Electronic Design

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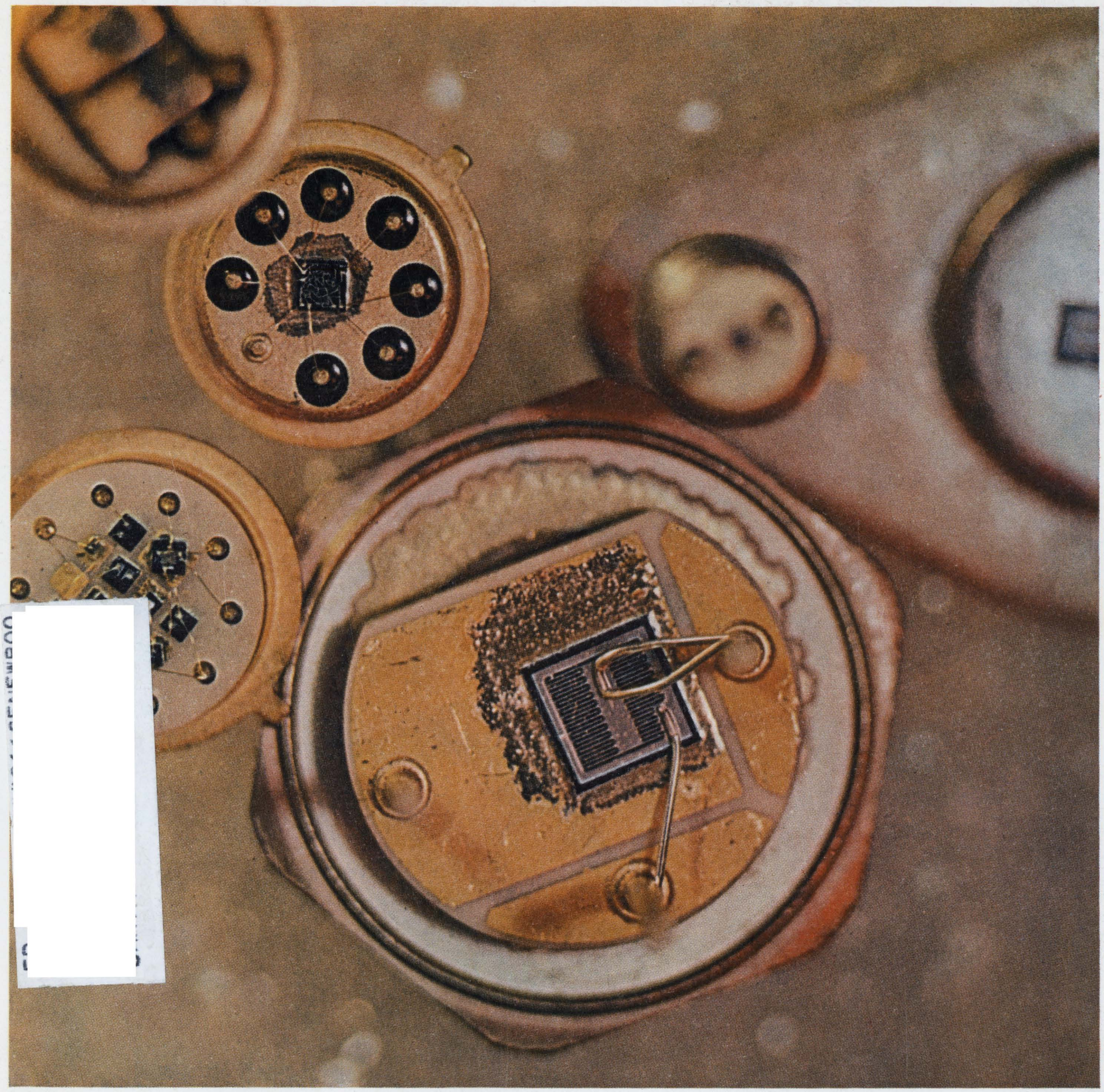
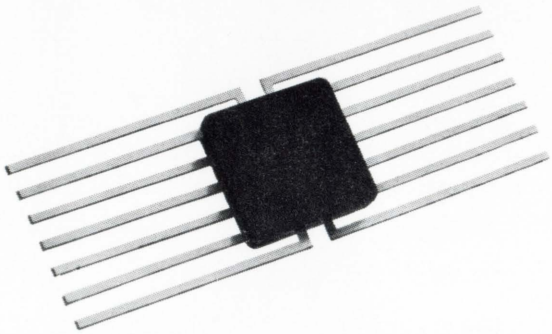
MAY 17, 1966

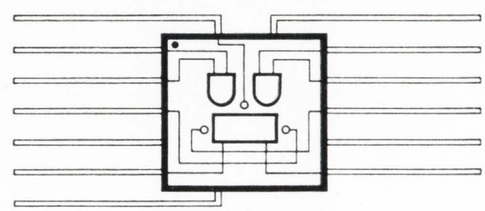


When the chips are down, an applications-oriented semiconductor directory is your best bet for optimum device selection. Bipolars, FETs, UJTs and integrated circuits are listed by key parameters. You also learn who-makes-what in diodes, SCRs and rectifiers. Articles show design basics, trade-offs.

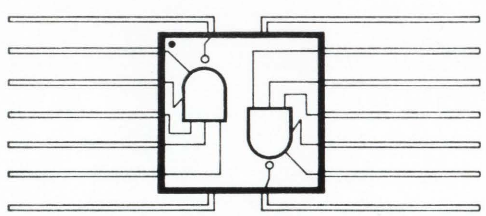
#3704-16

FAIRCHILD LOW POWER LOGIC

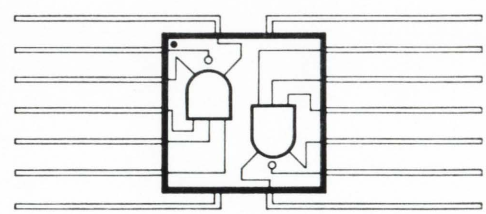




LPDTμL 9040



LPDTμL 9042



LPDTμL 9041

FEATURES:

Low Power drain .... less than 1mW/gate (typ.) @ 50% duty cycle
less than 4mW/clocked flip-flop
Single power supply requirement .... 5V optimum, 4.5V to 5.5V range
Guaranteed noise immunity .... 450mV min. at temperature extremes
Logic propagation delays .... 60nsec. typical
Binary clock rate 2.5Mc
Full temperature range .... −55°C to +125°C

LPDTμL LOW POWER DIODE-TRANSISTOR MICROLOGIC™ CIRCUITS

Fairchild LPDTμL integrated circuits offer high performance in the low milliwatt range. High resistance values and small chip geometry hold down power consumption. The flip-flop element operates either in the R-S or J-K mode, with maximum dissipation of 6mW at a 2Mc toggle rate. Gates provide fan-out capability of 10 LPDTμL low power logic unit loads, or one standard Fairchild DTμL diode-transistor logic unit load. (Standard Fairchild DTμL logic circuits can be used to extend the fan-out capability still further). The circuits come in Fairchild's Cerpak flat package, and can be used in satellites, battery-operated field equipment, or other instruments where reliability and high performance must be achieved with limited power. Fairchild LPDTμL low power integrated circuits are available in evaluation quantities from distributors. For complete information write to:

FAIRCHILD
SEMICONDUCTOR

FAIRCHILD SEMICONDUCTOR/A Division of Fairchild Camera and Instrument Corporation ■ 313 Fairchild Drive, Mountain View, California (415) 962-5011 ■ TWX: 910-379-6435

Micrologic is Fairchild's trademark for integrated circuits.

ON READER-SERVICE CARD CIRCLE 2

Electronic Design's
SEMICONDUCTOR DIRECTORY
1966

Mark B. Leeds,
Rene Colen
Technical Editors

Here is the industry's only complete applications-oriented semiconductor directory. Combining ELECTRONIC DESIGN's fourteenth annual transistor data chart and third annual microelectronics data chart with a who-makes-what diode guide, the directory gives you in one package:

- All the device information you need to pinpoint solid-state design needs—listed according to major design parameters.
- Technical articles explaining how to use the specifications, major application areas and the governing design parameters.
- Convenient Reader-Service Card (good for a full year) to order detailed device specifications direct from the manufacturer.

Transistors are classified according to seven application categories: Audio and General-Purpose, High-Frequency, Power, Low-Level Switching, High-Level Switching, Unijunction and Field-Effect. Within each category, types are arranged in order of improving values of a key design parameter. This listing method permits rapid identification of close substitutes, because device specifications can be compared at a glance. The manufacturer listed in the "Mfr." column is the original registrant of the type for which data are supplied. Alternate suppliers are listed in the "Remarks" column.

The diode chart provides a fast guide to the manufacturers who make the specific type of diode you need.

Microelectronic devices are divided into two major categories: Digital and Linear. Within these categories the devices are listed by logic type, in the case of digital circuits, and by application, in the case of linear circuits.

Cross-indexes for both transistors and microcircuits simplify the job of finding the specific device when the type number is known.

Keep your semiconductor data up-to-date by doing the following:

Step 1: Obtain specification sheets and other data, by finding the appropriate numbers on the manufacturers' literature list (pp. 4-9) and circling them on the Reader-Service Card.

Step 2: Get your own copy of the 1966 Semiconductor Directory by circling Reader-Service No. 500.

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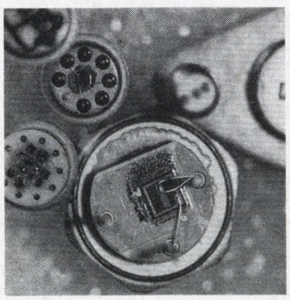
TRANSISTORS

DIODES/RECTIFIERS

MICROELECTRONICS



The cover photo, courtesy of Fairchild Semiconductor, Mountain View, Calif., shows a number of popular solid-state devices. At the upper right is part of an SCR (2N4319 type); resting on the left portion of the SCR structure is a FET (F1100 type); in the center foreground is a 2N1724 power transistor with an isolated collector; to its left, a hybrid flip-flop (SH2300 type); slightly above and to the right of the flip-flop is a μA709 monolithic operational amplifier; at the extreme upper left is part of a dual-bipolar unit (2N2060 type).

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61,114 copies this issue.

List of 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. Consult dot charts (Transistors: p. 21, Diodes/Rectifiers: p. 164, and Microelectronics: p. 179, 182, 188) to learn who makes what in each device category. Starred (*) listings mean requests for literature and data sheets must go directly to the manufacturers.

