New York. Phone: (212) 757-9130.

Rated at values up to 700 A (average) and 2800 V (peak reverse voltage), a new silicon rectifier can withstand surge currents up to 7000 A (1 cycle at 60 Hz). Mechanical symmetry permits use of the same rectifier as a direct or reverse polarity device. Junction-to-case thermal resistance is 0.05°C/W. Encapsulated in a flatpack 2-1/4 inches OD and 1-1/8 inches thick, the rectifier is designed for heat-sink mounting.

CIRCLE NO. 426

Triacs control 15 A rms at peaks to 500 V

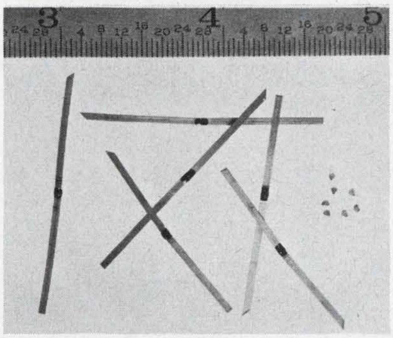


General Electric, Semiconductor Products Dept., Syracuse, N. Y. Phone: (315) 456-2798. P&A: $3.29 in 1000 lots (200 volts); stock.

Types SC50 and SC51 Triacs are capable of controlling 15 A rms at peak voltages up to 500 V. They can withstand a peak one-cycle forward current of 100 A at 80°C junction temperature. Peak forward blocking voltage rating is 500 V. The operating temperature range is −40 to 115°C. The Triacs are available as either a press-fit or a stud-mounted unit.

CIRCLE NO. 427

Silicon pin microdiodes rated to 1 kV PIV



Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif. Phone: (213) 391-8271. P&A: $6 (100 lots); stock to 2 wks.

Silicon pin microwave switching and limiting microdiodes have the glass hermetic seal integrally bonded to the silicon crystal surface. This provides semiconductor surface protection in excess of 1000 volts PIV. Average dissipation is 0.75 to 5 watts depending on heat sinking. Applications are phase shifters, modulators, attenuators and high-power switches. Units meet or exceed MIL-S-19500C.

CIRCLE NO. 428

GaAs Schottkys for high-power, low-noise

Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J. Phone: (201) 464-3000. Price: $50, $90 in evaluation quantities.

Epitaxial gallium arsenide Schottky barrier diodes are designed for high-power low-noise applications. The MS-1650-X and 1651-X can withstand repetitive pulses of 10 ergs (2-ns duration) at X-band. Higher burn-out resistance is realized at lower frequencies. High cutoff frequencies and low noise follow from the low dielectric constant, low skin resistance and low series resistance. At about 10 GHz, the 1650 has a single-ended noise figure of 7 dB maximum; 6.5 dB for the 1651. These ratings are based on an IF amplifier noise figure of 1.5 at 30 MHz. The diodes are available in a low-reactance microwave pill package. Capacitance values to match system impedance requirements and matched pairs are also available.

CIRCLE NO. 429

Eliminate Power Supply Obsolescence...Simplify Stocking Problems With These

New Wide Range Compacts from ERA!

Small Size, Wide Range DC Power Modules Permit Improved Design & Procurement Flexibility

The new Transpac® WR Series are ultra-compact, fully repairable, 71°C silicon power modules which provide regulated DC power over an extremely wide, adjustable voltage range.

Now you can use a single model for all your regulated power requirements ... simplify your stocking requirements ... eliminate power supply obsolescence ... and enjoy significant purchasing economies.

STANDARD MODELS

Output Voltage (DC)	Current (71°C)	Size WxDxH (inches)	Weight (lbs.)	Model	Price
1-33	0-500 ma	3¼ x 3¼ x 5¼	3.5	WR33P5	$120.
1-33	0-1 amp	3¼ x 4 x 5 15/16	5.1	WR331	$155.
1-18	0-2 amps	4 x 4 11/16 x 5 15/16	6.5	WR182	$170.
1-33	0-2 amps	4¼ x 5 x 6⅞	7.8	WR332	$185.
1-33	0-4 amps	5 5/16 x 7¼ x 6¼	13.3	WR334	$255.
1-33	0-8 amps	8¾ x 7⅝ x 6 15/16	22.5	WR338	$305.

SPECIFICATIONS

Input: 105-125 VAC, 50-400 cps
Ripple: Less than 800 microvolts RMS or 0.005%, whichever is greater
Line Regulation: Better than ±0.01% or 5 mv for full input change
Load Regulation: Better than 0.05% or 8 mv for 0-100% load change
Voltage Adjustment: Continuous (Taps and screwdriver adjustment)
Short Circuit Protection: Microseconds response, automatic recovery
Vernier Voltage: External provision
Transient Response: Less than 50 microseconds
Maximum Case Temperature: 130°C
Operating Temperature: −20°C to +71°C free air, full ratings
Temperature Coefficient: Less than 0.01% per degrees C or 3 millivolts
Long-Term Stability: Within 5 millivolts (8 hours reference)

WRITE TODAY FOR CATALOG #148

ERA

ELECTRONIC RESEARCH ASSOCIATES, INC.

Dept. ED-4, 67 Sand Park Road • Cedar Grove, N. J. 07009 • (201) 239-3000

Subsidiaries: ERA Electric Co. • ERA Acoustics Corp. • ERA Dynamics Corp. • ERA Pacific, Inc..

ON READER-SERVICE CARD CIRCLE 99

Consistently high levels of quality control for precious metal plating requires measurement of plating thickness—in microinches—with reproducible results!

To be sure that Cinch equipment would produce contacts meeting even the most rigid plating specifications, an elaborate, continuing program of quality control was developed. Based on beta ray backscatter measurements, it involved—

1. Devising a new BetaScope calibration system traceable to the Bureau of Standards.
2. Designing new methods for consistent contact alignment in the BetaScope.
3. Establishing new procedures for the statistical analysis of data obtained from plating thickness measurements.

RESULT: Cinch can provide the exact plating thickness required at any point, or at all points, on a contact. Plating processes can be controlled to guarantee minimum plating depth because variations can be detected immediately.

At Cinch, the Quality Control Director reports directly to the President. Cinch is the *only* connector manufacturer whose products are accepted without incoming inspection by one of the nation's leading communications equipment manufacturers.

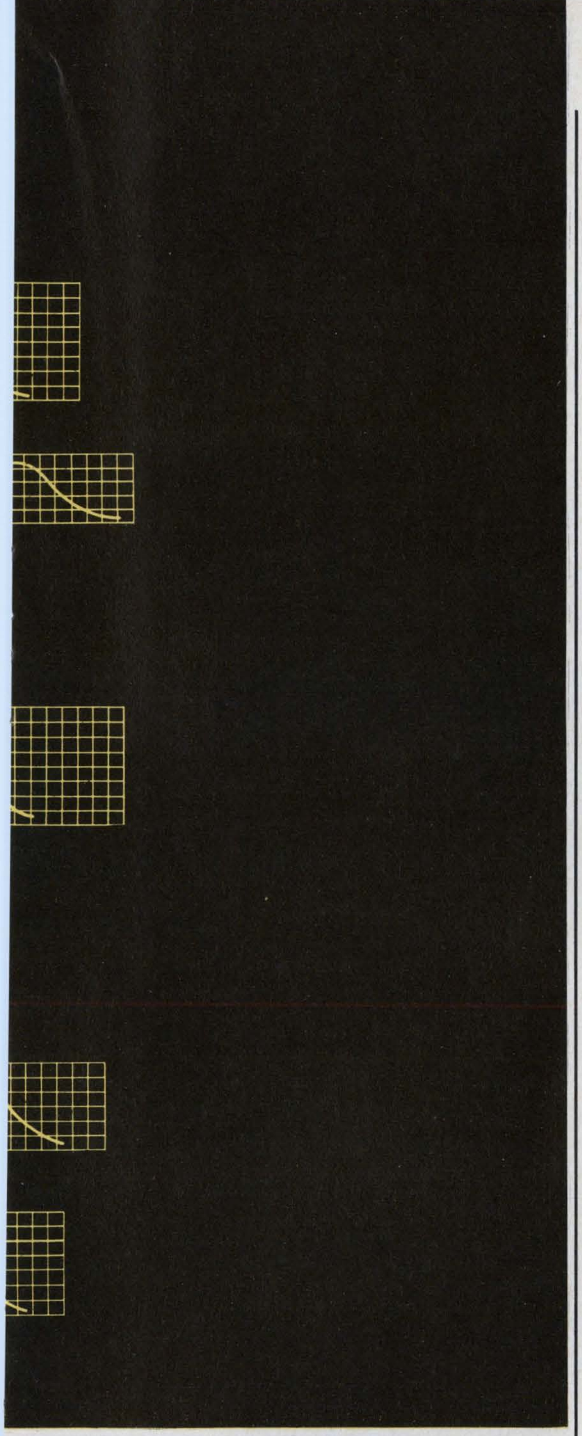
This sophisticated approach to quality control is another example of the extra dimension in Cinch's capabilities. Beyond the ability to develop fine products, we also offer in-depth production engineering, and tool, die, mold and equipment design and fabrication.

CINCH

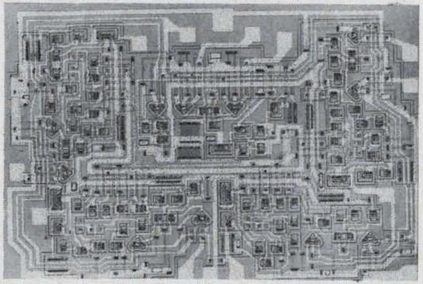
DIVISION OF UNITED-CARR

MEMBER
THE CINCH
ELECTRONICS
GROUP

CONSISTING OF CINCH MANUFACTURING COMPANY, CINCH-GRAPHIK, CINCH-MONADNOCK, CINCH-NULINE, UCINITE (ELECTRONICS) AND PLAXIAL CABLE DEPT.



Bipolar LSI array shifts at 25 MHz



Sylvania Electric Products, Inc., 100 Sylvan, Woburn, Mass. Phone: (617) 933-3500.

A universal 4-bit shift register, containing the equivalent of 175 components on a 60 x 85-mil chip, shifts at speeds exceeding 25 MHz. The register is capable of performing parallel and serial to parallel and serial or serial to parallel conversion, storage, delay and shifting operations in all parts of digital computers or control systems and can perform arithmetic operations such as multiplication and division. The register can shift left or right from parallel units. The SM100 can also perform a serial shift right. There is a simple control signal which, upon command, will permit parallel entry into all four bits which then again, upon command, can be shifted serially. By simple wiring at the package terminals, it can be converted to a shift register that can shift left and right. It can be clocked by either of two separate clock signals. Packaging is 14-lead dual-in-line.

CIRCLE NO. 430

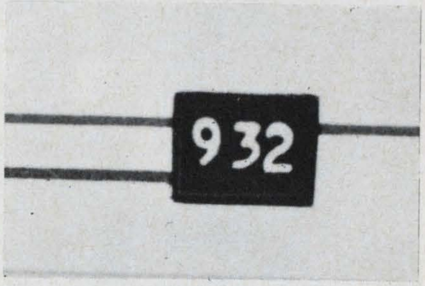
16-flip-flops on one card asembly

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. Phone: (617) 876-2800.

As many as 16 reset-set flip-flops come on a single card assembly. Eight quadruple 2-input DTL integrated circuits are used to achieve high speed and excellent noise immunity by cross-coupling gate pairs. Customer options of 2 through 16 flip-flops are available. The set and reset inputs and outputs of all flip-flops are accessible through a 70-pin connector.

CIRCLE NO. 431

Resistor networks ratio-matched to 0.2%



Microtek Electronics, Inc., 138 Alewife Brook Pkwy., Cambridge, Mass. Phone: (617) 491-4330.

Matched thick-film resistor networks in values from 100 Ω to 100 kΩ are offered. The networks are fired on a common alumina substrate to assure stability and temperature tracking. Temperature tracking of 25 ppm/°C from −55° to +125°C is standard. Networks show less than 0.05% change in absolute resistor value after 1000 hours load life. The network shown above consists of two resistors ratio-matched to 0.2% and meets MIL-STD 202C method 106B.

CIRCLE NO. 432

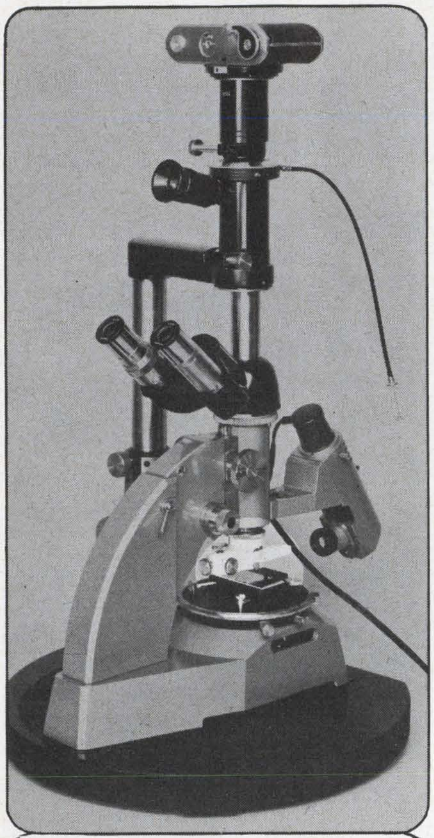
IC op-amp priced at a low of $5

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-2530. P&A: $4.95 (over 10,000); stock.