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Airtron Div., Litton Industries 200 E. Hanover Ave. Morris Plains, N.J. 07950 (201) 539-5500	Data sheets. Article reprints.		201	
	Alpha Industries 381 Elliot St. Newton Upper Falls, Mass. 02164 (617) 969-5310	Data sheets. Catalogs. Customer applications service.		202	
AL	**Amelco Semiconductor** 1300 Terra Bella Ave. Mountain View, Calif. 94042 (415) 968-9241	Short form catalog.	203		204
	American Electronic Laboratories Inc. P.O. Box 552 Lansdale, Pa. 19446 (215) 822-2929	Data sheets. Catalogs. Article reprints. Customer applications service.		205	
	American Semiconductor Corp. 4 N. Hickory Ave. Arlington Heights, Ill. 60004 (312) 392-8830	Data sheets. Catalogs.		206	
AMP	**Amperex Electronic Corp.** Providence Pike Slatersville, R.I. 02876 (401) 762-9000	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	207	208	209
	Atlantic Semiconductor Inc. 905 Mattison Ave. Asbury Park, N.J. 07712 (201) 775-1827	Data sheets. Catalogs. Data manuals.		210	
	Bell, F. W., Inc. 1356 Norton Ave. Columbus, Ohio 43212 (614) 294-4906	Data sheets.		211	
BE	**Bendix Semiconductor Div.** South St. Holmdel, N.J. 07733 (201) 747-5400	Catalogs. Design aids.	212	213	
	Bradley Semiconductor Corp. 275 Welton St. New Haven, Conn. 06506 (203) 787-7181	Data sheets.		214	
BU	**Burroughs Corp. Electronic Components Div.** P.O. Box 1226 Plainfield, N.J. 07061 (201) 757-5000	Data sheets. Facilities brochure.	215	216	
CBS	**CBS Laboratories** High Ridge Road Stamford, Conn. (203) 325-4321			*	*
	Chatham Electronics Div. Tung-Sol Electric Inc. 630 W. Mt. Pleasant Ave. Livingston, N.J. 07039 (201) 992-1100	Data sheets. Catalogs.		217	
	Computer Diode Corp. Pollitt Drive Fair Lawn, N.J. 07410 (201) 797-3900	Data sheets.		218	
	Conant Laboratories 6500 O St. Lincoln, Neb. 68501 (402) 488-0432	Catalogs.		219	
CDC	**Continental Device Corp.** 12515 Chadron St. Hawthorne, Calif. 90250 (213) 772-4551	Data sheets. Catalogs. Article reprints.	220	221	

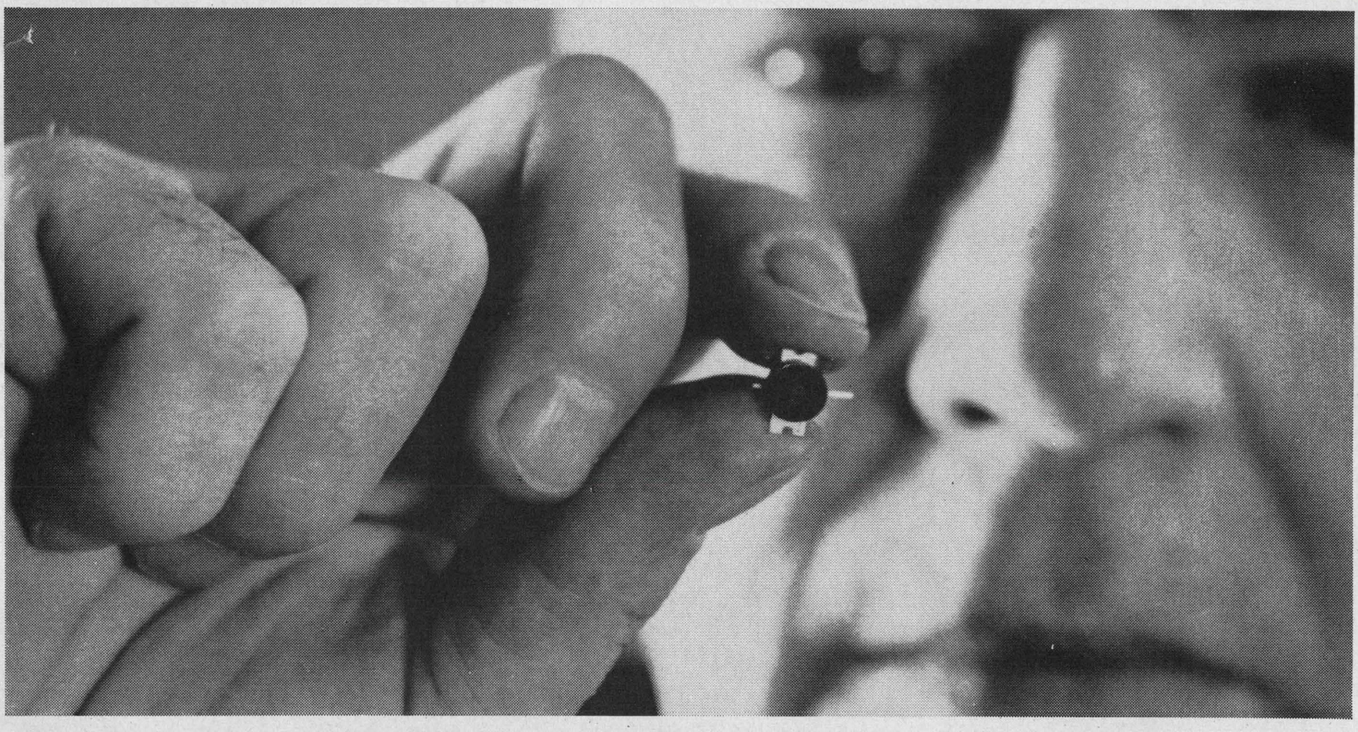
Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
CT	**Crystalonics Inc.** 147 Sherman St. Cambridge, Mass. 02140 (617) 491-1670	Short form catalog.	222	223	
DE	**Delco Radio Div., General Motors Corp.** 700 E. Firmin St. Kokomo, Ind. 46901 (317) 457-8461	Short form catalog.	224	225	
	Delta Semiconductors Inc. 879 W. 16th St. Newport Beach, Calif. 92660 (714) 646-3286	Data sheets. Catalogs.		226	
DIC	**Dickson Electronics Corp.** P.O. Box 1387 Scottsdale, Ariz. 85252 (602) 947-5751	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.	227	228	
	Diodes Incorporated 20235 Nordhoff Chatsworth, Calif. 91311 (213) 341-4850	Data sheets. Catalogs.		229	
	Eastern Delta Corp. 29-09 Broadway Fairlawn, N.J. 07411 (201) 797-4200	Data sheets.		230	
	Eastron Corp. 25 Locust St. Haverhill, Mass. 01830 (617) 373-3824	Data sheets. Catalogs. Application notes.		231	
	Edal Industries 4 Short Beach Road East Haven, Conn. 06512 (203) 467-2591	Data sheets. Catalogs. Article reprints. Customer applications service. Design aids.		232	
	Edgerton, Germeshausen & Grier, Inc. 160 Brookline Ave. Boston, Mass. 02215 (617) 267-9700	Data sheets. Application notes.		233	
	Electro-Optical Systems Inc. 255 N. Halstead Pasadena, Calif. 91107 (213) 449-1230			*	
	Electronic Devices Inc. 21 Gray Oaks Ave. Yonkers, N.Y. 10710 (914) 965-4400	Data sheets.		235	
ETC	**Electronic Transistors Corp.** 153-13 Northern Blvd. Flushing, N.Y. 11354 (212) 539-6700	Data sheets. Catalogs.	236		
	Erie Technological Products Inc. 644 W. 12th St. Erie, Pa. 16512 (814) 456-8592	Catalogs. Application notes.		237	
FA	**Fairchild Semiconductor** 313 Fairchild Drive Mountain View, Calif. 94040 (415) 962-5011	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.	238	239	240
	Fansteel Metallurgical Corp. Number One Tantalum Place North Chicago, Ill. 60064 (312) 336-4900			*	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
GE	**General Electric Co. Semiconductor Products Dept.** Bldg. 7, Electronics Park Syracuse, N.Y. (315) 456-2798	Data sheets. Catalogs. Application notes. Article reprints.	242	243	244
GI	**General Instrument Corp. Technical Service Center** 600 W. John St. Hicksville, N.Y. 11802 (516) 681-8000	Data sheets. Catalogs.	245	246	247
GME	**General Micro-electronics Inc.** 2920 San Ysidro Way Santa Clara, Calif. 95051 (408) 245-2966	Catalogs.	248		249
	General Semiconductors, Inc. 230 W. 5th St. Tempe, Ariz. 85281 (682) 966-7263	Data sheets. Catalogs. Data manuals. Customer applications service.		250	
	Green Rectifier Corp. 1-10 30 St. Fairlawn, N.J. 07411 (201) 797-8100			*	
	HP Associates 620 Page Mill Road Palo Alto, Calif. 94304 (415) 321-8510	Data sheets. Application notes.		252	
	Heliotek Div., Textron Electronics Inc. 12500 Gladstone Ave. Sylmar, Calif. 91342 (213) 365-6301			*	
HOF	**Hoffman Electronics Corp. Semiconductor Div.** Hoffman Electronic Park El Monte, Calif. 91734 (213) 686-0123	Data sheets. Catalogs. Application notes. Article reprints.	254	255	256
HU	**Hughes Aircraft Co. Microelectronics Div.** 500 Superior Ave. Newport Beach, Calif. 92663 (714) 548-0671	Data sheets. Application notes.	257	258	259
	Hunt Electronics Co. 2617 Andjon Dallas, Tex. 75220 (214) 352-8421			*	
ITT	**ITT Semiconductors** 3301 Electronics Way West Palm Beach, Fla. 33402 (305) 842-2411	Catalogs.	260	261	262
IND	**Industro Transistor Corp.** 35-10 36th Ave. Long Island City, N.Y. (212) 392-8000		*		
	Instrument Systems Corp. 770 Park Ave. Huntington, N.Y. (516) 423-6200	Data sheets.		264	
IN	**Intellux, Inc.** 26 Coromar Dr. Goleta, Calif. 93017 (805) 968-3541	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service. Design aids.			265
	International Diode Corp. 90 Forrest St. Jersey City, N.J. 07304 (201) 432-7151			*	

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
IEC	**International Electronics Corp.** 316 South Service Road Melville, L.I., N.Y. 11749 (516) 694-7700	Data sheets. Catalogs. Customer applications service.	267	268	
	International Rectifier Corp. 233 Kansas St. El Segundo, Calif. 90245 (213) 678-6281	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service. Design aids.		269	
	IRC Inc., Semiconductor Div. 71 Linden St. W. Lynn, Mass. 01905 (617) 598-4800	Data sheets. Catalogs. Customer applications service.		270	
KMC	**KMC Semiconductor Corp.** Parker Road Long Valley, N.J. 07853 (201) 876-3811	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.	271	272	
KSC	**KSC Semiconductor Corp.** 437 Cherry St. West Newton, Mass. (617) 969-8451		*		
	Korad Corp. 2520 Colorado Ave. Santa Monica, Calif. 90404 (213) 393-6737			*	
LAN	**Lansdale Transistor & Electronics Inc.** 1111 N. Broad St. Lansdale, Pa. 19446 (215) 855-9004		*		
	Ledex, Inc. 123 Webster St. Dayton, Ohio 45402 (513) 224-9891	Catalogs.		274	
	MSI Electronics Inc. 116-06 Myrtle Ave. Richmond Hill, N.Y. (212) 441-6420	Data sheets. Catalogs.		275	
	Mallory Semiconductor Co. 424 S. Madison St. DuQuoin, Ill. 62832 (618) 542-2154	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service. Design aids.		276	
MEP	**Mepco, Inc.** Columbia Road Morristown, N.J. 07960 (201) 539-2000	Data sheets.			277
	MicroSemiconductor Corp. 11250 Playa Court Culver City, Cal. 90230 (213) 391-8271	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service. Design aids.		278	
	Micro State Electronics Corp. Subsidiary of Raytheon Co. 152 Floral Ave. Murray Hill, N.J. 07971 (201) 464-3000	Data sheets. Catalogs. Application notes. Article reprints.		279	
	Microwave Associates Northwest Industrial Park Burlington, Mass. 01803 (617) 272-3000	Data sheets.		280	
MO	**Motorola Semiconductor Products, Inc.** 5005 E. McDowell Road Phoenix, Ariz. 85008 (602) 273-6900	Data sheets. Short form catalogs. Application notes.	281	282	283

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	National Electronics Inc. Geneva, Ill. 60134 (312) 232-4300	Data sheets.		284	
NA	**National Semiconductor Corp.** Commerce Road Danbury, Conn. (203) 744-0060		*		*
NOR	**Norden Div., United Aircraft Corp.** Helen St. Norwalk, Conn. 06856 (203) 838-4471	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.			285
NUC	**Nucleonic Products Co., Inc. Components and Devices Div.** 3133 E. 12th St. Los Angeles, Calif. 90023 (213) 968-3464	Data sheets.	286	287	
	Ohmite Manufacturing Co. 3601 Howard St. Skokie, Ill. 60076 (312) 675-2600			*	
PR	**Philbrick Researches, Inc.** Allied Drive at Route 128 Dedham, Mass. 02026 (617) 329-1600	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service.			288
PH	**Philco Corp.** Church Road Lansdale, Pa. 19446 (215) 855-4681	Data sheets. Short form catalogs. Application notes. Article reprints. Design aids.	289	290	291
	Power Components, Inc. P.O. Box 421 Scottdale, Pa. 15683 (412) 887-6600	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		292	
RAD	**Radiation Inc.** P.O. Box 37 Melbourne, Fla. 32901 (305) 723-1511	Data sheets.		293	294
RCA	**Radio Corp. of America Electronic Components & Devices** 415 S. Fifth St. Harrison, N.J. 07029 (201) 485-3900	Catalogs.	295	296	
RA	**Raytheon Co. Semiconductor Operation** 350 Ellis St. Mountain View, Cal. 94041 (415) 968-9211		*	*	*
	Rectico Inc. 20 Village Park Road Cedar Grove, N.J. 07009 (201) 239-6464	Catalogs.		297	
	Saratoga Semiconductor Div. Espey Mfg. Corp. P.O. Box 422 Saratoga Springs, N.Y. (518) 584-4100	Data sheets.		298	
	Sarkes Tarzian, Inc. 415 N. College Ave. Bloomington, Ind. 47401 (812) 332-1435	Data sheets. Catalogs. Application notes. Data manuals. Customer applications service. Design aids.		299	
	Schauer Mfg. Corp. 4500 Alpine Ave. Cincinnati, Ohio 45242 (513) 791-3030	Catalogs. Application notes. Price lists.		300	

Show us where you can't afford to use silicon power and we'll show you the new Bendix B-5000. (25 watts at 2.5 amps, 10 volts and 100°C.)



It costs under 40¢.*

New manufacturing and packaging techniques make the B-5000 possible. These techniques include new internal device element assembly, along with new-concept plastic molding operations. The result is a simple, low-cost, reliable silicon power transistor *with no power compromise* when mounted upon the normal heat sink.

B-5000's low cost opens up whole new application areas for you. Now you can afford to put silicon power to work in many industrial and consumer products. Lighting equipment, TV sets, audio amplifiers, appliance sensing amplifiers and industrial controls, to mention a few. Compare the cost of the Bendix® B-5000 with any other silicon power unit of equal rating. You'll discover significant savings.

B-5000 offers advances in size, weight and thermal resistance. Leads and collector strips are a highly conductive material, offering excellent solderability, strength and ability to withstand flex and pull. Plastic encapsulant offers outstanding insulation resistance, hermeticity, adhesion ability and high temperature characteristics. In no way does B-5000 compromise traditionally accepted reliability practices.

With B-5000 you can tailor mounting techniques to fit your needs exactly. Depending on heat sink, available space and degree of assembly line mechanization, B-5000 can be mounted in the fashion best suited to your operation. For example, B-5000 is readily adaptable to the newer assembly solder techniques without degradation.

B-5000 lends itself equally well to other commonly used production line techniques.

Electrical specifications

Characteristic	Limits			Test Conditions				
	Min.	Max.	Unit	VCB V	VCE V	IC A	IB mA	TJ °C
VCEO	35	—	V			0.2		
ICEO	—	10	mA		25			
ICBO	—	1.5	mA	14				150
VBE	—	1.2	V		14	0.5		
hFE	30	250	—		14	0.5		
hFE	20	—	—		14	1.0		
VCE(s)	—	1.2	V			1.0	50	

Absolute maximum ratings

VCEO = 35 volts, IC = 3 amps, IB = 1 amp, Tstg = −65 to 175°C, TJ = −65 to 150°C.

For complete information about the new Bendix B-5000 silicon power transistor, write to us in Holmdel, New Jersey.

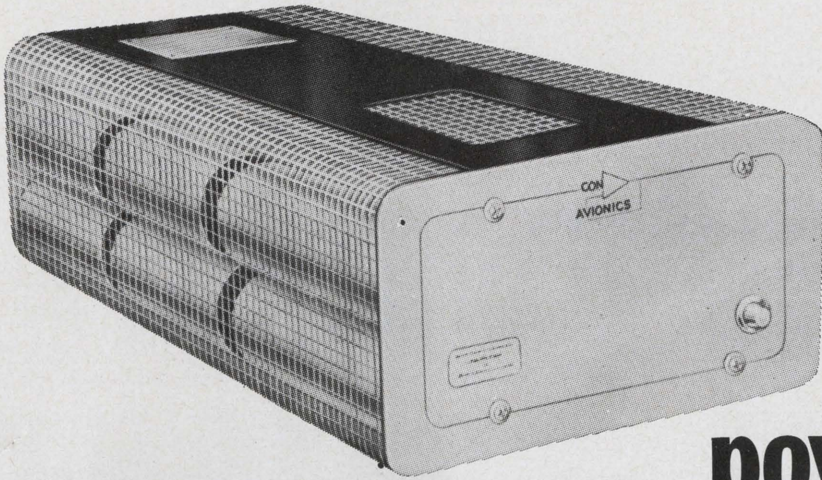
*In volume quantities

Bendix Semiconductor Division
HOLMDEL, NEW JERSEY

THE Bendix CORPORATION

ON READER-SERVICE CARD CIRCLE 4

Code	Company	Type of Information Offered	Transistor	Diode	Micro-electronics
	Semcor Div., Components Inc. 3540 W. Osborn Road Phoenix, Ariz. 85019 (602) 272-1341	Data sheets. Catalogs.		301	
	Semicon Inc. Sweetwater Ave. Bedford, Mass. 01730 (617) 275-8542	Data sheets. Catalogs.		302	
	Semiconductor Devices Inc. 875 W. 15th St. Newport Beach, Calif. 92663 (714) 642-5100	Data sheets. Catalogs.		303	
	Semiconductor Specialists Inc. 5700 W. North Ave. Chicago, Ill. 60639 (312) 622-8860	Data sheets. Catalogs. Customer applications service.		304	
	Semi-Elements Inc. Saxonburg Blvd. Saxonburg, Pa. 16056 (412) 352-1548	Catalogs.		305	
	Semtech Corp. 652 Mitchell Road Newbury Park, Cal. 91320 (213) 628-5392	Data sheets. Catalogs. Application notes. Data manuals. Customer applications service. Design aids.		306	
SA	**Siemens America Inc.** 230 Ferris Ave. White Plains, N.Y. 10603 (914) 948-3434	Data manuals.	307		
SIG	**Signetics Corp.** 811 E. Arques Ave. Sunnyvale, Calif. 94086 (408) 739-7700	Data sheets. Application notes. Article reprints.			308
STC	**Silicon Transistor Corp.** E. Gate Blvd. Garden City, N.Y. (516) 742-4100	Data sheets. Catalogs. Application notes. Customer applications service.	309	310	
SI	**Siliconix Inc.** 1140 W. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-1000	Catalogs.	311		312
	Slater Electric Inc. 45 Sea Cliff Ave. Glen Cove, N.Y. (516) 671-7000	Data sheets. Catalogs. Application notes.		313	
	Solar Systems Inc. 8241 N. Kimball Ave. Skokie, Ill. 60076 (312) 676-2040	Data sheets. Catalogs. Application notes. Article reprints. Data manuals. Customer applications service.		314	
SSP	**Solid State Products Inc.** One Pingree St. Salem, Mass. 01970 (617) 745-2900	Data sheets. Catalogs. Application notes. Customer applications service.	315	316	
SOL	**Solitron Devices Inc.** 1177 Blue Heron Blvd. Riviera Beach, Fla. 33404 (301) 848-4311	Data sheets. Short form catalogs. Data manuals.	317	318	
SSD	**Sperry Semiconductor** 380 Main Ave. Norwalk, Conn. 06852 (203) 847-3851	Data sheets. Catalogs.	319		
SPR	**Sprague Electric Co.** 491 Marshall St. North Adams, Mass. 01247 (413) 664-4411	Data sheets. Application notes. Short form catalog.	320		321
SW	**Stewart-Warner Microcircuits Inc.** 730 E. Evelyn Ave. Sunnyvale, Calif. 94086 (408) 245-9200	Data sheets. Catalogs. Application notes. Article reprints. Customer applications service.			322
SY	**Sylvania Electric Prod.** 100 Sylvan Road Woburn, Mass. 01801 (617) 933-3500	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	323	324	325
	Syntron Company 283 Lexington Ave. Homer City, Pa. 15748 (412) 479-8011	Data sheets. Catalogs.		326	
TRWS	**TRW Semiconductors Inc.** 14520 Aviation Blvd. Lawndale, Calif. 90260 (213) 679-4561	Data sheets. Article reprints. Short form catalog.	327	328	
TI	**Texas Instruments Inc.** P.O. Box 5012 Dallas, Tex. 75222 (214) 235-3111	Data sheets. Catalogs. Application notes. Customer applications service.	329	330	331
TR	**Transitron Electronic Corp.** 168 Albion St. Wakefield, Mass. 01881 (617) 245-4500	Short form catalog.	332	333	334
	Trio Laboratories 80 DuPont St. Plainview, N.Y. 11803 (516) 681-0400	Data sheets. Application notes. Customer applications service.		335	
UC	**Union Carbide Electronics** 365 Middlefield Road Mountain View, Calif. 94041 (415) 961-3300	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.	336		
	Unitrode Corp. 580 Pleasant St. Watertown, Mass. 02172 (617) 926-0404	Data sheets. Catalogs. Data manuals. Customer applications service. Samples. Test reports.		337	
	Vactec Inc. 2423 Northline Industrial Blvd. Maryland Heights, Mo. 63045 (314) 432-4200	Data sheets.		338	
	Varian/Bomac Div. Beverly, Mass. 01915 (617) 922-6000	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		339	
VAR	**Varo Inc., Special Products Div.** 2201 Walnut St. Garland, Tex. 75040 (214) 276-6141	Data sheets. Catalogs. Article reprints. Design aids.		340	341
VEC	**Vector Solid State Labs.** Southampton, Pa. 18966 (215) 357-7600		*		
	Western Semiconductors Inc. 2200 Fairview St. Santa Ana, Calif. 92704 (714) 546-2250	Data sheets. Catalogs. Application notes. Customer applications service. Design aids.		343	
WH	**Westinghouse Electric Corp. Molecular Electronics Div.** Box 7377 Elkridge, Md. 21227 (301) 796-3666	Data sheets. Short form catalog.			344
WH	**Westinghouse Electric Corp. Semiconductor Div.** Youngwood, Pa. 15697 (412) 925-7272	Data sheets. Catalogs. Application notes. Article reprints. Design aids. Short form catalog.	345	346	