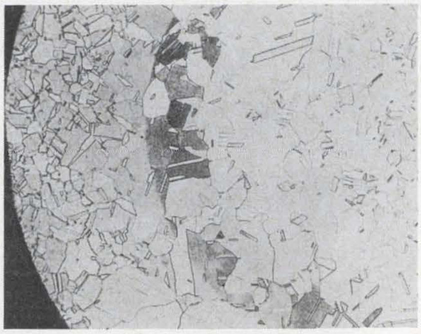
Fairchild Semiconductor's μA709-C op-amp is designed for industrial users now paying $15 to $35 for op-amp modules. The unit is available in a hermetic metal TO-5 can with typical input offset current of 100 nA with an input offset voltage of 2 nA. The large signal voltage gain is 45,000 with an input voltage range of ±10 V. The typical output voltage swing is ±14 V. In industrial use, the amplifier is suitable for dc servo systems, high-impedance analog computers, low-level instrumentation applications and for the generation of special linear and nonlinear transfer functions.

CIRCLE NO. 433

Don't risk missing any issues of **ELECTRONIC DESIGN.** Send in your renewal card today.



Boron-deoxidized copper resists oxidation



Anaconda American Brass Co., 414 Meadow St., Waterbury, Conn. Phone: (203) 757-2021.

Boron-deoxidized copper alloy offers superior resistance to oxygen penetration, high purity, high electrical and thermal conductivity and good joining characteristics. Key to the resistance to oxygen penetration is the presence of the boron (approximately 0.01%) which "ties up" any oxygen already in the alloy by combining with it, thus rendering it harmless, and also "tying up" any oxygen that may be present during processing. Temperatures in excess of 2730°F are required to release the oxygen. The alloy is virtually equivalent to oxygen-free copper in other respects. Potential uses are seen in magnetrons, synchrotrons, klystrons and other electron accelerator components, transistor and diode bases, lead frames for ICs, armature and transformer windings, coaxial cables, generator connectors, connectors in signal systems, commutator bars and risers and ground and motor leads.

CIRCLE NO. 435

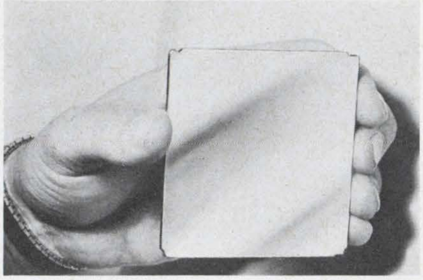
Magnetic film seals and shields

Emerson & Cuming, Inc., 59 Walpole, Canton, Mass. Phone: (617) 828-3300. P&A: $3 to $5/foot; stock.

RF and mechanical sealing is simplified by a flexible plastic magnet core, bonded to a highly conductive plastic film. By applying a strip of the film around the edge of an opening, the plastic magnet draws the door or cover into contact with the conductive plastic, forming the RF and mechanical seal.

CIRCLE NO. 436

Mirror-finish metal for IC substrates



Sherman Industries, Inc., American Silver Co. Div., 36-07 Prince St., Flushing, N. Y. Phone: (212) 353-8012.

Mirror-finish metal strip is designed for use as metal substrates for integrated circuitry. Metal substrates tend to eliminate many of the problems of expansion usually encountered with ceramics. In addition, the metal substrates provide an integral return path, thus making it unnecessary to include a return path in the circuitry. The strip is available in copper and aluminum in widths up to 3 inches.

CIRCLE NO. 437

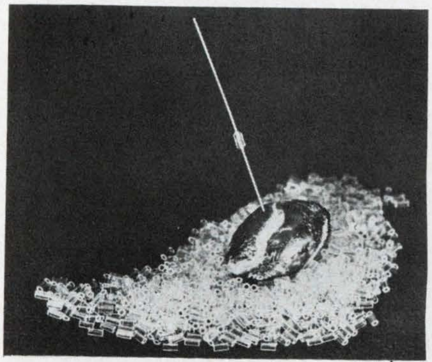
Clean contacts from spray can

Spray Products Corp., Industrial Div., P. O. Box 1988, Camden, N. J. Phone: (609) 663-7040.

A specially formulated solvent is designed for use on electric and electronic contacts. Applied as an aerosol spray from a pushbutton can, SPC electrical contact cleaner combines high density with low surface tension and viscosity to penetrate microscopic cracks and crevices. Dirt, grease and other foreign matter is either dissolved or lifted to the surface where the force of the aerosol propellent blows it away. The cleaner evaporates completely and leaves no residue.

CIRCLE NO. 438

Low-alkali glass seals at 740°C



Corning Glass Works, Corning, New York. Phone: (607) 962-4444.

Heat damage and electrical degradation due to alkali poisoning are minimized when semiconductor devices are encapsulated in this sealing glass. The glass is a lead-alumino-borosilicate composition with an alkali content of less than 0.1%. It can be sealed at approximately 740°C. The expansion and viscosity of the glass provides good hermetic seals to molybdenum, Kovar and tungsten. Loss tangent is 0.001 and dielectric constant is 6.91, both at 1 MHz. The glass is available as cut tubing.

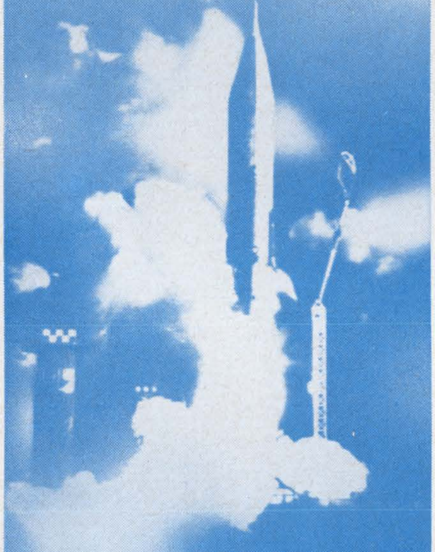
CIRCLE NO. 439

Silicon tetrachloride for wafer makers

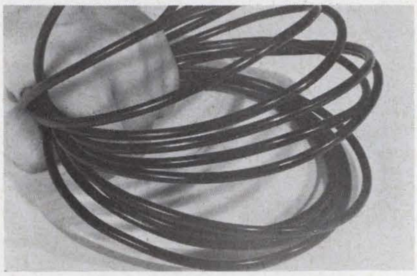
Dow Corning, 500 S. Saginaw, Midland, Mich. Phone: (517) 636-8000.

Semiconductor-grade silicon tetrachloride is a clear, nonflammable, low-boiling liquid for use in the manufacture of epitaxial silicon wafers. The high-purity material enables device manufacturers to produce uncompensated epitaxial depositions with consistent control of resistivity at levels above 50 Ω-cm, n-type. The silicon tetrachloride may also be doped with either n-type or p-type carriers to meet specific resistivity specifications. It is packaged in nine-liter Pyrex bottles with a 2-inch flange at the mouth. About 24 pounds of product is shipped in each bottle. With a modified cap, the bottle may be converted into a vaporizer for direct use in an epitaxial system. This makes it unnecessary to transfer to another container.

CIRCLE NO. 440



RFI-proof coax aluminum-sheathed

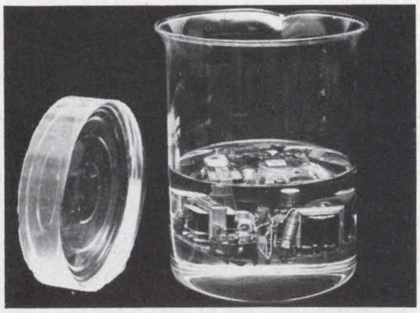


Amphenol Corp., Amphenol Cable Div., 6235 S. Harlem Ave., Chicago. Phone: (312) 261-2000.

Solid aluminum-sheath coaxial cable claims RFI shielding performance far superior to existing cables. Designated BC-59, the new cable is equivalent in size to RG59/U (0.242 inch OD). On shielding tests it was rated at 80 to 90 dB down, as opposed to 30 dB down for standard RG59/U. It is also 30% lighter and has 5% better attenuation performance. Other electrical characteristics are the same. The performance is achieved by replacing standard braided sheath with a sheath of solid aluminum foil. The foil is applied to the cable core during the jacket extrusion process. Extrusion of the polyethylene jacket over the foil chemically bonds the foil to itself and to the polyethylene.

CIRCLE NO. 434

Potting compound makes it clear

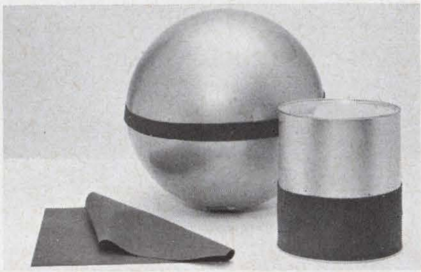


Emerson & Cuming, Inc., Canton, Mass. Phone: (617) 828-3300. P&A: $5 to $6; stock.

Eccosil 2 CN is a transparent, water-clear potting silicone. It can be cured by catalyst addition at room or somewhat higher temperature. Because of its flexibility, it provides good protection to embedded components against shock and vibration.

CIRCLE NO. 441

Flexible silicone sheet cuts reflectivity

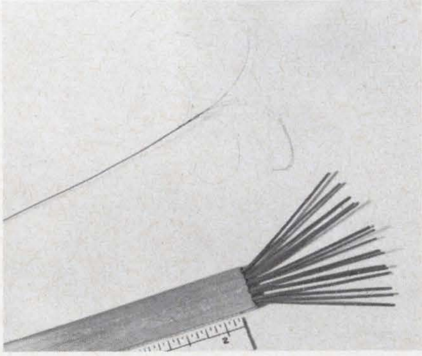


Emerson & Cuming, Inc., Microwave Products Div., Canton, Mass. Phone: (617) 828-3300. Price: $10/square foot.

A high-loss flexible silicone material when bonded to a metal surface will effectively prevent the flow of microwave currents. It will therefore reduce the back-scatter or reflectivity of metal structures caused by surface currents. It can also be draped over objects to alter reflectivity characteristics. Radiation patterns of antennas can be modified by the application of Eccosorb GDS to elements, dishes, horns, etc.

CIRCLE NO. 442

Superconductive wire useful to 100 kilogauss

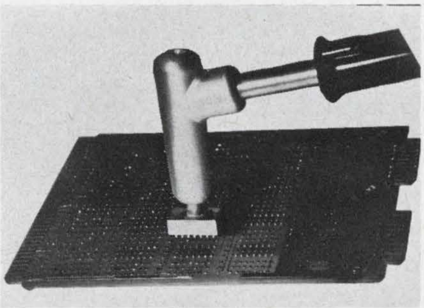


Avco Corp., 2385 Revere Beach Pkwy., Everett, Mass. Phone: (617) 389-3000.

Composite superconductors consist of fine, high-current-density niobium-titanium wires encased in copper. They are available in round, square and strip configurations with one to 20 wires. They are useful at fields up to 100 kilogauss. Ratio between the superconductor and the copper substrate varies from one to over five. Overall current densities of more than 20,000 A per square centimeter at 45 kilogauss have been achieved.

CIRCLE NO. 443

Multipin tip fits any soldering iron

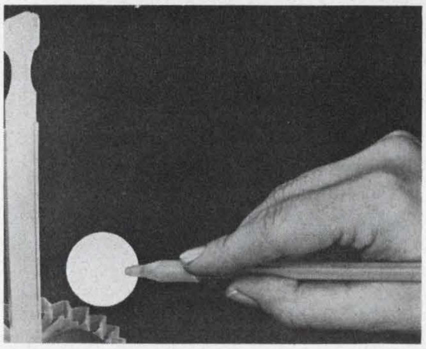


Air-Vac Engineering Co., Inc., 100 Gulf St., Milford, Conn. Phone: (203) 874-2541.

A tip for soldering and desoldering multipin components fits any standard soldering iron. The head can be used in conjunction with ring-shaped solder preforms to speed assembly of electronic circuit boards by simultaneously soldering 14 component pins. The same unit can also be used for desoldering electronic components. When placed over the pin connectors, it will simultaneously melt the solder in all the eyelets for each part. The 14-hole tip is iron-plated copper.

CIRCLE NO. 444

Teflon-tipped probe treats chips gently

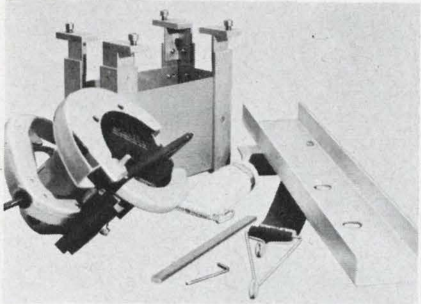


Fluoroware, Inc., County Road 17, Chaska Industrial Park, Chaska, Minn. Phone: (612) 448-3131. Price: $6.75, $2 (tip only).

A vacuum operated probe ensures gentle handling of chips, wafers, substrates and other miniature semiconductor materials. It features a Dupont Teflon FEP tip to prevent damage. Tip hole diameter is 1/16 inch. The vacuum pickup body has a tapered end to accept 3/16- to 1/4-inch ID hoses.

CIRCLE NO. 445

Waveguide cut, assembled in the field



Dielectric Products Engineering Co., Inc., Littleton, Mass. Phone: (617) 486-3575.

Waveguide may be cut and assembled in the field with this kit of tools and materials. It is possible to cut waveguide and mount flanges to close tolerances without welding, machining, heating or resorting to the use of dissimilar metal assemblies. Waveguide sizes from W/R 430 to W/R 2100 can be handled. The kit includes positioning and cutting guides, tools, sealant and a power saw. Vswr of field-assembled flanges is 1.02 over the waveguide band at waveguide rated power.