the price of systems power supplies

Just Dropped $100

(Con Avionics Has Another New Line)

When we cut $100 from the going market price for systems power supplies, we kept all the features you need most.

For example, Con Avionics' new line carries an unconditional five year guarantee. It has a Mean Time Between Failure of 35,000 hours, calculated according to Mil Handbook 217. We use silicon transistors exclusively, so the units operate to 75°C. They are designed and manufactured to meet specifications under the worst possible combination of operating conditions.

The secret to maintaining all this quality at a low price lies in designing a *systems* power supply right from the start. Most modules used in high power systems applications are just modified lab units.

But when you design a supply just for systems use you worry about things like panel space. So Con Avionics new HS supplies are available in rack and half-rack size. You can pack 12 volts at 20 amps into 5¼″ of panel height and 8″ of width.

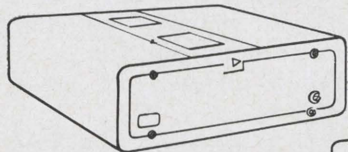
And in a system supply you design-in optimum air flow, for both vented and forced air cabinets. Our units are self-cooled, too.

Before you buy another power supply for a systems application, remember that the price is now $100 lower than it used to be. Call, write, wire or TWX Mr. Gerry Albers at Con Avionics for all the details.

PARTIAL SPECIFICATIONS

Input: 105-125 VAC, 47-63 cps
Regulation: (Line and load combined) ±0.05%
Ripple: 1 mv RMS max.
Response time: 25 microseconds
Temperature Coefficient: 0.015%/°C or 18 mv/°C., whichever is higher
Temperature: 75°C max.

The entire voltage range between 5.5 vdc and 51.0 vdc is covered in twenty-six models. Currents range from 8.0 amps to 46.0 amps. Wattages from 104.5 to 816.



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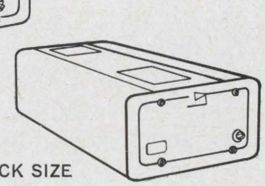

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ON READER-SERVICE CARD CIRCLE 5

Select the best transistor for the job by knowing which parameters govern for a given application. Here is the lowdown–from dc to RF and low-level thru large signal.

Modern bipolar transistors, unlike first-generation types (devices generally numbered below 2N700), have been specifically tailored to achieve optimum performance in certain applications. The key to transistor selection, then, lies in understanding and consulting the parameters which reflect a transistor's suitability for any particular application.

Here is a master chart which shows the governing parameters according to major application categories. It embraces small- and large-signal amplifiers, low- and high-speed low-level switching circuits, power switching networks and RF power amplifiers. The frequency range runs from dc to the gigahertz region.

Application categories narrow the search

Simply stated, the best transistor for an application is one which performs the intended function at lowest cost. Years ago, when nearly all transistors were made by an alloy process, differences between types could be predicted quite readily. Compromises were inevitable; the general trade-off was between frequency response and power-handling ability.

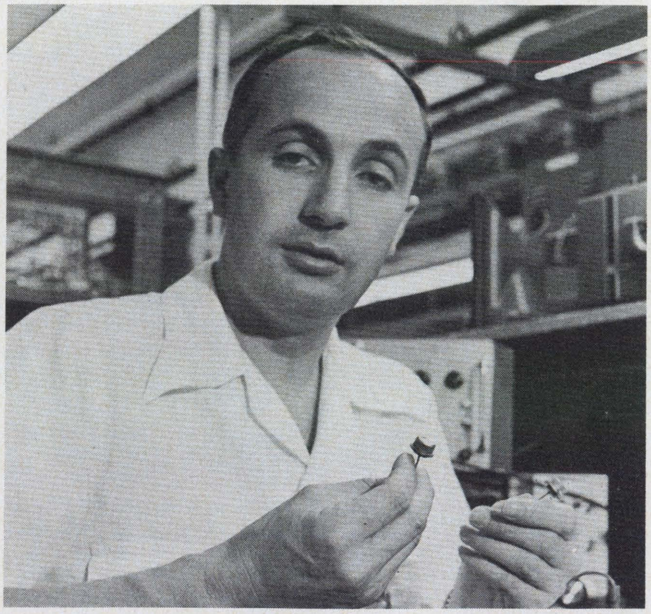
For a time, the dream of a universal transistor was entertained with the advent of mesa, planar and annular types of transistors. But the vision never materialized because with each technological advance it was found that transistors tailored to very specialized applications could be designed. These devices enabled performance in these applications to exceed by far all prior expectations.

To narrow the search for the transistor best suited to your application, a key parameter chart (see table) has been developed. The chart is applicable to the majority of available devices, including modern ones made by mesa or passivated technologies as well as older types made by alloy and grown processes.

The following definitions delineate the application categories.

- **Small-signal amplifiers to 3 Mhz.** These devices handle small amounts of power, and they need only have a limited frequency response. Operation is small-signal, that is, no large excursions of collector current are required, although collector-voltage swings may be large.
- **Small-signal amplifiers above 30 MHz.** These devices are similar to those above but are primarily intended for RF applications. There are some differences in the significant characteristics, particularly in gain, noise and agc.
- **Low level, low-speed switching and large-signal drivers.** These cover switching speeds or amplification at frequencies below 1 MHz. They are generally of the same type as those in the first category, but additional specifications such as saturation voltages and response times are needed to define switching and large-signal performance.
- **Low-level, high-speed switching.** Devices in this group are typified by a high f_T value ($>$ 50 MHz, generally) and a low storage time.
- **Large-signal amplifiers and power switching.** Representative devices have a dissipation figure in excess of five watts at a 25°C case temperature.
- **RF power amplifiers.** Devices in this category

William D. Roehr, Manager, Device Characterization Section, Applications Engineering, Motorola Semiconductor Products Inc., Phoenix, Ariz.



"Why settle for second-best?" Pick the optimum transistor type for your application by using author Roehr's guide to distinguishing between bipolar devices. It shows where and why transistors can and should be used.

are especially designed for use as power amplifiers and oscillators at frequencies exceeding 10 MHz.

Gain: major factor in small-signal amplifiers

In small-signal amplification to 30 MHz, the primary characteristic of the amplifier is the power gain of the circuit. The power gain of an amplifier-operated common-emitter with no circuit feedback is easily determined from the transistor h parameters:[1]

$$G = \frac{R_L\, h_{fe}^2}{(1 + h_{oe} R_L)\,(h_{ie} + \Delta h R_L)}, \qquad (1)$$

where R_L is the load resistance, h_{fe} the small-signal current gain (β), h_{oe} the input admittance and h_{ie} the input impedance. Note that Δh is the determinant of the $h_{ie}-h_{fe}-h_{re}-h_{oe}$ matrix where h_{re} is the voltage feedback ratio. In many cases $R_L << h_{oe}$, so that Δh and gain may be approximated by[2]

$$G = \frac{h_{fe}^2 R_L}{h_{ie}}. \qquad (2)$$

At low frequencies, input impedance h_{ie} may be written as $r'_b + h_{fe}\, r_e$, so that Eq. 2 may be further simplified to

$$G = h_{fe}\left[\frac{R_L}{r_e + (r'_b/h_{fe})}\right], \qquad (3)$$

where r'_b is the transistor base resistance, and r_e the transistor dynamic emitter resistance. A transistor stage has a power gain equal to the product of a current gain and a voltage gain. Parameter h_{fe} establishes the current gain and the resistances (primarily the R_L/r_e ratio) determine the voltage gain.

The actual amplifier design can proceed once the h parameters as a function of the operating point and some data on their inter-relationships are known. This information is usually found on the curves of a transistor data sheet.

Frequency response: a figure of merit

Second in importance only to gain in small-signal amplifiers is the frequency response. Here the gain-bandwidth frequency (f_T) is of prime interest.[3] It serves as a very useful figure of merit.

To calculate circuit cutoff-frequency, the capacitance from base to collector (C_{ob}) must also be considered. For a common-emitter amplifier without degeneration, the response will be down 3 dB at the critical frequency given by

$$f_c \approx \frac{f_T/h_{fe}}{2\pi f_T R_L C_{ob}}. \qquad (4)$$

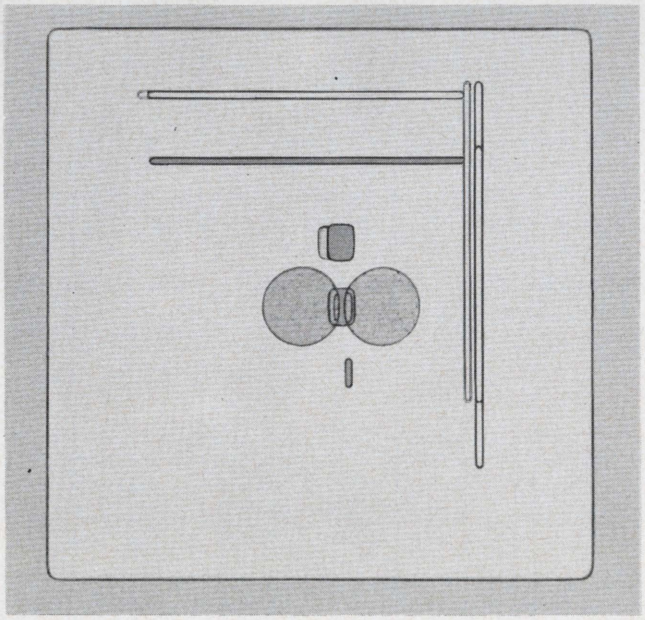
Older specification sheets generally use the term "beta-cutoff frequency," $f_{\alpha e}$, which is related to f_T by

$$f_{\alpha e} \approx f_T/h_{fe}. \qquad (5)$$

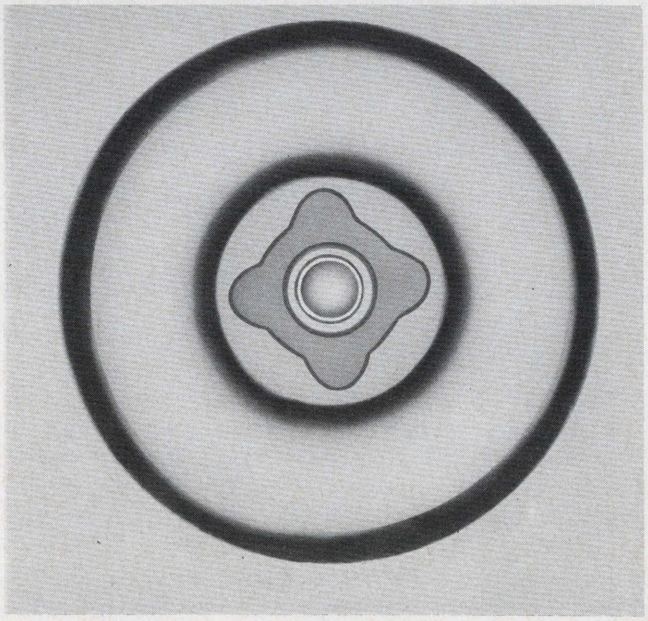
In the front ends of preamplifiers, the noise figure is all-important. Noise will be lowest for transistors having high h_{fe} and low r'_b values. Designing for low noise is usually quite involved,[4] but helpful data sheet design curves are usually supplied. If it is not specified, assume that the transistor will usually be too high to be satisfactory for first-stage preamplifier operation, particularly when low frequencies are to be handled.

Aside from gain, frequency response and noise, there are a number of other, in general, secondary parameters that must be considered.

For linear operation, the available voltage swing must generally be confined. This avoids



This micropower switching transistor geometry is the 2N3493 device (Motorola). Featuring input and output capacitances of 0.7 pF, the transistor itself is in the rectangular-shaped overlap area between the circles.



A ring-dot geometry is exhibited by the 2N3783 bipolar transistor. Suitable for very low-noise RF amplification, this Motorola device has a maximum noise of only 2.2 dB at 200 MHz. The yolk-colored pattern is the base area.

distortion due to saturation in the low-voltage region and avalanche effects in the high-voltage area. The guideline to follow—since linearity is seldom specified—is to take the specified value of V_{BE} and nine-tenths of V_{CBO} as suitable limits for load-line excursions.

Even though small-signal amplifiers dissipate low power, the power-dissipation rating at ambient temperature and the maximum junction-temperature rating deserve some attention. In addition, although the I_{CBO} leakage current is negligible in modern silicon transistors, it is large enough to cause stability problems in germanium types; where it, too, must be taken into account. In all transistors, the variation of base-emitter voltage and current gain as a function of temperature directly affects stability,[5] although V_{BE} and h_{fe} were neglected in older treatments of the subject because the effect of I_{CBO} was so much greater.

Devices classified as general purpose transistors will perform best in audio and video amplifying applications. In general, the best present types are silicon pnp passivated units, as they have the flattest curve of h_{fe} vs I_C and the lowest noise.

Engineers occasionally stretch a point in their search for a universal device. They may use a transistor which has been optimized for some other function in a small-signal amplifier application, just because the device is handy, or economical in large quantities. This may be foolhardy. For example, both silicon and germanium transistors intended for high-speed switching or *RF* amplification are poor choices as general-purpose devices. The switches, if made of silicon, will be gold-diffused to reduce storage time in saturated-mode switching service. This manufacturing practice causes the h_{fe} to be low and to fall off at low current, and also produces high leakage currents and high noise. A germanium-type switch is a poor choice because of low voltage-ratings and relatively high leakage currents. Similarly, the RF device will exhibit low gain at low frequencies and its h_{ef} is often very sensitive to changes in I_C and/or V_{CE}.

Oscillation frequency index of RF performance

RF small-signal amplifier applications require a new look at the gain and frequency parameters. The characteristics of importance in the RF region are in general quite different from those in the audio realm. Here too, gain is important, but the best indicator of it in the high-frequency region above the beta-cutoff frequency $f_{\alpha e}$ is f_{max}, the

Key parameters based on application

Device types	Use category	Required specification ratings						Characteristics limits							
		P_C	P_A	T_J	V_{CBO}	V_{CEO} or $*V_{CES}$	V_{EBO}	f_T or $*f_{max}$	C_{ob} or $*C_{re}$	h_{FE} or $*h_{fe}$	SV_{CE}	Noise fig.	Edge of sat	t_S	Functional test
Alloy (GPA or GPS) Grown, mesa Planar Annular (no gold) (standard diffusion)	Small-signal amplifiers (to 30 MHz)		X	X		X		X	X	X*		X	X		–
Drift, mesa Planar Annular (RF diffusion)	Small-signal amplifiers (above 30 MHz)		X	X		X		X*	X*			X			G_e, agc
Alloy, grown (no gold) Mesa Planar Annular	Low-level, low-speed switching (to 1.0 MHz); Large-signal drivers (below 30 MHz)		X	X	X	X	X	X	X	X	X		X	X	–
Mesa, Planar, Annular { gold-doped or low-voltage (standard diffusion)	Low-level, high-speed switching (above 1.0 MHz)		X	X	X	X	X	X	X	X	X		X	X	–
All power types with standard base diffusion	Large-signal amplifiers; Power-switching (below 10 MHz)	X		X	X	X	X	X	X	X	X		X	X	–
RF types only	Power-class amplifiers; Oscillators (above 10 MHz)	X		X		X*			X		X				G_e, P_{out}

maximum frequency of oscillation.[6]

The power gain at high frequencies for practical amplifiers is given as

$$G_e \approx \frac{f_T}{8\,\pi f^2\, r'_b\, C_{re}}, \tag{6}$$

where f_T is the gain-bandwidth product, f the frequency of operation, r'_b the base-spreading resistance and C_{re} the collector-base feedback capacity. The maximum frequency of oscillation, f_{max}, may be found by solving Eq. 6 for the frequency where power gain is unity. This yields

$$f_{max} \approx \sqrt{\frac{f_T}{8\,\pi\, r'_b\, C_{re}}}. \tag{7}$$

Note that power gain will increase at the approximate rate of 6 dB/octave as circuit operation is shifted down in frequency from f_{max}. Precise calculations can be made by using the two-port admittance parameters provided on the modern data sheet.

Once again, for the input stages of a system, noise figure is important.[7] As with audio amplifier types, devices that do not have a specified noise figure will probably not be suitable for front-end operation at vhf and uhf.

Agc is a bias factor

RF devices generally exhibit a maximum gain when operated at certain bias conditions. Many transistors are designed to have special automatic gain control (agc) characteristics, so that gain decreases at a certain rate in relation to changes in the dc bias.

The gain may be reduced by decreasing the collector current (reverse agc), or increasing the collector current (forward agc). All transistors are capable of reverse-agc operation, whereas a forward agc characteristic is obtained only by special device design. Forward-agc operation is suitable only at frequencies above $f_{\alpha e}$; reverse agc may be used at any frequency. Forward agc has the advantage of an increasing signal-handling capability with rising input signal. This agc information is usually supplied for devices which are designed for particular use as gain-controlled amplifiers.

Other characteristics to be considered include the breakdown-voltage rating, V_{CEO}, because it comes into play when choosing power supply voltages, and allowable output-voltage swings. Ambient-temperature power rating and the junction-temperature limit are of only passing interest. This is because RF applications are typified by low power-dissipation figures. Functional tests of gain and noise, as specified on some data sheets, show the optimum operating point and are an excellent guide to whether the device will be suitable for a given application.

As for the matter of "universality," the RF device is most emphatically a special product. General-purpose and switching transistors are not nearly as suitable in RF applications. In general, the gain of these units will be very low, they will be unstable, and they will exhibit high noise.

Saturation, dc modes set switching stage

In low-level, low-frequency ($\leqq$ 1 MHz) switching, many of the characteristics specified for most modern devices must be weighed. The same type of transistor that makes a good audio amplifier may very well serve as a good switch.

Here, specifications additional to the audio figures are required. Of primary importance in a switching system is the gain of the stage which approaches the dc gain (h_{FE}). Also, because most devices operate in a saturated mode, the saturation voltage is of considerable interest. It sets a system-voltage level and largely determines the power dissipation.