CIRCLE NO. 446

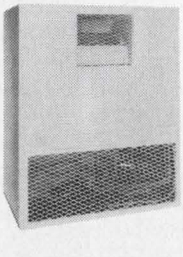
Air-operated tool makes solderless connections

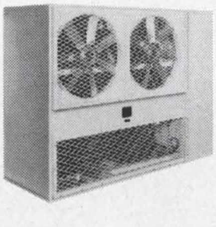
Gardner-Denver Co., Gardner Expressway, Quincy, Ill. Phone: (217) 222-5400.

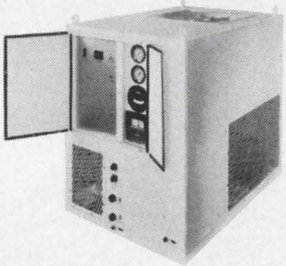
A lightweight, quiet, air-operated Wire-Wrap tool is designed for use with wire in size from 20 to 30 AWG. The air motor requires only 4 cfm of air. The tool is available in wrapping speeds of 3500 and 5500 rpm.

CIRCLE NO. 447

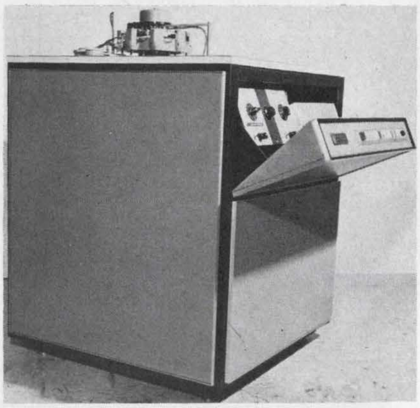
Don't forget to return your **ELECTRONIC DESIGN** renewal card.







Machine tests chips, sorts into 10 bins



Bulova Watch Co., Inc., Systems and Instruments Div., Bulova Pk., Flushing, N. Y. Phone: (212) 335-6000. P&A: $24,300; dual version, about $32,000; 16 wks.

Transistors, diodes and integrated circuits can be tested, classified and placed in bins, automatically, at the rate of 7200 per hour, by a new system from Bulova Watch Co.'s Systems and Instruments Div. The chip tester-classifier, model 85002, tests the units before they are packaged, avoiding the waste of packaging rejects. The system will automatically feed, orient, test and sort into 10 categories square or rectangular chips from 20 to 250 mils long. It will then feed each selected classification into a magazine, keeping it properly oriented for subsequent bonding or placement operations. Testing rates range from 200 to 800 ns per piece, depending on the number of parameters.

The chips are untouched by hand from insertion in the machine to placement in the magazine. Readings are taken by precious-metal contacts nested in the equipment.

The machine claims distinct advantages over go-no-go wafer testing units. Testing each chip in a wafer avoids the necessity of breaking up the wafer later to separate the qualified chips from the rejects. The chips are sorted into 9 acceptable categories, according to specs, and rejects. Operation is simple and requires no special skill. A portable laboratory microscope is required for the setup for each different kind of chip to be tested. The machine measures 32 in. square by 36 in. high. A dual version is available to double the production output.

CIRCLE NO. 448

A-to-D converter digitizes at 40 MHz

Northern Scientific, Inc., 2551 W. Beltline, Middleton, Wis. Phone: (608) 836-6511. P&A: $3200 (single converter), $4200 (dual); 30 days.

A 40-MHz digitizing rate is achieved by the NS-625 dual analog-to-digital converter. The unit also features a digital-to-zero offset control, two 12-bit address scalers, independent operation for each converter, exclusive circuitry for internal rejection of noncoincident events and overflows, patchcord programing and optional internal logical level interface. The converter uses the peak detection technique. Standard output levels for the data and control signals are ±0.5 volt for zero and 6±0.5 volt for one. Coincidence circuitry provides for operation in two-parameter mode with coincidence timing adjustable from 0.5 to 2.5 μs. Noncoincident events produce only 3-μs dead time.

CIRCLE NO. 449

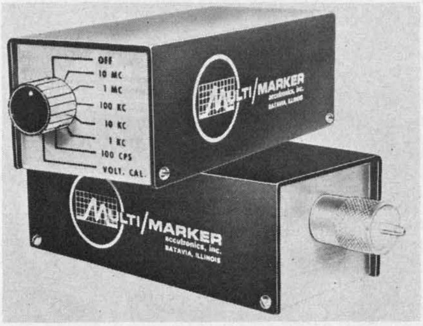
Interval counter uses dc level gating

Anadex Instruments, Inc., 7833 Haskell Ave., Van Nuys, Calif. Phone: (213) 782-9527. Price: $845.

Dc level gating is used in this time interval counter. It provides a variety of interval measurements such as pulse length, pulse spacing and time between electrical events. The counter has start/stop dc levels which are adjustable from +30 to −30 V with ± slope control. A switch is provided for single-line or two-line gate inputs. Measurements from 10 μs to 100,000 s are possible.

CIRCLE NO. 450

Time mark generator accurate to ±0.007%



Accutronics, Inc., 12 South Island, Batavia, Ill. Phone: (312) 879-1000. P&A: $225; stock.

Six crystal-controlled frequencies from 100 Hz to 10 MHz at ±0.007% accuracy and a 1-V p-p calibrator at better than ±0.5% are provided by the Multi/marker. Mercury battery powered, it uses silicon planar epitaxial transistors throughout. The unit can be plugged directly into a scope to calibrate the sweep and vertical amplifiers. For field work it can be used as a secondary frequency standard, for calibration of counters or as a trigger source.

CIRCLE NO. 451

Low-cost pulser has 1-ns rise, fall time

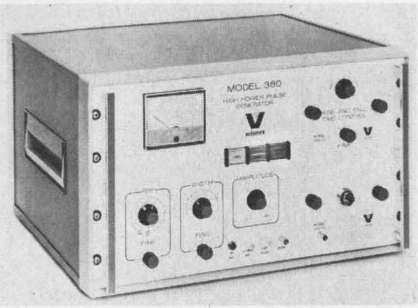
Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $990; stock after May 1.

Fast, clean pulses with rise and fall times less than 1 ns are featured in model 8001A pulse generator. Overshoot and ringing on leading edges are less than 3% of pulse amplitude (6% on trailing edges). Pulse tops are flat within 2%. Pulse amplitude is continuously variable from 0.04 V to 10 V across 50 Ω. Pulse width is also continuously variable from 100 ns to 500 ns.

CIRCLE NO. 452

It's time to renew your subscription to **ELECTRONIC DESIGN.** Return your renewal card today.

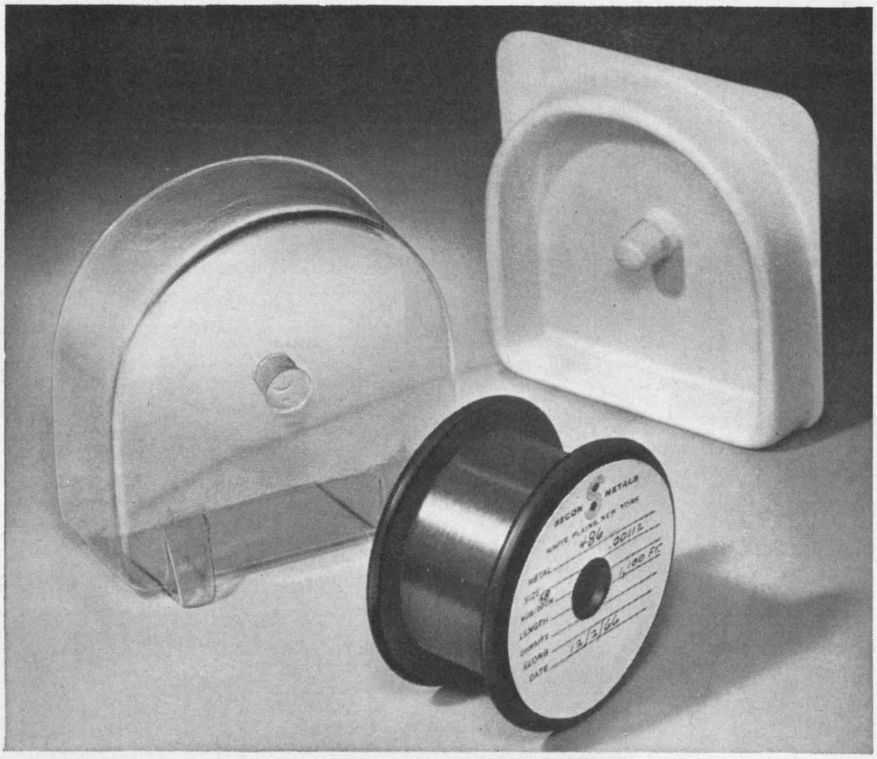
5-kW pulser has 10-ns rise time

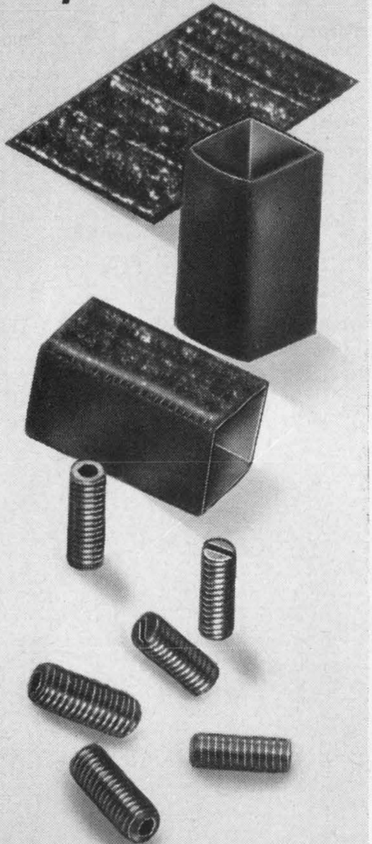


Velonex, 560 Robert Ave., Santa Clara, Calif. Phone: (408) 244-7370. P&A: $4200; 30 to 60 days.

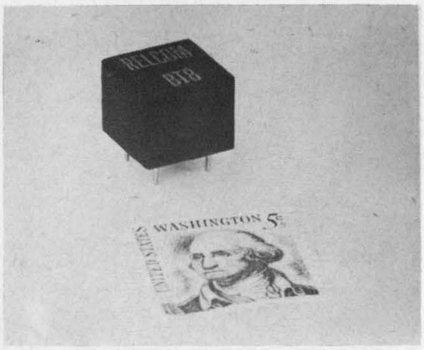
A high-power pulse generator has a 10-ns rise time and a 12-ns fall time. A variable rise-fall time control plug-in and high-current and high-voltage plug-ins provide flexibility with output voltages to 1 kV, or output current to 100 A into 0.5 Ω.

CIRCLE NO. 453





Balanced transformers cover 50 kHz to 1 GHz

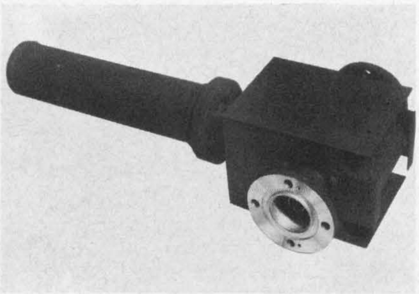


Relcom, 2164 E. Middlefield Rd., Mountain View, Calif. Phone: (415) 961-6265. P&A: $11 (over 100); stock.

Broadband balanced transformers for hybrid junctions, isolated vector addition and division, impedance matching (2:1, 4:1, 8:1, 16:1), balance modulators, phase detectors or phase comparators cover 50 kHz through 1 GHz. Model BT8 features frequency coverage from 1 MHz through 200 MHz with 4:1 impedance matching. Power loss is typically 1 dB, amplitude unbalance is less than 0.1 dB from 1 to 50 MHz and less than 1 dB from 50 to 200 MHz.

CIRCLE NO. 454

Coax circulator rated at 1.2 kW

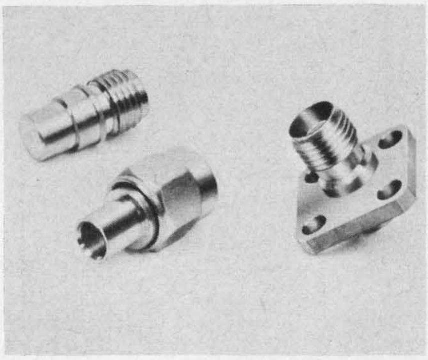


Litton Industries, Airtron Div., 200 E. Hanover Ave., Morris Plains, N. J. Phone: (201) 539-5500. P&A: about $1000; 90 days.

High-power coaxial three-port junction circulators can double as duplexers or low-loss isolators. Model 336265 features an average power of 1.2 kW cw with an insertion loss of 0.4 dB maximum. It covers 1.7 to 2.4 GHz, has an isolation of 20 dB, vswr of 1.2 and has 1-5/8-inch coax connectors.

CIRCLE NO. 455

Stripline connectors for semirigid cable

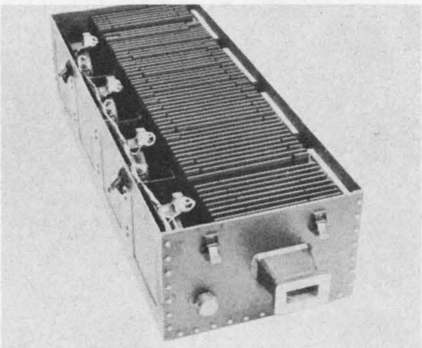


Elpac, Inc., 3760 Campus Dr., Newport Beach, Calif. Phone: (714) 546-8640.

Miniature stripline connectors for 0.141-inch semirigid cable mate with OSM, RBM and other standard connectors. Body, flange and coupling nut are of stainless steel. The dielectric is solid Teflon. The heat-treated beryllium copper center contact makes it possible to precut the cable to exact length, and to complete the assembly without tools. The five styles are male and female, male and female square flange and male right angle.