Finally, the remaining set of major parameters is the switching times.[8] Included here is the storage time, for in the case of the older, alloy-junction devices, it can be lengthy. Nearly all modern types of transistors, however, have storage times which are quite small by comparison; they are therefore suitable for low-speed switching circuits. It is nonetheless desirable to have a storage time (t_s), specification, which is approximated by

$$t_s = \tau_s \ln \frac{I_{B1} + I_{B2}}{(I_c/h_{FE} + I_{B2})}, \tag{8}$$

where τ_s is the storage-time time-constant, I_{B1} the turn-on base current, I_{B2} the turn-off base current, I_C the collector current and h_{FE} the dc current gain. Equation 8 is helpful in estimating storage time at a point other than the one specified on the data sheet. For alloy devices, Eq. 8 holds quite well; for modern devices, it is found that τ_s varies somewhat with I_C. In the latter case, Eq. 8 may result in an error of 2:1 and therefore should not be used indiscriminately.

Another figure of merit is the sum of the rise and fall times. An index of the rise-and-fall-time values can be obtained from f_T and C_{ob}. Parameter f_T predominates in the rise-time equation in the high-current region, while output capacitance C_{ob} is paramount in the low-current region. To predict rise time, t_r, both parameters must be known and used in:

$$t_r \approx \left(\frac{1}{2\,\pi f_T} + R_L\, C_{ob}\right)\left(\frac{I_C/I_{B1}}{1 - I_C/2\, I_{B1}\, h_{FE}}\right). \tag{9}$$

In Eq. 9 f_T is the gain-bandwidth product, R_L the load resistance, C_{ob} the collector-base capacitance, I_C the collector current, I_{B1} the base current and h_{FE} the dc current gain.

Load line control is essential

The expression is reasonably accurate providing that $I_C/I_{B1} < h_{FE}/2$. In applying it, the I_{B1} value must approximate a step of current, R_L should be a pure resistor and the values of f_T and C_{ob} must be averaged over the load line used.

The voltage breakdown rating, V_{CEO}, usually proves to be the best indicator of an upper voltage limit. But in many cases, careful control of the load line and the reverse bias placed on the transistor makes it possible to switch voltages up to the V_{CBO} rating.[9]

For switching applications such as multivibrators and flip-flops, where capacitors are used in the base-coupling circuit, the V_{EBO} rating must be known, as it is quite easy to exceed this limit inadvertently.

The rated dissipation at ambient temperature and the maximum junction-temperature limit rate attention, but are not of prime importance, because the power dissipated here is fairly small.

The leakage currents of germanium and silicon devices may be a selection factor. In today's silicon transistors they are so low that they are not of design significance. On the other hand, the leakage of germanium devices may prove troublesome.

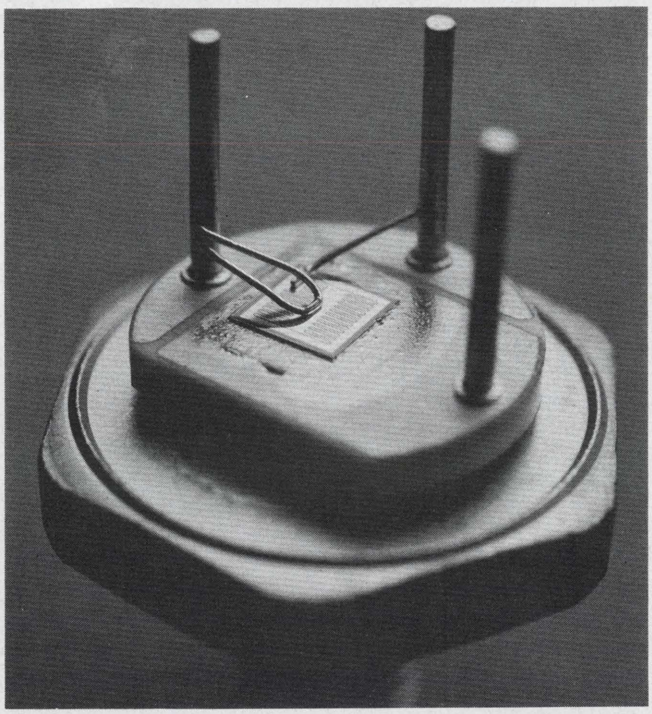
Silicon transistors are generally preferable to germanium types in switching applications because the former have a higher V_{BE} turn-on voltage. This and their lower leakage currents make it easier to maintain the cut-off state.

Storage time a key in high-speed switching

The characteristics of importance to high-speed switching applications are essentially the same as those in the previous group. But there is greater emphasis on the storage-time specifications, since they prove to be a primary limit on how fast a logic system can operate.

To achieve low storage time, the recommended devices are low-voltage germanium or gold-doped silicon units. These transistors are generally unsuitable for applications other than switching. Silicon npn types achieve the fastest switching.

Designers are sometimes tempted to use an RF transistor in a switching application. The results are disappointing, for RF devices have low V_{EBO} ratings, low h_{FE} values, high storage times and poor saturation characteristics.



This power transistor features an isolated collector. Shown before being sealed, this semiconductor type (2N1724) unit comes in a TO-61 package.

Power rates high in large-signal amplifiers

In large-signal amplification, large amounts of power are handled and the power rating of the transistor at a specified case temperature becomes of paramount interest. The voltage which it can tolerated, as indicated primarily by the BV_{CEO} rating, is also of great importance. The other voltages normally mentioned on data sheets generally do not greatly affect these applications.

In such devices, the edge of the saturation region, as evidenced by the knee in the collector V-I curve is significant. This is particularly so for the linear power amplifier, as it is obviously desirable to handle current peaks and voltage excursions as close to the saturation region as possible for maximum efficiency. Edge of saturation information can often be obtained from data sheet curves. In power transistors, saturation will often occur when $V_{CE} > V_{BE}$.

These power units are also used in power-switching, where many of the characteristics that are of consequence are the same parameters that govern in low-level applications. In this category, storage time may also limit the speed at which switching can be handled, although speed itself is usually not of primary importance.

Rise time at high currents is a major interest, but because of the current range over which these devices are switched, the use of f_T measured at a single point does not correlate with measured rise time if fitted to Eq. 9, and the rise-time specifications and curves must be used. Gain (h_{FE}) matters because efficiency is a prime consideration, and so too does saturation voltage because of the large currents usually handled. The product of the current and saturation voltage largely determines the power dissipation and dictates the requirements for the heat dissipator.

Current excursions modify frequency response

A common denominator for both large-signal-amplification and power-switching applications is frequency response. The gain-bandwidth frequency (f_T) serves as an indicator of amplifier high-frequency response, but as with switching service, the amplifier's large current excursions cause discrepancies. When attempting to calculate frequency response, Miller effect due to C_{ob} should be considered as well as f_T.

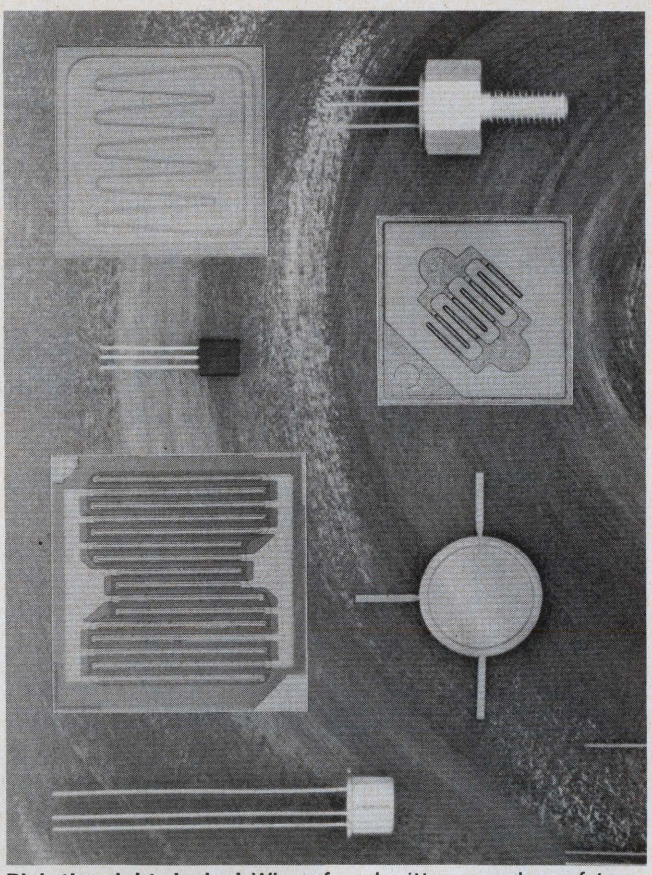
Generally, better amplifier performance predictions can be obtained from proper use of the transistor switching data. If rise-time data is plotted as a function of I_C with V_{CE} as a parameter (under the condition $I_C/I_{B1} << h_{FE}$), a large signal cut-off frequency can be found from

$$f_A = \frac{I_C}{2\pi t_r h_{FE} I_{B1}} \qquad (10)$$

In Eq. 10, f_A is the large-signal common-emitter cut-off frequency and I_C the ON collector current. Parameter t_r is the rise time obtained from switching data at the collector current (I_C) and voltage swing of interest. Note that V_{CE} of the switching test is the same as ΔV_{CE} in amplifiers, and $I_{C(on)}$ of the switching test corresponds to $I_{C(PK)}$ in amplifiers; h_{FE} is the transistor dc current gain and I_{B1} is the turn-on base current used in the switching test.

Flat curves of h_{FE} vs I_C are desirable for silicon transistors, as they are commonly driven from high-impedance sources to obtain the best thermal stability and the lowest distortion. For germanium power transistors, a low-impedance drive circuit is required to achieve the same ends, so that a flat curve of transconductance vs collector current is needed.[10]

An extremely important characteristic of power devices is the safe operating area.[11] Data are usually presented in graphic form showing permissible regions of V_{CE}-I_C operation as a function of time. Unfortunately, safe area does not correlate very well with the power ratings based upon thermal resistance. All the same, safe area, not power rating, is more often than not the arbiter of power-handling ability, and therefore is the prime concern.



Pick the right device! When faced with a number of transistor geometries, cans, etc., to choose from, use the key parameters as a guide to application.

Functional tests guide RF operation

RF operation creates conditions such that conventional parameters simply give no indication of a particular transistor's suitability. The only way to select devices, then, is to refer to the functional test on the manufacturer's data sheet. Here you will find the power gain at a given power output under the optimum conditions for which the devices were designed.

Bear in mind that the BV_{CES} voltage rating has proved to be the most useful single voltage rating for RF power transistors. As in low-frequency power applications, the edge of saturation is significant and so is safe area information. Secondary considerations are the maximum temperature rating and 25°C case power-dissipation rating. When designing the tuning circuit, output capacitance C_{ob} must be known.