CIRCLE NO. 456

S-band dummy load convection-cooled

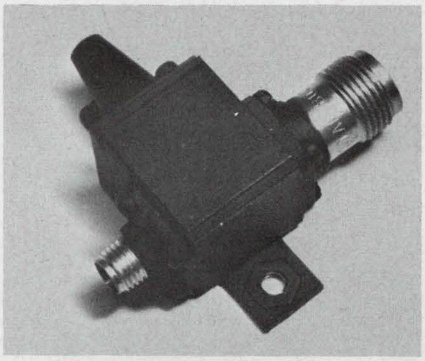


Microlab/FXR, 10 Microlab Rd., Livingston, N. J. Phone: (201) 992-7700.

S-band dummy loads are capable of handling fully rated peak power and 20-kW average power without the use of liquid cooling. They feature a built-in forced-air cooling system equipped with an air-flow safety interlock switch. Frequency range is 2.7 to 3.3 GHz and maximum vswr is 1.2.

CIRCLE NO. 457

Submin circulator weighs 1 ounce

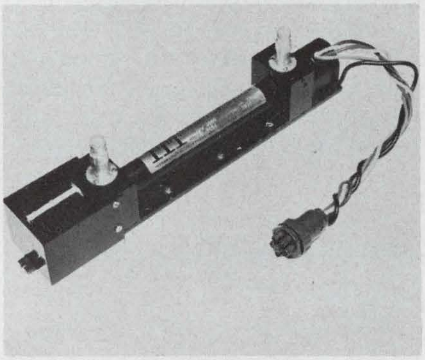


Litton Industries, Airtron Div., 200 E. Hanover Ave., Morris Plains, N. J. Phone: (201) 539-5500. P&A: $70 to $100; 30 days.

A subminiature three-port junction coaxial circulator, measuring 5/8 x 3/4 x 3/4 inches and weighing 1 ounce, is available in Y or T configurations. It covers a frequency range of 4.2 to 4.4 GHz. Other models are available in the frequency range of 1 to 10 GHz, covering 5 to 10% bandwidths. Isolation is 20 dB, insertion loss is 0.3 dB and vswr is 1.2.

CIRCLE NO. 458

Ten-watt TWT weighs 2.5 pounds

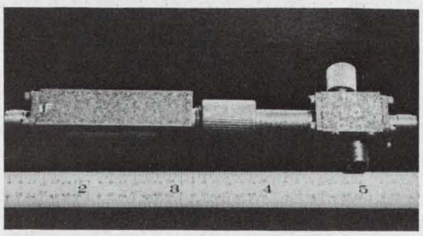


ITT, 320 Park Ave., New York. Phone: (212) 752-6000.

A lightweight 10-watt traveling-wave tube covers the 8-to-12-GHz band. Type F-2094 has 40 dB of gain at rated output. It is of metal-ceramic construction. The tube is ppm focused and forced-air cooling is used. The collector is isolated and can be used at voltages depressed up to 50% below helix-cathode voltage. A dc blocking capacitor is built into the RF output.

CIRCLE NO. 459

IF mixers cover C through Ku-band

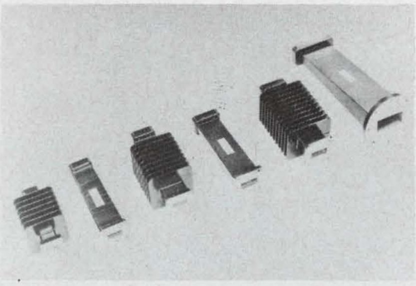


Sage Labs., Inc., 3 Huron Dr., Natick, Mass. Phone: (617) 653-0844. P&A: $400 to $600; 45 days.

Four miniature microwave balanced mixers cover high C-band through Ku-band in four signal RF bands: 5 to 7 GHz, 7 to 9.4 GHz, 9.4 to 12 GHz and 12 to 15 GHz. IF is 3 GHz, and the LO frequency is the sum of RF and IF. Conversion loss is 15 dB, signal-to-IF isolation is greater than 40 dB, and LO-to-signal isolation is greater than 8 dB. All models use 1/4-36 connectors.

CIRCLE NO. 460

Dummy loads handle 25 to 2000 watts

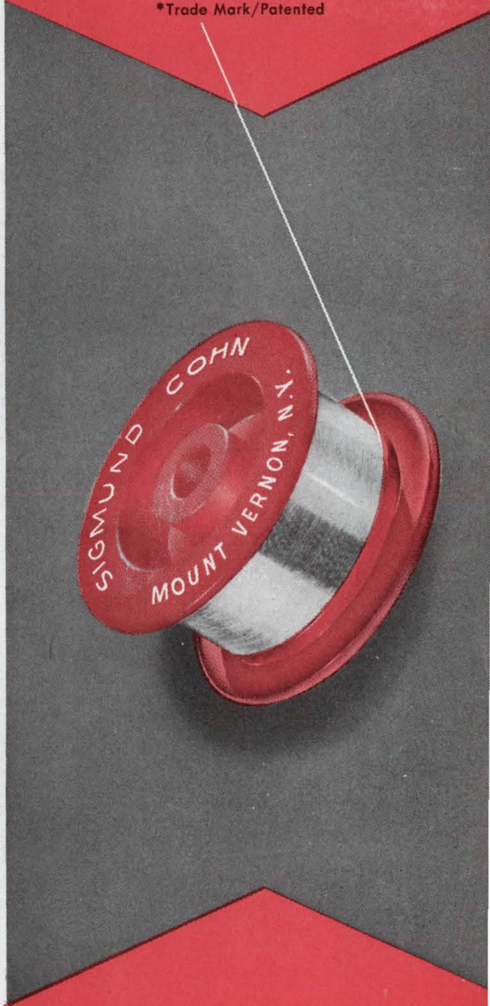


Raytheon Co., Special Microwave Devices Operation, 130 Second Ave., Waltham, Mass. Phone: (617) 899-8400. P&A: from $150; 30 days.

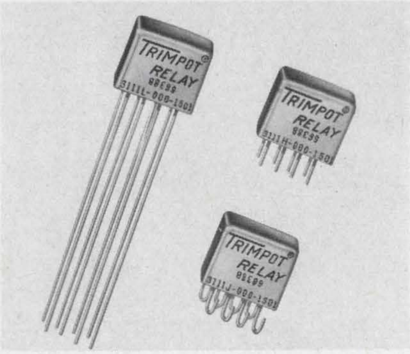
Twenty-one lightweight air-cooled dummy loads handle high power levels. For example, the LKuM1 weighs 4.8 ounces and handles 25 watts average power, while the LCH100 weighs 3.6 pounds and handles 2000 watts of average power. Available finned or unfinned, the loads operate over uhf, L, S, C, X and K-bands.

CIRCLE NO. 461

Don't forget to return your **ELECTRONIC DESIGN** renewal card.



Subminiature relay has 130-mW sensitivity

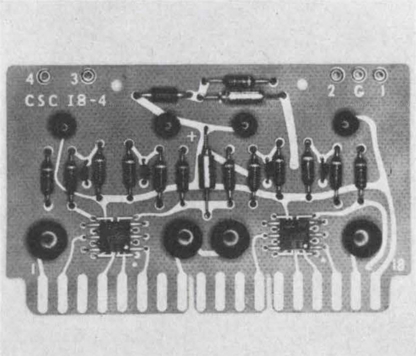


Bourns, Inc., 200 Columbia Ave., Riverside, Calif. Phone: (714) 684-1700. P&A: $21.30 (10 to 24); stock.

A dpdt 0.5-A relay, has 0.1-in. pin spacing, pick-up sensitivity of 130 mW and an operating temperature range of −65° to 125°C. Contact material of gold-plated semiprecious metal, highly resistant to arcing and film formation, provides an operating life of 150,000 cycles.

CIRCLE NO. 462

Logic card drives 8 transmission lines

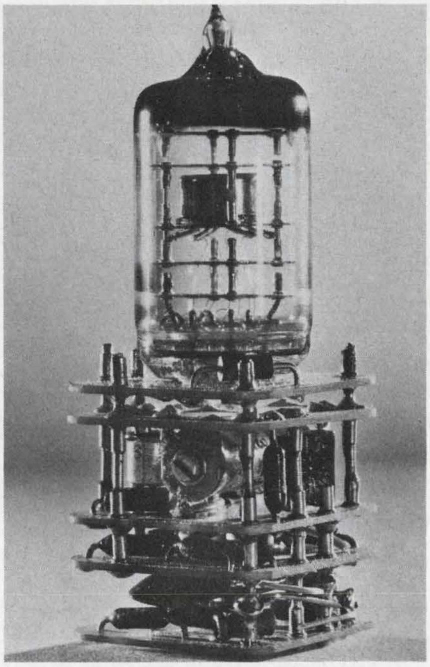


California Systems Components, Inc., 9176 Independence Ave., Chatsworth, Calif. Phone: (213) 341-1050. P&A: $95; stock.

Four independent gated transmission line driver circuits are designed into this logic card. Each driver circuit is capable of driving up to two 50-Ω transmission lines in parallel. With a 25-Ω max load the circuit will have less than 10-ns rise and fall times and less than 20-ns stretch. The card features DTL integrated circuits and silicon discrete transistors.

CIRCLE NO. 463

Miniature oscillator accurate to 1 part in 10^8

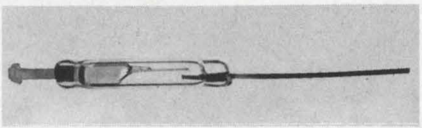


Marconi Co. Ltd., Chelmsford, Essex, England. Phone: Chelmsford 53221.

A temperature stabilization technique, employing a microelectronic circuit, is embodied in a new range of miniature master oscillators. The oscillators, which have a short term stability of 1 part in 10^8, have applications in airborne equipment and portable man-pack receivers employing the most advanced methods of radio communication.

CIRCLE NO. 464

Mercury-wetted reed bounce free

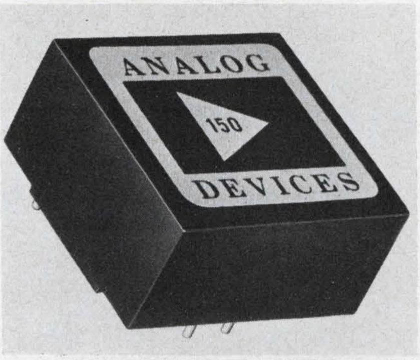


Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J. Phone: (201) 743-6800.

Mercury-wetted reed switches, available spst-NO, are bounce-free and stable in contact resistance and pull-in sensitivity. They are capable of switching loads of 1 A at 50-Vdc for 50 x 10^6 operations. The switch has a glass diameter of 0.25 inch, glass length of 0.7 inch and over-all uncut length of 1.625 inches.

CIRCLE NO. 465

Op-amp runs 1000 hours from two 3-V cells



Analog Devices, 221 Fifth St., Cambridge, Mass. Phone: (617) 491-1650. P&A: $30; stock.

This differential dc operational amplifier gives 1000 hours service from a pair of Mallory #TR132R batteries. Besides conventional instrumentation uses, model 150 has applications in upgrading or retrofitting existing instruments and systems. It can operate (with battery pack) thousands of volts above ground, provide isolated measurement for high voltage cables, increase range, sensitivity and input impedance of d'Arsonval meters, turn dc meters into wideband ac instruments, raise input impedance of chart recorders and other apparatus, and operate remotely from solar-powered photovoltaic cells. Output is 1.5 V at 2.5 mA.

CIRCLE NO. 466

Linear amplifiers from 20 to 80 MHz

Applied Research, Inc., 76 S. Bayles Ave., Port Washington, N. Y. Phone: (516) 767-8707. P&A: $3500 and $4500; 45 to 60 days.

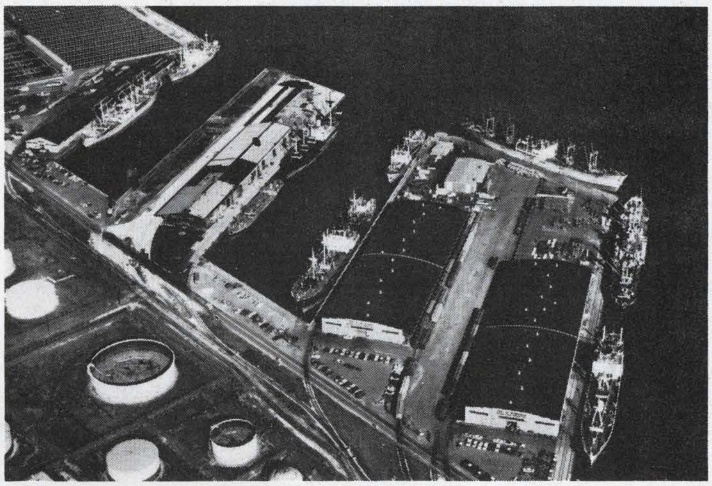
Two solid-state high power RF amplifiers have been developed featuring linear operation, low power drain and high power output. The units are useful in transmission systems, as spectrum analyzers, direction finders and signal sources.

CIRCLE NO. 467

Remember to return your **ELECTRONIC DESIGN** renewal card. Don't miss any issues in '67.

Milwaukee offers MORE transportation

Locate your plant in Milwaukee and get your products to market fast.



EXPANDED WORLD PORT NEW EXPRESSWAYS EXPANDED AIRPORTS / NEW RAIL TERMINAL / NEW BUS TERMINAL

Did you know that some other city officials actually refer to us as "hustlers"?

We're delighted!

Because when they call us hustlers, they're enviously referring to our extremely well organized, highly developed transport system, unequaled by any other midwestern industrial city. With your plant here, your raw products move *in* fast, your finished products move *out* fast. And all this happens at lower shipping cost than you'd experience elsewhere.

Here's the run-down on our move-out: the best located deep-water world port on the Great Lakes with a natural harbor connecting three navigable rivers. This is fast access to the St. Lawrence Seaway to Europe and ideal for barge transport to the Gulf of Mexico. Rail transport? Five railroads converge on Milwaukee with reciprocal and main line switching in the city. Furthermore, Milwaukee has 62 truck lines in operation with a wide choice of terminal service. Five commercial airline carriers serve us at our rapidly expanding General Mitchell Field, private and corporate aviation is booming at Timmerman Field. Our $400 million dollar expressway system is being rushed to completion so your product can rush to its destination.

Finally, Milwaukee is *"shut-down-proof"*. No floods, hurricanes or tornadoes. And, an occasional snowstorm is always defeated by the finest equipped force in the nation within a few hours.

Rush a letter to us now! We'll "hustle" the answers you need.

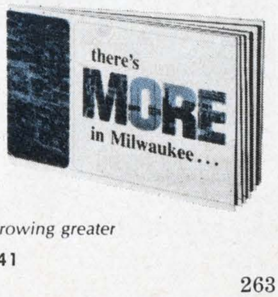
Division of Economic Development
Dept. ED-4 *Office of the Mayor / Room 201, City Hall / Milwaukee, Wisconsin 53202*

Gentlemen: Please send free copy of "there's MORE in Milwaukee". Inquiries handled in strict confidence.

NAME________________________________

ADDRESS______________________________

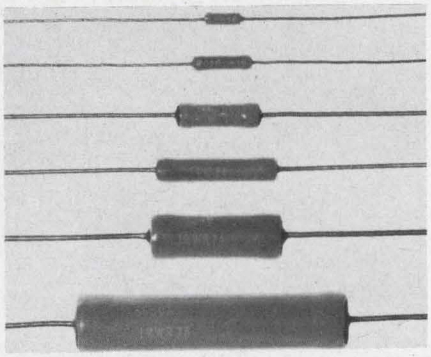
CITY________________ STATE__________ ZIP_______



MILWAUKEE... GREAT FOR BUSINESS, GREAT FOR LIVING, and *growing greater*

ON READER-SERVICE CARD CIRCLE 141

Power resistors for MIL and commercial

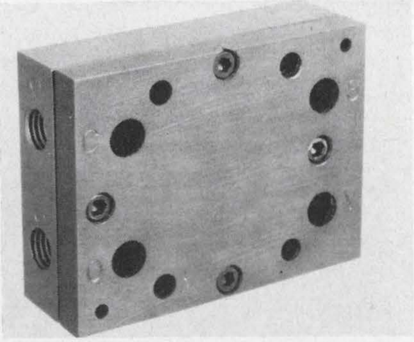


Shallcross Manufacturing Co., Preston Street, Selma, N. C. Phone: (919) 965-2341.

Two precision wirewound power resistors are offered for military and commercial applications. One series of power resistors is produced for established reliability programs requiring documentation and meets MIL-39007. Another series is offered as a general purpose power resistor for MIL-R-26 and commercial applications. Power ratings are 1 to 15 and 1 to 18 W.

CIRCLE NO. 468

Amplifier controls fluid pressures

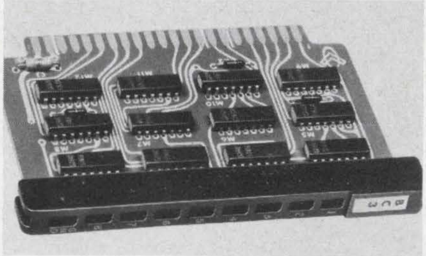


Fluidonics, Div. of Imperial-Eastman Corp., 6300 W. Howard St., Chicago. Phone: (312) 774-1700.

A pressure area amplifier for controlling high fluid pressures by using low pressure sources is offered for use with any filtered noncorrosive fluid, such as air, water, oil or natural gas. The amplifiers are available for use with corrosive fluids. The action of the amplifier is similar to that of a valve as the fluid flow can be proportionately controlled from full flow to shutoff.

CIRCLE NO. 469

12-stage counter card for time-base generators

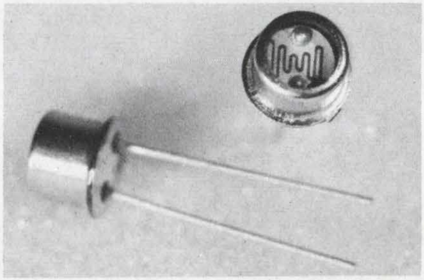


Control Logic, Inc., 3 Strathmore Rd., Natick, Mass. Phone: (617) 655-1170. P&A: $105.25; stock.

Capable in binary or BCD code, a 12-stage counter card is particularly useful in time base generators and as frequency dividers. The 12 flip-flop stages may be used as a 4-bit to 12-bit binary or as a 1-to-3-digit BCD counter. Two or more cards may be used to construct counters of any length. The counters operate from dc to 1 MHz and have a maximum propagation delay per decade of 120 ns.

CIRCLE NO. 470

CdS photocells measure 1/4 inch across



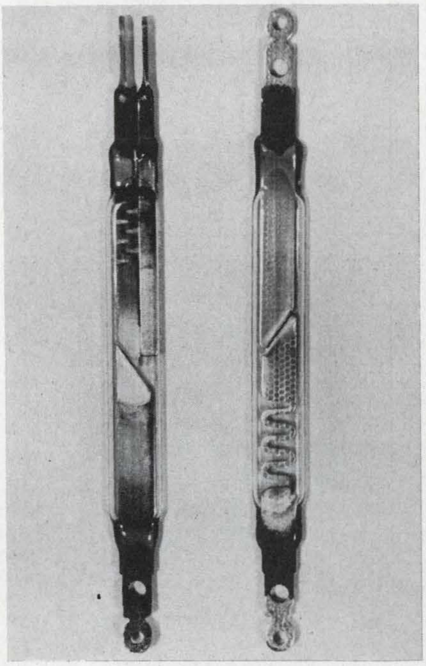
Sylvania Electric Prod., Inc., Electronic Components Group, Emporium, Pa. Phone: (315) 568-5881.

Hermetically sealed photocells, measuring less than 1/4 inch in diameter, are suited for use in high-density photoconductor arrays. The TO-18 photocells are rated for 50-mW power dissipation. They are available in light/resistance ratings ranging from 3000 to 125,000 Ω (at 2 footcandles), with a dark/light resistance ratio of 100 to 1.

CIRCLE NO. 471

Don't risk missing any issues of **ELECTRONIC DESIGN.** Send in your renewal card today.

Flat-sealed contacts live to be 10 billion



Tele-Norm Corp, 32-31 57th St., Woodside, N. Y. Phone: (212) 988-1935. P&A: $5.50 to $27 (1 to 9); stock.

Flat-sealed contacts (FSC) are less than half the size of usual reed switches but operate at higher speeds for at least 10 billion operations on dry circuit switching. Form A and Form C are the same size and the magnetic latching relay available with Form A needs no holding current. For switching systems and electronic circuitry, the FSC contacts come pakaged in 1, 2, 4, 6, 10, 16 and 22-contact relays for panel mounting or for printed circuitry.

CIRCLE NO. 472

IC logic cards in 50 configurations

Wyle Products Division, 133 Center St., El Segundo, Calif. Phone: (213) 322-1763.

A line of IC logic cards includes positive and negative logic, mercury reed relays, input and output level converters, gate expanders and many other functions. Included in the new series is a breadboard blank card with mounting space for eight dual in-line IC packs and discrete components.

CIRCLE NO 473

You can buy a sample now of this new General Electric solid state lamp!

This is the SSL-1, actual size. It's a 2- to 5-volt solid state light source that emits 40 footlamberts of visible light end on @ 50 ma. Turns on and off at the rate of 10,000 cycles per second. Resists shock and vibration better than any filament lamp. Lasts indefinitely with no loss in efficiency!

SSL-1 is a remarkable new development of General Electric Miniature Lamp research. You'll want to consider it in your business, wherever tiny tough lamps are required. As an indicator or photo cell driver, it has hundreds of applications in computers, missiles, telephone equipment and aircraft, to name a few.

ORDER SAMPLES TODAY

Perhaps the SSL-1 can help save space, improve performance, reduce maintenance cost in *your* product. It's easy enough to find out: SSL-1 lamps are available now at just $9.50 each. Order today. Just fill in the coupon and mail it with your check or money order. (Or contact your regular GE lamp representative.) Your calibrated SSL-1 will come to you cradled in styrofoam, protected in a rigid plastic box.

Need more data? Send for free technical bulletin #3-7041. It's yours for the asking.

Miniature Lamp Department

GENERAL ELECTRIC

TO: General Electric Company
Miniature Lamp Department
P.O. Box 2422, Nela Park, Cleveland, Ohio 44112
Attn: J. D. McMullen

Please send me________new GE SSL-1 lamp(s) at $9.50 ea.

Total enclosed $________

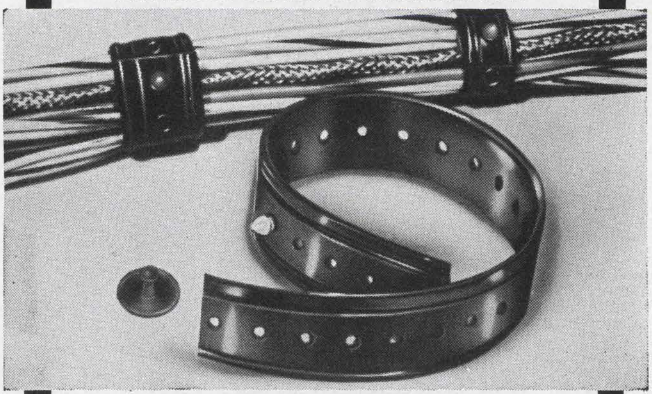
Name________

Company________

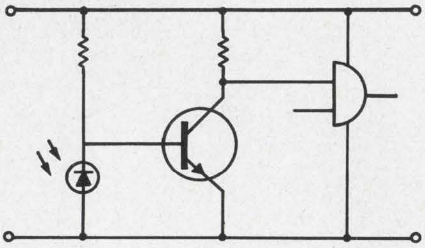
Address________

City________State________Zip________

ON READER-SERVICE CARD CIRCLE 143



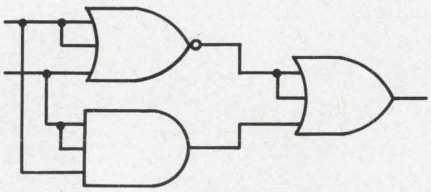
Application Notes



Photocell/IC applications

Integrated circuit applications for photocells are fully described in a 6-page brochure. Features are the advantages of silicon photocells, the degree of performance of photovoltaic devices, definitions of modes of operation, application considerations and charts illustrating uses of the cells such as the discrete transistor preamp shown above. Sensor Technology, Inc.

CIRCLE NO. 474



DTL applications handbook

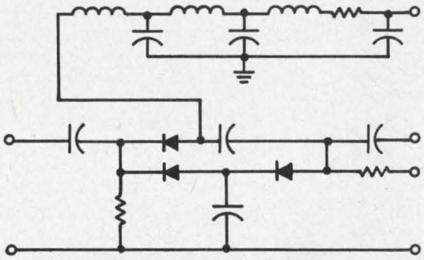
A new, 32-page Applications Handbook gives the system designer complete descriptions of Signetics DTL family. In addition to the text which presents circuit descriptions and characteristics, more than 100 illustrations present design information and detailed application examples, such as the digital comparator above, in the form of schematic and block diagrams. Signetics Corp.

CIRCLE NO. 475

Reversible counter uses

"Using a Reversible Counter" is a 44-page book surveying some varied applications for reversible counters. There is a treatment of transducers for converting length, angle, flow rate, etc., to electrical signals suitable as inputs to the counter. Transducers covered include laser interferometers, optical gratings, tachometers and several types of flow meters. An extensive list of references completes the manual. Hewlett-Packard.

CIRCLE NO. 476



Pin diode attenuators

Constant-impedance current-controlled attenuator design is detailed in an 8-page note. The attenuators span 10 MHz to 1 GHz using pin diodes. Design equations, curves and component selection are fully explored. hp Associates.

CIRCLE NO. 477

Printed motors

The class of servos in which the printed motor has been applied is the intermittent motion, or incrementer system. In these applications, low inertial load is required to be started and stopped rapidly and repeatedly. This 13-page brochure describes the characteristics and applications of such motors. Printed Motors Div. of Photocircuits, Inc.

CIRCLE NO. 478

SCR control circuits

A set of eight application notes details the design of SCR control circuits for varying devices. Controls for blowers, electric drills, electric fences, dc flashers and alarm circuits are included. Schematics and tables of values aid the discussions. ITT Standard.

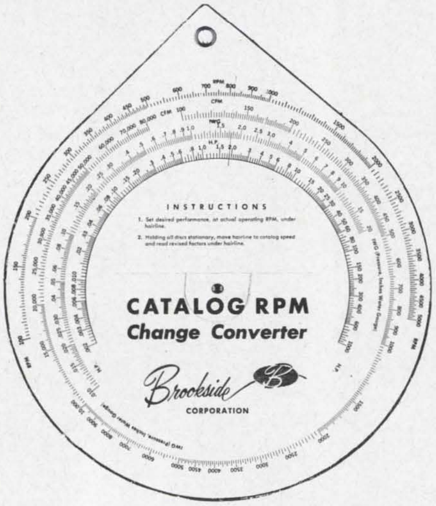
CIRCLE NO. 479

Regulated supply

Use of an IC op-amp as the sense and control element in a power supply regulator is the theme of a 4-page loose-leaf brochure. Text and schematics describe the external circuitry needed for regulated outputs of 20 to 28 Vdc from a 30-V unregulated source. Molecular Electronics Div., Westinghouse.