Sewing up the tailored device choice

A theme of this discussion has been that there is no universal transistor. It is wisest to select transistors with specifications tailored by the manufacturer to a given application.[12]

It is found, for example, that devices intended for high-speed, low-level saturated switching service possess very high noise figures and very low gain as audio-frequency amplifiers. Germanium switches, made from low-resistivity material to achieve low storage time, similarly should not be used indiscriminately in audio amplifiers.

Devices intended for RF applications are designed to have very low base-spreading resistances. For this, a diffusion profile in the base is made to have an average low resistivity. As a result, the input capacity is rather high, the current gain very low, rendering this type of device unsuitable for audio and switching applications.

Conversely, the switching device, designed to have a high emitter-breakdown voltage and a low input capacitance, will have a high-base-spreading resistance. This results in low power gain and high noise when it is operated as an RF amplifier. In the power area, too, the same types of trade-offs are evident. ■ ■

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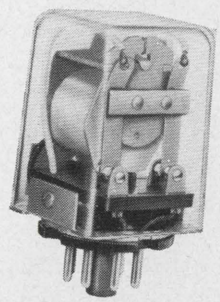

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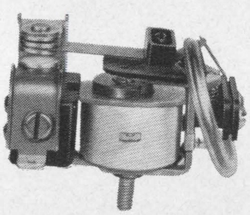
SPECIFICATIONS

- *Contacts: SPDT, DPDT, 3PDT*
- *Contact Rating: 5 and 10 amps.*
- *Pull-in: 22 milliseconds average*
- *Drop-out Speed: 12 milliseconds average*
- *Size: $1\frac{3}{8}$" x $2\frac{1}{8}$" x $1\frac{3}{8}$"*
- *Weight: 3 ounces*

POWERFUL PARTNER

25PS Medium Power Relay



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SPECIFICATIONS

- *Contacts: SPDT*
- *Contact Rating: 20 amps. 115/230 VAC 60 cycle resistive • 1 HP @ 115/230 VAC motor-inductive*
- *Pull-in: 50 milliseconds max.*
- *Drop-out Speed: 30 milliseconds max.*
- *Size: $2\frac{1}{4}$" x $1\frac{9}{32}$" x $1\frac{13}{16}$"*
- *Weight: 3 ounces*

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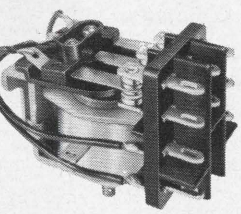
25AA Open Frame General Purpose Relay



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SPECIFICATIONS

- *Contacts: SPDT, DPDT, 3PDT*
- *Contact Rating: 5A and 10A @ 115 VAC•5A-1/10 HP @ 115 VAC, 1/6 HP @ 230 VAC•10A-1/6 HP @ 115 VAC, 1/3 HP @ 230 VAC*
- *Pull-in: 22 milliseconds average*
- *Drop-out Speed: 12 milliseconds average*
- *Size: $1\frac{7}{8}$" x $1\frac{9}{32}$" x $1\frac{1}{2}$"*
- *Weight: 2 ounces*

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How to use the charts

A tint pairs the transistor type with the value of its *key parameter* for most applications in each transistor category. Devices are listed in order of increasing value of that key parameter. Note, however, that since various manufacturers may characterize their types differently, some "jumps" may take place in the sequence. Consider, for example, a type in the high-frequency category. Its key characteristic will be $f_{\alpha e}$ or f_T (values of f_T are preceded by a single asterisk). But $f_{\alpha e}$ is the frequency at which h_{fe} drops to 0.707 of its low-frequency value, and f_T is the gain-bandwidth product, or the product of h_{fe} and frequency at a point where h_{fe} is dropping by 6 dB per octave. Thus, f_T is about h_{fe} times greater than $f_{\alpha e}$ for a given type.

Under *maximum ratings,* manufacturers were asked to specify collector power dissipation at 25°C case temperature, this generally being the most meaningful single rating. The derating factor can then be used to estimate P_c for other operating temperatures.

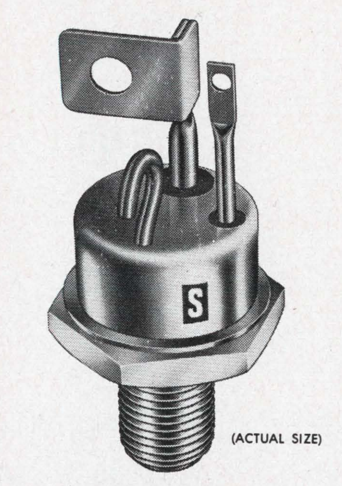
Either V_{CEO} or V_{CBO} is listed as a maximum voltage rating. V_{CEO} is related to collector-emitter diode breakdown and V_{CBO} to collector-base diode breakdown. But bear in mind that many manufacturers' data sheets will list other important voltage ratings, such as V_{CES} or V_{CER}.

Under *characteristics,* ELECTRONIC DESIGN asked manufacturers to supply typical values —maximums, minimums or spreads. Where deviations from this occur, they are noted.

Finally, a word of caution: the characteristics listed serve primarily as a guide and generally should not be used *exclusively* for direct comparison of types. This is because it is impossible to list the wide variety of test conditions under which characteristics have been measured. V_{CEO}, for example, can differ considerably for comparable devices when measured at a collector current of 100 μA in one case and 1 mA in another. The best bet is to consult the manufacturers' data sheets before making the final selection. Also, scan the articles that preface each listing section. Each article contains important information about parameter evaluation.

Key to Symbols

$f_{\alpha e}$	= small-signal short-circuit forward current transfer ratio cutoff frequency (commont-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 emit ter)
C_{ob}	= output capacitance (common-base)
t_r	= rise time
t_s	= storage time
$V_{CE(sat)}$	= collector-to-emitter saturation volt-
g_m	age 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



(ACTUAL SIZE)

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Type Number	DESIGN LIMITS				PERFORMANCE SPECIFICATIONS					
	P_T	BV_{CBO}	$V_{CEO\ (SUS)}$	BV_{EBO}	h_{FE}		V_{BE} (sat)	V_{CE} (sat)	I_{CBO}	f_T
	Watts	Volts	Volts	Volts			Volts	Volts	μA	MHz
	25°C Case	$I_C = 1mA$	$I_C = 0.2A$	$I_E = 1mA$	$I_C = 75A$	$I_C = 90A$	$I_C = 50A$, $I_B = 5A$		$V_{CB} = 60V$	
	Max.	Min.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Typ.
MHT8920	350	80	60	8	10	5	2.0	1.5	10	20
MHT8921	350	100	80	8	10	5	2.0	1.5	10	20
MHT8922	350	120	100	8	10	5	2.0	1.5	10	20
MHT8923	350	140	120	8	10	5	2.0	1.5	10	20
	50°C Case	$I_C = 2mA$			$I_C = 50A$		$I_C = 50A$, $I_B = 10A$		V_{CB} = RATED	MIN.
2N3149	300	80	80	10	10	—	2.5	1.5	2000	0.1
2N3150	300	100	100	10	10	—	2.5	1.5	2000	0.1
2N3151	300	150	150	10	10	—	2.5	1.5	2000	0.1

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ON READER-SERVICE CARD CIRCLE 6

Key to Transistor Types

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 epitaxal
PL	Planar
SBT	Surface barrier
SP	Surface precision alloy
TDP	Triple-diffused planar
PADT	Past alloy diffused technique

Materials

ge	germanium
si	silicon

Manufacturers and their lines

Manufacturer	Symbol	Audio A	High-Frequency HF	Power P	Low-Level LL	High-Level HL	Field-Effect FET	Unijunction UJT
Amelco	AL	●	●	●	●	●	●	
Amperex	AMP	●	●	●	●	●		
Bendix	BE		●	●		●		
Burroughs	BU				●			
Continental Device	CDC	●	●	●	●	●		
Crystalonics	CT	●	●	●	●		●	
Delco	DE			●		●		
Dickson	DIC						●	
Electronic Transistor	ETC	●	●	●	●	●		
Fairchild	FA	●	●	●	●	●	●	
General Electric	GE	●	●	●	●	●		●
General Instrument	GI	●	●	●	●	●	●	
General Micro-electronics	GME	●	●		●		●	
Hughes	HU				●	●	●	
ITT Semiconductors	ITT		●	●	●	●		
Industro Transistor	IND	●	●		●			
International Electronics	IEC	●	●		●			
KMC Semiconductor	KMC		●				●	
KSC Semiconductor	KSC		●	●		●		
Lansdale	LAN	●	●	●	●			
Motorola	MO	●	●	●	●	●	●	●
National Semiconductor	NA	●	●	●	●	●		
Nucleonic Products	NUC	●	●	●	●	●		
Philco	PH		●		●			
Radio Corp. of America	RCA	●	●	●	●	●	●	
Raytheon	RA	●	●		●	●		
Siemens America	SA	●	●	●	●	●		
Silicon Transistor	STC		●	●		●		
Siliconix	SI						●	
Solid State Products	SSP		●	●		●		
Solitron	SOL			●				
Sperry Semiconductor	SSD	●	●		●			
Sprague	SPR	●	●	●	●	●		
Sylvania	SY	●	●	●	●	●		
Texas Instruments	TI	●	●	●	●	●	●	●
Transitron	TR	●	●	●	●	●		
TRW Semiconductors	TRWS	●	●	●		●	●	
Union Carbide	UC	●	●			●	●	
Vector	VEC		●	●	●			
Westinghouse	WH		●	●		●		

Audio and General Purpose

Mostly audio and general-purpose types handling less than one watt.
Listed in order of increasing forward-current transfer ratio.