CIRCLE NO. 480

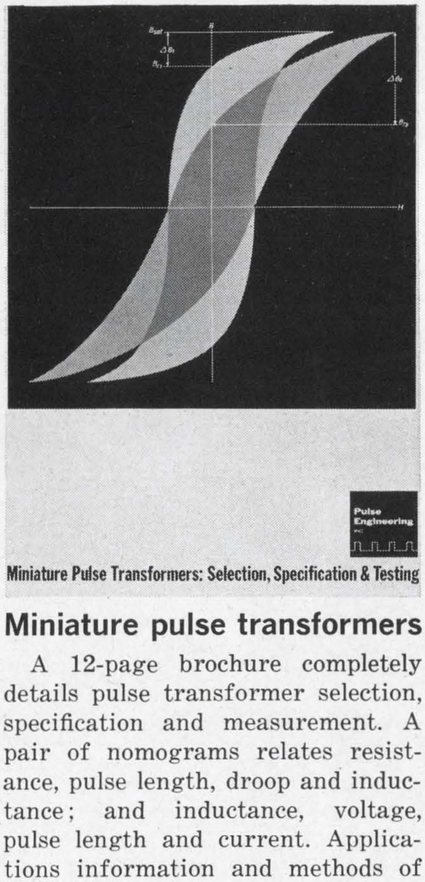
Design Aids



Cooling system design rule

Relate actual cooling system, performance with desired system characteristics using this circular slide rule. When the selected fan's catalog performance (including horsepower) and speed are placed under the hairline, actual system performance is determined by moving the hairline to the actual operating speed. Brookside Corp.

CIRCLE NO. 481

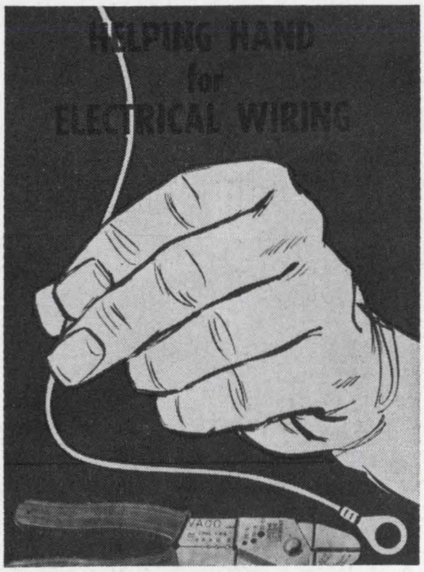


Miniature Pulse Transformers: Selection, Specification & Testing

Miniature pulse transformers

A 12-page brochure completely details pulse transformer selection, specification and measurement. A pair of nomograms relates resistance, pulse length, droop and inductance; and inductance, voltage, pulse length and current. Applications information and methods of measurement are fully covered. Pulse Engineering, Inc.

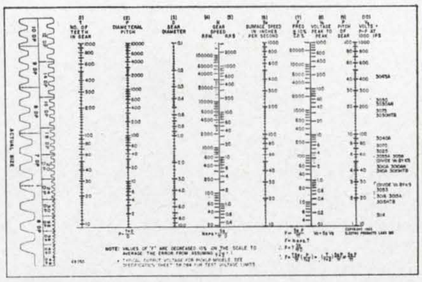
CIRCLE NO. 482



Production line 'how to'

Two pocket-sized guidebooks, "How to Use Screwdriver" and "Helping Hand for Electrical Wiring," present "how to" facts, illustrations and pointers. "Helping Hand" details techniques in electrical connections and splices. It covers a discussion of basic electricity complete with diagrams to illustrate wiring methods, tools and accessories. Sections show assembly line applications in control panels, transformers, relays and motors. The booklet includes wire size and decimal equivalent charts, an "automatic" terminal selector and a glossary. Vaco Products Co.

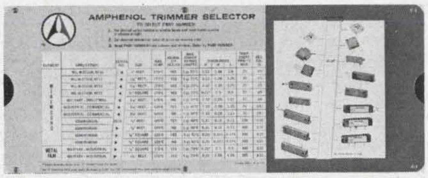
CIRCLE NO. 483



Magnetic pickup handbook

Magnetic pickups are completely defined in a handy 6-page fold-out booklet. A set of charts and the nomogram shown above aid in calculations. The nomogram relates the number of gear teeth, diameteral pitch, gear diameter, gear speed, surface speed, frequency, peak-to-peak voltage, gear pitch and peak-to-peak voltage at 1000 inches per second. Electro Products Laboratories, Inc.

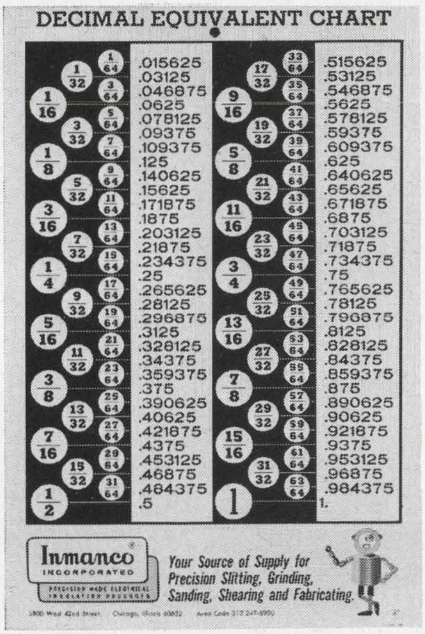
CIRCLE NO. 484



Trimmer selector

Amphenol Controls' entire line of wirewound and metal film trimmers is presented in slide rule form for easy selection. The desired series number, by application and size, is set in one window and the model number is read opposite a photo of the trimmer at the right. By turning the rule over and setting the desired resistance value, part number and per cent resolution are given. Ordering may then be done by noting Amphenol prices and comparing them with those of Bourns, Dale, Spectrol, IRC, Daystrom and Helipot which are given in a handy table. Amphenol Controls Div.

CIRCLE NO. 485



DECIMAL EQUIVALENT CHART

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	1.

Inmanco
INCORPORATED
PRECISION MADE ELECTRICAL INSULATION PRODUCTS

Your Source of Supply for Precision Slitting, Grinding, Sanding, Shearing and Fabricating.

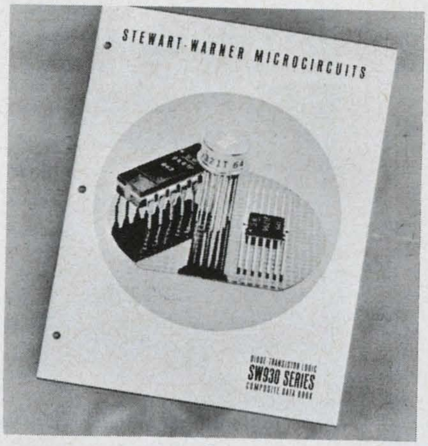
Decimal equivalent wall chart

This 16 x 10-1/2-in. wall chart converts frequently used fractions to decimals at a glance. Decimals are carried to 6 places for accuracy. Accompanying the wall chart is the latest Product Data Bulletin from the manufacturer covering electrical insulation products. Inmanco, Inc.

CIRCLE NO. 486

Don't forget to return your **ELECTRONIC DESIGN** renewal card.

New Literature



DTL data book

A 20-page data book details the DTL930 series of compatible monolithic integrated logic circuits. Circuits are shown for all data presented, specifically defining how data was derived, and circuits, logic and pin layouts, diagrams and package dimensions are presented along with details of product reliability programs. A glossary of terms defines parameters used. Descriptions are given of test techniques. Stewart-Warner Corp.

CIRCLE NO. 487

Switch uses unlimited

"Uses Unlimited" describes a dozen switch applications in solving industrial problems. One of the illustrated features describes an application in which inspection is accomplished on an eight-dimension steel stamping. Another feature deals with minimizing the effects of radio frequency interference. Other switch applications describe flow-actuated proximity, explosion-proof and mercury switches in unusual installations. Micro Switch, Div. of Honeywell.

CIRCLE NO. 488

360-page products catalog

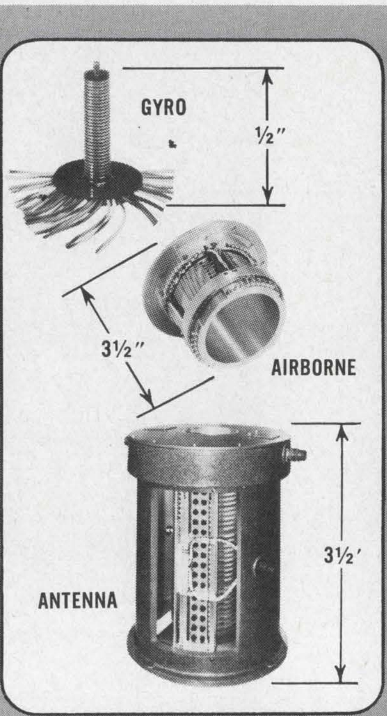
A 360-page volume features product listings from 113 manufacturers, with pricing up-to-date. An accurate index provides specific assistance in finding the desired product. Complete line catalogs from 21 manufacturers are available.

Available on company letterhead from Esco Electronics, 3130 Valleywood Drive, Dayton, Ohio.

NPL

SLIP RINGS

These assemblies provide a means of transferring electrical energy from stationary to rotating elements. They are used in rotating radar antenna systems, fire control systems, missile guidance and tracking, gyroscopes, rotary components, stress and temperature analysis, power transmissions, and in many other applications where electrical connections must be maintained between stationary and rotating units.



NPL

NORTHERN PRECISION LABORATORIES INC.
202 Fairfield Road • Fairfield, New Jersey 07006 • Area Code 201 227-4800

ON READER-SERVICE CARD CIRCLE 148

"I DON'T MIND PAYING A LITTLE LESS"

With An Airways Businessman's Credit Card He'll Save Even More Money

Being a practical man and a business traveler, this man knows he qualifies for a special Rent-A-Car discount by presenting his AIRWAYS BUSINESSMAN'S CREDIT CARD at any of over 200 AIRWAYS offices. He knows AIRWAYS regular rates are lower than other rent-a-car companies *including their 20% corporate discounts.* With an AIRWAYS BUSINESSMAN'S CREDIT CARD he knows he'll enjoy *even greater savings.* He knows AIRWAYS provides 1967 Chevrolets, Buicks, Pontiacs —even Cadillacs. He also knows he'll save time because he simply calls when he arrives at the airport and AIRWAYS will probably arrive before his luggage. We have downtown offices, too. **He knows it — AIRWAYS knows it — now YOU know it.**

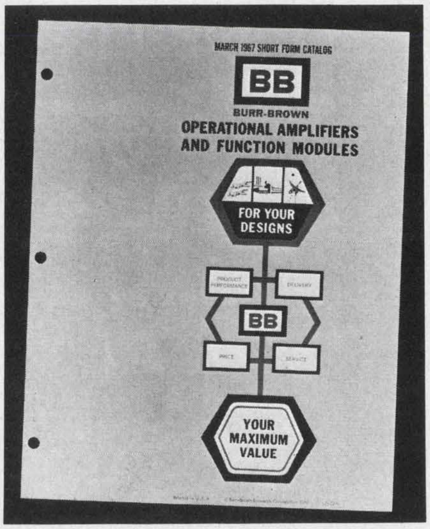
Send for your free AIRWAYS BUSINESSMAN'S CREDIT CARD now. Write to: Dept. 000

AIRWAYS RENT-A-CAR
5410 West Imperial Highway
Los Angeles, California 90045

Pontiac Le Mans

AIRWAYS RENT-A-CAR®

ON READER-SERVICE CARD CIRCLE 149



MARCH 1967 SHORT FORM CATALOG

BB

BURR-BROWN

OPERATIONAL AMPLIFIERS AND FUNCTION MODULES

FOR YOUR DESIGNS

BB

YOUR MAXIMUM VALUE

Op-amp and function modules

This 16-page illustrated catalog describes analog and hybrid plug-in modules along with twenty-two op-amps, a line of instrumentation amps, seven function modules, a line of active filters and eleven power supplies. It includes 50 op-amps which are available in various package styles. The instrumentation amp line includes transducer amps, preamps, and galvanometer amps. The epoxy-encapsulated line of function modules includes squaring modules, a quarter-square multiplier, a noise generator, logarithmic amps, an analog comparator and electronic switch modules. Burr-Brown Research Corp.

CIRCLE NO. 489

82-page instruments catalog

An 82-page catalog entitled "Modular Instruments" is available. It contains specifications on modular nuclear instruments. Also included is a guide to assist the user in selecting the proper combination of modules for a specific application. A separate section describing input and output accessories which are used to complete the modular system is contained. Nuclear-Chicago Corp.

CIRCLE NO. 490

CO_2 laser applications

"On the significance and use of CO_2 lasers" is an 8-page report covering theory and applications. A complete rundown on lab experiments is included. Seed Electronics Corp.

CIRCLE NO. 491

Power transistor selection

A 28-page book covers silicon and germanium transistors for military, industrial and commercial applications. Each family of transistors is presented in a separate section and includes typical h_{FE}, V_{BE} and V_{CE} curves, along with specification charts and outline dimension drawings. Suggested applications are included. Solitron Devices.

CIRCLE NO. 492

Wire marking brochure

A 12-page brochure describes a line of wire/cable harnessing, marking and accessory products. Included in the booklet are three types of harnesses, adjustable P-clips, three types of markers and grommet strip. Illustrations with dimensional drawings and tables providing physical properties, chemical properties, applications, ordering data and specifications are included. Electrovert, Inc.

CIRCLE NO. 493

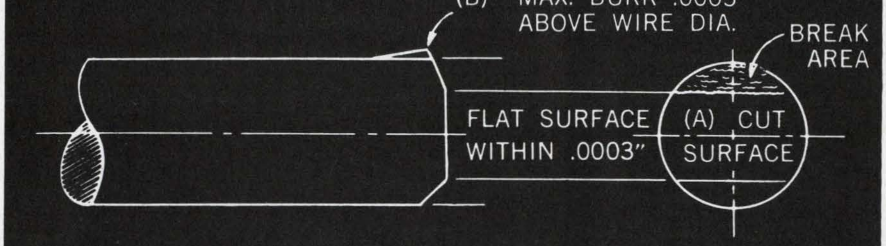
Coaxial switches

A 12-page technical discussion completely covers coaxial switches. Included are principles of operation, descriptions of basic design types and relative merits, contact arrangements and switching actions, operational differences, definitions of terms and performance characteristics, drive methods, trade-off characteristics and a guide to specification. The discussion includes a comparison of the merits of electromechanical switches vs solid-state switches. Sage Labs.

CIRCLE NO. 494

Remember to return your **ELECTRONIC DESIGN** renewal card. Don't miss any issues in '67.

How far can you go when you specify square cut leads?



Straightening and cutting wire isn't as simple as it looks. Especially when you need a surface on which to weld or solder. Here's what we've developed on a typical .018 diameter lead.

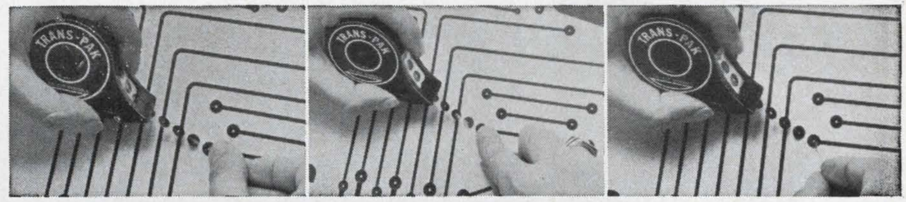
Cut Surface — 80% minimum cut (See "A" above)
Cut Off Burr — Maximum .0005" above wire diameter (See "B" above)
Flatness — Within .0003"
Overall Length Tolerance — ±.002"

Ask Art Wire. Send a print or a part for a quotation.

Write for catalog and samples.

ART WIRE & STAMPING COMPANY
17 Boyden Place, Newark, N. J. 07102

ON READER-SERVICE CARD CIRCLE 150



POSITION .... PRESS .... PEEL

TRANS-PAK Die-Cut SYMBOLS

THE FASTEST METHOD OF PREPARING PRINTED CIRCUIT MASTERS

NOW IN A NEW HANDY DISPENSER

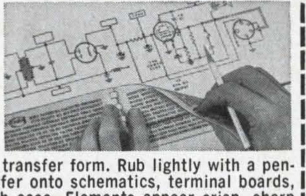
Yes, here is the original TRANS-PAK "Position . . . Press . . . Peel" method with a brand new twist . . . a new, handy dispenser that makes the preparation of printed circuit masters easier than ever before. No inking, no cutting, no stripping. One convenient package gives you terminal pads, elbows, connectors, teardrops or any other symbol, die-cut to exacting tolerances for dimensional stability and distortion-free placement. Just reach for the dispenser and "press down" a perfect symbol. Takes just seconds.

TRANS-PAK pressure-sensitive die-cut symbols are available in black crepe paper and red translucent material. Never a die-charge for special orders.

POSITION TITLES, WORDS, LETTERS, NUMBERS IN SECONDS, TOO!

deca-dry®
BY CHART-PAK, INC.

ELECTRONIC MARKING KIT



Kit contains all the standard titles, codes, words, letters and numbers in dry transfer form. Rub lightly with a pencil and instantly they transfer onto schematics, terminal boards, printed circuit masters with ease. Elements appear crisp, sharp . . . look just like the finest printing. Won't move, crack or peel. Produce razor sharp copies in most reproduction processes.

Chart-Pak Inc. A subsidiary of Avery Products Corp. 344 River Rd., Leeds, Mass. 01053

Please send catalog describing TRANS-PAK Printed Circuit Symbols.

☐ **I am interested in Deca-Dry Electronic Marking Kit!**

Name .... Title ....
Company ....
Address ....
City .... State .... Zip ....

Look in the Yellow Pages under Art Supplies, Drafting Supplies, Charts/Business, Tapes for your dealer's name.

ON READER-SERVICE CARD CIRCLE 151

Advertisers' Index

impact

Union Carbide Electronics, Mountain View, California has just placed the largest exclusive advertising campaign in magazine publishing history.

Their objective: To become an even greater factor in the fast-paced twenty-one billion dollar electronics industry.

Their campaign: 138 pages over the next 12 months.

Their magazine: **Electronic Design.**

Union Carbide Electronics and their agency, Hal Lawrence, Inc., decided the best return on their advertising investment would be achieved by concentrating in the magazine read by the greatest number of their prime customers and prospects.

They backed up their decision by scheduling multi-page semiconductor advertisements in every bi-weekly issue of Electronic Design.

Advertisements that will be selling the men who specify what goes into what the sales department sells, the accounting department accounts, the production department produces.

138 pages over the next 12 months . . . that's **impact.**

Electronic Design

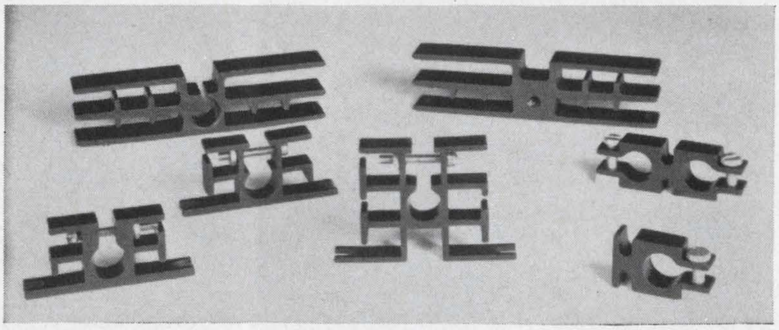
MOST READ BY THE MEN WHO SPECIFY

Winner of Industrial Marketing and Jesse Neal Awards for Editorial Excellence in 1966

Hayden Publishing Co., Inc., 850 Third Avenue, New York 10022

Publishers of Electronic Design and Microwaves Magazines . . . Hayden, Rider and Ahrens Books

Free Convection / Compact Conduction



Both the 2700 and 2800 series Astrodyne heat sinks provide easy, secure mounting of transistors for printed circuit board and other applications. Model 2700 series have a thermal resistance of 10 to 30° C /watt. Fins permit optimum free air flow and minimum conduction losses. This series is well suited for close card packaging.

Model 2800 units provide sufficient surface contact with chassis or other metal mounting surface to assure good heat dissipation not provided by conventional transistor mounting clips. They offer a temperature difference between transistor case and chassis of 2° C /watt per transistor.

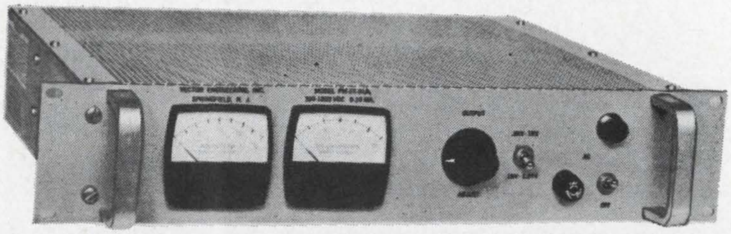
Both the 2700 and 2800 series feature split mounting hole with screw clamps to permit compensation for transistor case tolerances and maximum effective contact area between the case and sink. The units, as pictured, will accommodate both TO-5 and TO-9 transistor cases. Mounting holes for other transistors can be made to customer specification.

The black-anodized aluminum units are available from stock. Technical data and price information will be sent on request.

astrodyne, inc.
SUBSIDIARY OF ROANWELL CORP.
207 CAMBRIDGE ST., BURLINGTON, MASS. (617) 272-3850

ON READER-SERVICE CARD CIRCLE 153

"REGULATED"
HIGH VOLTAGE POWER SUPPLIES
Operate PHOTOMULTIPLIER and MICROWAVE tubes
with Line and Load Regulation ±0.001%
Output Ripple: 2 Millivolts PEAK to PEAK



VECTOR ENGINEERING INC.'s Model PM-1K-01A
provides a highly regulated stable source of D.C. Power. Either output terminal may be grounded thus providing a plus or minus output voltage.

SPECIFICATIONS:

Output Voltage: 200-1800
Output Current: 0-10MA
Ripple: 2MV Peak to Peak
Line Regulation: 0.001%
Load Regulation: 0.001%
Stability: 0.01%/HR
Dimensions: 3½"Hx19"Wx14½"D

Guaranteed to operate continuously in an ambient temperature of 0 to 50°C. A pair of 2% accuracy (full scale) meters are mounted on the front panel to monitor both voltage and output current.

For further information concerning this supply or other "CUSTOM DESIGNED" high voltage, regulated, low ripple, low T.C. power supplies, contact Vector Engineering, Inc. directly.

VECTOR engineering inc.
58 BROWN AVENUE, SPRINGFIELD, NEW JERSEY 07081 · TEL. 201: 379-7800
TWX: 710-983-4448

ON READER-SERVICE CARD CIRCLE 154

Electronic Design

Advertising Representatives

New York 10022
Robert W. Gascoigne
Thomas P. Barth
Samuel M. Deitch
850 Third Avenue
(212) PLaza 1-5530
TWX: 867-7866

Philadelphia
Fred L. Mowlds, Jr.
P. O. Box 206
Merion Station, Pa. 19066
(215) MO 4-1073

Boston
Richard Parker
7 Redstone Lane
Marblehead, Mass. 01945
(617) 742-0252

Chicago 60611
Thomas P. Kavooras
Berry Conner, Jr.
720 N. Michigan
(312) 337-0588

Cleveland
Robert W. Patrick
8410 Treetower Drive
Chagrin Falls, Ohio 44107
(216) 247-7670

Los Angeles 90303
Stanley I. Ehrenclou
Terrence D. Buckley
W. James Bischof
2930 W. Imperial Highway
Inglewood, Calif.
(213) 757-0183

San Francisco
Ashley P. Hartman
175 South San Antonio Rd.
Ste. 243
Los Altos, Calif. 94022
(415) 941-3084

Southwestern 75206
Tommy L. Wilson
6200 North Central Expressway
Dallas, Tex.
(214) EMerson 1-2311

London W. 1
Brayton C. Nichols
44 Conduit Street

Verviers, Belgium
Andre Jamar
1, Rue Mallar, 1
(087) 253.85

Tokyo
Yoshihiro Takemura
International Planning Service, Inc.
Room 231 Tokyu-Mita Bldg.
1, Shiba-Mita Koun-cho
Minato-ku, Tokyo

BPEA

BPA

AMERICAN BUSINESS PRESS, INC.

Electronic Design

ELECTRONIC DESIGN'S aims are fourfold. It aids progress in the electronics manufacturing industry by promoting good design. It gives the electronic design engineer concepts and ideas that will make his job easier and more productive. The magazine serves as a central source of timely, up-to-the-minute electronics information. And finally it seeks to encourage two-way communication between manufacturer and engineer.

Want a subscription? ELECTRONIC DESIGN is circulated free of charge to qualified engineers and engineering management doing design work, supervising design or establishing standards in the United States, Western Europe and the United Kingdom. If you think that you are entitled to a free subscription, use the postage-free application form that you will generally find inside the back cover. When it is not included in an issue, write to us direct for an application form.

If you are not qualified, you may take out a paid subscription at the following rates: $25 a year if you live in the U.S.A. or $35 a year if you live elsewhere. Single copies may be purchased for $1.50 each.

If you change your address, send us an old mailing label and your new address. If you have been receiving ELECTRONIC DESIGN free of charge, you will have to requalify to continue doing so.

We strive for accuracy. We take the utmost pains to ensure the highest standard of accuracy throughout the magazine. A single mistake in practical design information can have serious consequences. But to err is human, and for all the care we take, an occasional error slips through. Whenever this occurs, we publish a correction at the earliest opportunity. You will find these corrections printed at the end of the Letters column. If you should spot an error, be sure to let us know. You may save your colleagues heartaches.

Microfilm copies are available of complete issues of ELECTRONIC DESIGN and of single articles that have been published since the beginning of 1961. Complete issues cost 4¢ a page, individual pages cost 50¢ each, plus shipping and handling charges. The minimum charge is $3; delivery time runs from 10 days for single pages to five weeks for complete issues. For further details and to place orders, get in touch directly with University Microfilms, Inc., 300 N. Zeeb Road, Ann Arbor, Mich. 48106; telephone (313) 761-4700.

Want to contact us? If you have any inquiries about these or other matters, or if you have a manuscript outline or article idea, address your correspondence to:

Howard Bierman, Editor,
ELECTRONIC DESIGN,
850 Third Avenue,
New York, N.Y. 10022.

Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card.

(Advertisement)

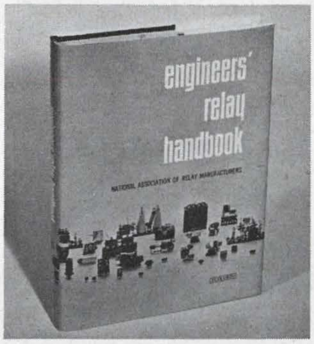
New "Tape Lift" Printed Circuit Drafting Aids

No engineer or draftsman should be without the most up-to-date cross-reference guide to better Printed Circuit Drafting Catalog. It is complete with prices and illustrations of over 1200 sizes of "Tape Lift" pads, shapes and other aids for faster, more accurate, distortion-free printed circuit master drawings. Write for FREE catalog.

By-Buk Company
4326 West Pico Blvd., Los Angeles, Calif. 90019
Telephone: (213) 937-3511

178

Engineers' Relay Handbook

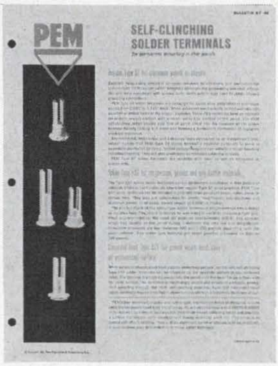


A definitive work that is fast becoming a standard reference text for the relay user. Prepared and edited by the National Association of Relay Manufacturers, this book is a complete guide to the principles, properties, performance characteristics, application requirements, specifications, and testing of relays. Systems and product engineers will find the *Handbook* an indispensable help in determining the correct types of relays for their applications. For further information about this unique sourcebook, write Dept. ED

Hayden Book Co., Inc.
116 W. 14th Street
New York, N. Y. 10011

179

Pem Self-clinching Solder Terminals



Bulletin ST-166 describes a complete line of PEM self-clinching solder terminals for permanent mounting on thin panels. Information discloses data on PEM spline and concealed head types as well as the regular type ST. These solder terminals provide permanent electrical connections, resistant to vibrations and environmental disturbances and are electroplated with tin and stearic acid wax for ease of soldering and resistance to oxide development during storage. Bulletin ST-166 includes dimensions, installation suggestions and design limitations.

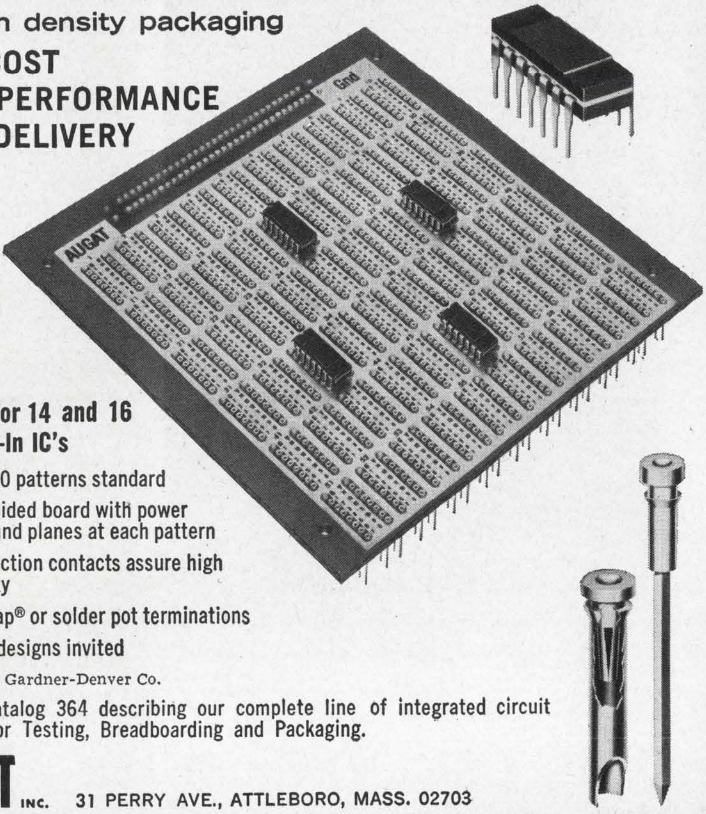
Penn Engineering & Manufacturing Corp.
Box 311
Doylestown, Pennsylvania 18901

180

IC PACKAGING PANELS

for high density packaging

LOW COST
HIGH PERFORMANCE
FAST DELIVERY



PANELS For 14 and 16 Lead Plug-In IC's

- 30 and 60 patterns standard
- Double-sided board with power and ground planes at each pattern
- Wiping-action contacts assure high reliability
- Wire-Wrap® or solder pot terminations
- Custom designs invited

®Trademark Gardner-Denver Co.

Request Catalog 364 describing our complete line of integrated circuit products for Testing, Breadboarding and Packaging.

AUGAT INC. 31 PERRY AVE., ATTLEBORO, MASS. 02703

ON READER-SERVICE CARD CIRCLE 155

RFI/EMI Detection

with CEI's Ultra-Sensitive New VLF-LF Receiver

CEI's new Type 355 Receiver is designed for RFI and EMI detection, covering the 1 kHz to 600 kHz frequency range in a single band. Selectable IF bandwidths (1 kHz, 6 kHz, 20 kHz, 50 kHz) assure detection of both wideband and narrowband signals.

All solid state, the Type 355 is unusually sensitive, with an excellent noise figure and high image and IF rejection. A modified version is also available, Type 355-1, which provides X-Y outputs to record on an X-Y plotter. For complete specifications, please contact:

CEI

COMMUNICATION ELECTRONICS INCORPORATED
6006 Executive Blvd., Rockville, Md. 20852 · Phone (301) 933-2800 · TWX: 710-824-9603

ON READER-SERVICE CARD CIRCLE 156

Designer's Datebook

MAY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUNE

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

For further information on meetings, use Reader Service card.

May 1-3

Commercial Utilization of Space Meeting (Dallas) Sponsor: American Astronautical Society; P. O. Box 1415, Grand Prairie, Tex. 75050.

CIRCLE NO. 495

May 3-5

Electronic Components Technical Conference (Washington, D.C.) Sponsors: IEEE, EIA; W. S. Hepner, Jr., Electronic Ind. Assoc., 2001 Eye St., Wash., D. C. 20006.

CIRCLE NO. 496

May 4-5

American Society of Naval Engineers Meeting (Washington, D.C.) Sponsor: ASNE; Miss R. Leonard, ASNE, Suite 507, 1012 14 St., N.W., Washington, D. C. 20005.

CIRCLE NO. 497

May 9-11

Frontiers of Energy Conversion—IEEE Region 6 Conference (Albuquerque, N. M.) Sponsor: Region 6 IEEE; B. D. Trembly, Barnhill Assoc., Albuquerque, N. M. 87101.

CIRCLE NO. 498

May 16-18

National Telemetering Conference (San Francisco) Sponsors: IEEE, AIAA, ISA; Lewis Winner, 152 W. 42 St., New York, N. Y. 10036.

CIRCLE NO. 499

May 18-19

Midwest Symposium on Circuit Theory (Lafayette, Ind.) Sponsors: IEEE, Purdue University; G. F. Lee, Purdue University, Lafayette, Ind. 47907.

CIRCLE NO. 600

hp new disciplines in DC

take the NEWEST CONCEPT in Bench DC Power Supplies

Advanced fabrication techniques result in higher quality at lower cost

Two Compact Models Available

0-25V @ 0-400 MA ... 0-50V @ 0-200 MA • 0.01% Regulation

Two extremely compact, well-regulated DC power supplies designed especially for bench use have just been added to the hp power supply line. New fabrication techniques have been employed for these supplies to minimize manufacturing costs while retaining component and circuit quality. Reliable, yet low cost, these "hand-size" battery substitutes have over-all performance features ideal for circuit development, component evaluation, and other laboratory applications.

The all-silicon circuit uses an input differential amplifier to compare the output voltage with a reference voltage derived from a temperature-compensated zener diode. These stable input and reference circuits are combined with a high gain feedback amplifier to achieve low noise, drift-free performance. Output voltage is fully adjustable **down to zero.** Special design precautions prevent output overshoot during turn-on or turn-off, or when AC power is suddenly removed.

The front panel meter can be switched to monitor output voltage or current. Constant Voltage/Current Limiting insures short-circuit-proof operation, and permits series and parallel connection of two or more supplies when greater voltage or current is desired.

The molded, impact-resistant case includes an interlocking feature for stacking several units vertically, thus minimizing bench space required for multiple supplies. Alternatively, up to three units can be mounted side by side on a standard 3½" H x 19" W rack panel.

DC Output:	Model 6215A, 0-25V at 0-400 MA Model 6217A, 0-50V at 0-200 MA
Either positive or negative output terminal may be grounded, or the supply may be operated "floating" up to 300V off ground.	
AC Input:	105-125 VAC*, 50-400 Hz
Load Regulation:	0.01% + 1 MV
Line Regulation:	0.01% + 4 MV
Ripple & Noise:	<200 μv RMS
Temperature Coefficient:	<0.02% + 1 MV/° C
Stability for Eight Hours After 30 Minutes Warm-up:	<0.1% + 5 MV
Transient Recovery Time:	<50 μs for output recovery to within 10 MV following a full load change
Output Impedance:	<0.03 ohms from DC to 1 KHz <.5 ohms from 1 KHz to 100 KHz <3 ohms from 100 KHz to 1 MHz
Maximum Ambient Operating Temperature: + 55°C	
Size:	3¼" (8.26 cm) H x 5¼" (13.34 cm) W x 7" (17.78 cm) D
Weight:	5¼ lbs (2,38 kilograms)
Price—Model 6215A: Model 6217A:	$90.00 $90.00

*210-250 VAC input also available

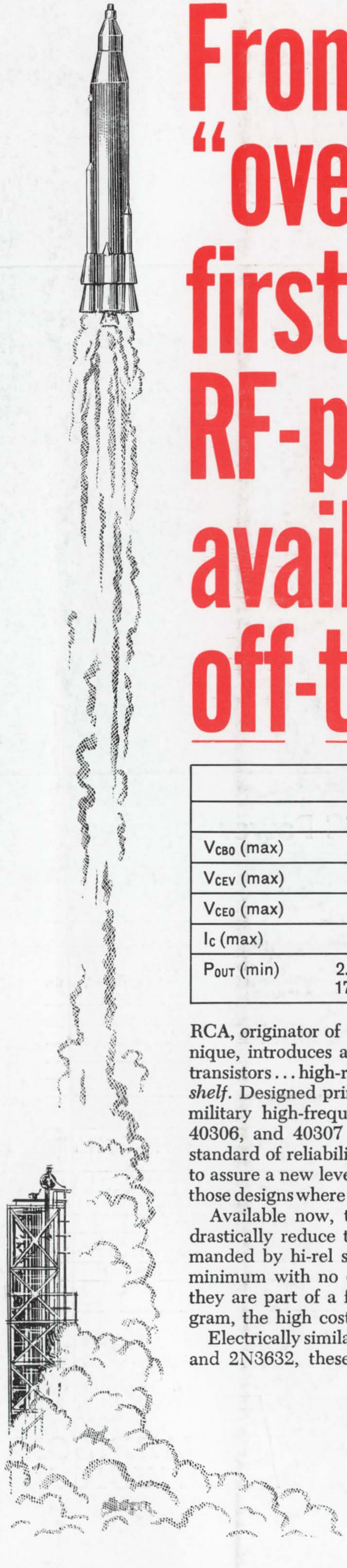
Contact your nearest Hewlett-Packard Sales Office for full specifications

HEWLETT
PACKARD hp HARRISON
DIVISION

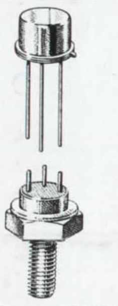
100 Locust Ave., Berkeley Heights, New Jersey 07922 TELEPHONE 201 - 464-1234 TWX 710-984-7972

21702

ON READER-SERVICE CARD CIRCLE 128



From RCA "overlay"... first high-reliability RF-power transistors available off-the-shelf

RATINGS FOR RF SERVICE					
	40305	40306	40307	Units	
V_{CBO} (max)	65	65	65	Volts	
V_{CEV} (max)	65	65	65	Volts	
V_{CEO} (max)	40	40	40	Volts	
I_C (max)	1.0	1.5	3.0	Amperes	
P_{OUT} (min)	2.5W @ 175 MHz	7.5W @ 100 MHz	13.5W @ 175 MHz		

RCA, originator of the revolutionary "overlay" technique, introduces another new concept in rf-power transistors... high-reliability units *available off-the-shelf*. Designed primarily for critical aerospace and military high-frequency applications, RCA 40305, 40306, and 40307 transistors go beyond the high standard of reliability established by RCA "overlay" to assure a new level of confidence... confidence for those designs where device failure cannot be tolerated.

Available now, these three "overlay" transistors drastically reduce the time and effort normally demanded by hi-rel specs... response time is kept to minimum with no delivery problems. And because they are part of a formal RCA high-reliability program, the high cost of "customizing" is eliminated.

Electrically similar to RCA types 2N3553, 2N3375, and 2N3632, these hi-rel devices are designed to meet MIL-S-19500. (Hi-rel selections of "overlay" types 2N3733, 2N4012, and 2N4440 are also available.) Each transistor is subjected to strictly controlled pre-conditioning tests including:

- Fine Leak, 1 x 10^{-8} cc/sec/max.
- Gross Leak, 70 psig, 16 hours min.
- Acceleration Test (2006 of MIL-STD-750, 10,000 G, Y_1 axis)
- Temperature Cycling (MIL-STD-202)
- Power Age (168 hours)
- X-ray Inspection, RCA Spec 1750326

For more information on RCA's "overlay" high-reliability capability, consult your RCA Representative. For technical data on 40305, 40306, and 40307, write: RCA Commercial Engineering, Section 1G4-4, Harrison, N.J. 07029.

ALSO AVAILABLE FROM YOUR RCA DISTRIBUTOR

RCA Electronic Components and Devices

RCA®

The Most Trusted Name in Electronics

ON READER-SERVICE CARD CIRCLE 129