Cross Index Key	Type No.	Mfr.	Type	h_{fe} $^*h_{FE}$	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_c (mA)	CHARACTERISTICS I_{co} (µA)	f_{ae} $^*f_T$ (MHz)	Package Outline (TO-)	Remarks
A 1	2N1439	NA	pnp,A,si	5-12	400	200	2.25	50	100	.025	–	5	CT
	2N1223	SSD	AJ	6	250	175	1.67	40	100	0.1	–	5	CT, SPR
	NS-664	NA	pnp,A,si	7-22	400	175	2.5	50	100	1	–	5	Industrial Type
	NS-668	NA	pnp,A,si	7-22	150	175	1	50	100	1	–	18	Industrial Type
	2N927	NA	pnp,A,si	8-22	150	200	.85	60	100	.025	–	18	SPR
A 2	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
	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
A 3	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
	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
	2N1440	NA	pnp,A,si	9-22	400	200	2.25	50	100	.025	–	5	AMP, CT
	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
	2N1643	CT	pnp,si	*10	250	160	1.9	25	50	.001	–	5	
	2N1672A	GI	npn,AJ,ge	*10	120	85	2	*55	–	25	2	5	
A 4	BCZ12	AMP	pnp,AJ,si	10	250	150	2	60	50	0.1	1	1	
	2N925	NA	pnp,A,si	10-24	150	200	.85	40	100	.025	–	18	SPR
	2N470	TR	npn,PL,si	10-25	200	175	1.2	15	25	.5	8	5	
	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
A 5	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
	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
	NS-731	NA	npn,DM,si	12-55	400	175	2.5	15	100	1	–	18	Industrial Type
	NS-733	NA	npn,DM,si	12-55	400	175	2.5	30	100	1	–	18	Industrial Type
	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	
	2N1248	TR	npn,PLE,si	*15	30	150	.24	6	5	.01	–	5	GE
A 6	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	100	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
	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	
	BCY30	AMP	pnp,AJ,si	15	250	150	2	*64	100	.1	.25	5	
	BCY33	AMP	pnp,AJ,si	15	250	150	2	*32	100	.1	.4	5	
A 7	BCZ13	AMP	pnp,AJ,si	15	85	–	.9	*20	10	.01	1.5	–	Sub min case
	2N529	GI	–	15-20	100	85	2	*15	–	5.0	2.5	5	
	NS-663	NA	pnp,A,si	15-36	400	175	2.5	50	100	1	–	5	Industrial Type
	NS-667	NA	pnp,A,si	15-36	150	175	1	50	100	1	–	18	Industrial Type
	MA885	MO	pnp,AJ,ge	15-40	200	100	2.67	*50	500	15	†0.5	5	†fab
	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

(see pages 4-9 for explanation of company abbreviations.)

Audio *(continued)*

					MAX. RATINGS					CHARACTERISTICS			
Cross Index Key	Type No.	Mfr.	Type	h_{fe} $*h_{FE}$	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)	Package Outline (TO-)	Remarks
A 8	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
	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
	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	11	5	TR
	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
	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
A 9	2N758A	NA	npn,DM,si	18-90	500	200	2.5	60	100	0.1	–	18	GI
	2N734	TI	npn,si	20	500	175	3.33	60	50	1	–	18	TRWS, TR
	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
	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	
A 10	2N1381	TI	pnp,ge	20	250	100	3.3	*25	200	14	–	5	
	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
	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	
	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	
A 11	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	
	A130	AMP	npn,PL,si	*20	360	200	2	*90	–	–	30	5	
	A310	AMP	npn,PL,si	*20	300	175	2	*135	–	.5	50	5	
	A311	AMP	npn,PL,si	*20	300	175	2	*80	–	.5	30	5	
	BCY38	AMP	pnp,AJ,si	*20	120	150	2	*32	250	.1	.45	5	
	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
	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
A 12	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	
	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
	2N1150	TI	npn,si	24	150	175	1	*45	25	2	–	–	TR
	2N924	NA	pnp,A,si	24-60	150	200	.85	25	100	.025	–	18	
	NS-662	NA	pnp,A,si	24-60	400	175	2.5	40	100	1	–	5	Industrial Type
	NS-666	NA	npn,A,si	24-60	150	175	1	40	100	1	–	18	Industrial Type
	2N330A	RA	pnp,si	25	380	160	2-9	·30	50	0.1	0.05	5	SSD, AMP, CT
A 13	2N563	GI	pnp,AJ,ge	25	150	85	2.5	*30	300	5	0.8	–	
	2N564	GI	pnp,AJ,ge	25	120	85	2	*30	300	5	0.8	5	IND
	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	
	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
	BCY31	AMP	pnp,AJ,si	25	250	150	2	*64	100	.1	.25	5	
A 14	BCY34	AMP	pnp,AJ,si	25	250	150	2	*32	100	.1	.6	5	
	SA2253	AL	npn,si	*25	–	150	–	*40	–	.05	–	5	
	2N531	GI	–	25-30	100	85	2	*15	–	5.0	3.5	5	
	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

(see pages 4-9 for explanation of company abbreviations.)

Audio *(continued)*

					MAX. RATINGS					CHARACTERISTICS			
Cross Index Key	Type No.	Mfr.	Type	h_{fe} $^*h_{FE}$	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)	Package Outline (TO-)	Remarks
A 15	2N1654	RA	pnp,si	*30	250	160	1.85	80	50	1	.050	5	CT, SPR
	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	
	BCY39	AMP	pnp,AJ,si	*30	120	150	2	*69	250	.1	.85	5	
	BCZ14	AMP	pnp,AJ,si	30	85	–	.9	*20	10	.01	1.5	–	sub min case
	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	
A 16	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
	2N650	MO	pnp,AJ,ge	30-70	200	100	2.67	*45	500	10	–	5	TI
	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	
	2N1191	MO	pnp,AJ,ge	30-70	200	100	2.67	*40	200	15	–	5	TI
	MA881	MO	pnp,AJ,ge	30-70	200	100	2.67	*60	500	10	†0.75	5	†fab
	MA886	MO	pnp,AJ,ge	30-70	200	100	2.67	*50	500	15	†0.75	5	†fab
	2N2711	GE	npn,PL,si	30-90	200	100	2.67	18	100	.5	–	98	NUC
A 17	2N2713	GE	npn,PEP,si	*30-90	200	100	2.67	18	200	0.5	–	98	Full line spread
	MPS2711	MO	npn,EP,si	*30-90	310	135	2.81	18	100	0.5	–	92	
	MPS2715	MO	npn,EP,si	*30-90	310	135	2.81	18	25	0.5	–	92	
	2N1051		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
	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	
	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	RCA	npn,AJ,ge	35	20	55	–	*10	2	10	2	1	LAN
A 18	2N2389	TI	npn,si	35	450	200	2.57	*75	500	0.01	–	50	
	BCY32	AMP	pnp,AJ,si	35	100	150	2	*64	50	–	4	9	
	2N533	GI	–	35-40	100	85	2.0	*15	–	5	4.5	5	
	40234	RCA	npn,P,si	35-180	500	175	3.3	18	100	0.5 (max)	*60	–	
	AC 121	SA	pnp,AJ,ge	35-190	900	90	20	20	300	5	1.5	1	
	2N2926	GE	npn,PL,si	†35-470	200	100	2.67	–	100	0.5	–	18	NUC, † Full line spread, GME
	MPS2926	MO	npn,EP,si	35-470	310	135	2.81	18	100	0.5	–	92	
	2N937	SSD	AJ	*36	385	160	2.85	30	50	0.1	–	18	CT, SPR
	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
A 19	2N1475	SSD	AJ	36	250	175	1.67	60	100	.050	–	5	AMP, CT, SPR
	2N759	NA	npn,DM,si	36-90	500	200	2.5	45	100	0.2	–	18	TR, GI, TI
	2N759A	NA	npn,DM,si	36-90	500	200	2.5	60	100	0.1	–	18	SPR, GI, TI
	2N335A	GE	npn,DG,si	37-90	500	175	3.33	45	25	.5	–	5	TR
	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
	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,
	2N739	TI	npn,si	40	500	175	3.33	80	50	1	–	18	TR,
	2N934	RCA	pnp,MS,ge	*40	150	–	–	13	–	–	–	18	
A 20	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	
	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	
	2N1565	TI	npn,si	40	600	175	4	60	50	1	–	5	TRWS, TR
	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	
	2N2868	GE	npn,PE,si	40	2800	200	16	40	1000	.010	130	5	
A 21	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	
	2N3065	CT	pnp,si	40	400	200	2.3	110	100	.01	–	46	
	2N3580	SSD	pnp,EP	*40	400	200	2.28	60	30	0.05	80	46	
	A306	AMP	npn,PL,si	40	360	200	2	*25	–	.01	100	18	
	BCY11	AMP	pnp,AJ,si	40	310	150	2.5	60	500	0.1	1.5	1	
	BCY12	AMP	pnp,AJ,si	40	310	150	2.5	32	500	0.1	1.5	1	
	ME900	AMP	npn,PL,si	40	360	200	2	*40	–	.01	100	18	
	SFT325	NUC	pnp,ge	*40	500	85	–	*32	500	30	–	1	
	2N480A	TR	npn,PL,si	40-100	200	175	1.2	45	25	.5	20	5	GE

(see pages 4-9 for explanation of company abbreviations.)

Audio *(continued)*

Cross Index Key	Type No.	Mfr.	Type	h_{fe} $*h_{FE}$	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_c (mA)	CHARACTERISTICS I_{co} (µA)	f_{ae} $*f_T$ (MHz)	Package Outline (TO-)	Remarks
A 22	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
	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	
	NS-732	NA	npn,DM,si	40-125	400	175	2.5	15	100	1	–	18	Industrial Type
A 23	NS-734	NA	npn,DM,si	40-125	400	175	2.5	30	100	1	–	18	Industrial Type
	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	–	RO97A package, CDC
	OC79	AMP	pnp,PADT,ge	42	0.55	75	1.2	*26	0.3	10	1.2	1	
	2N104	RCA	pnp,AJ,ge	44	150	70	–	*30	50	10	0.7	40	
	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
	MPS3709	MO	npn,EP,si	*45-165	310	135	2.81	30	30	0.1	–	92	
	2N3708	TI	npn,PE,si	*45-660	250	125	2.5	30	30	0.1	–	†	†Plastic
	MPS3708	MO	npn,EP,si	*45-660	310	135	2.81	30	30	0.1	–	92	
A 24	2N280	AMP	pnp,AJ,ge	47	125	75	2.5	30	10	150	0.1	–	Special Case
	OC71N	AMP	pnp,AJ,ge	47	110	75	0.45	30	10	–	–	1	
	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
	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
	2N918	FA	npn,PE,si	*50	300	200	1.71	15	50	0.002	*900	18	MO, TI, RCA, AL, TRWS
	2N1443	NA	pnp,A,si	50	400	200	2.25	15	100	.025	–	5	CT
	2N2616	FA	npn,PE,si	*50	800	200	4.56	15	50	0.002	*900	18	AL
	2N2729	FA	npn,PE,si	*50	800	200	4.56	15	50	0.002	900	18	AL
A 25	2N3581	SSD	pnp,EP	*50	400	200	2.28	40	30	0.02	30	46	
	A569	AMP	npn,PL,si	*50	300	175	2	*20	–	.01	100	18	Chopper, ▲Voff,=50µV
	A570	AMP	npn,PL,si	*50	300	175	2	*20	–	0.1	100	18	Chopper, Voff,=100µV
	A1341	AL	npn,si	*50	200	150	–	*75		.010	–	18	
	BC410	AMP	pnp,AJ,si	50	310	150	2.5	32	500	0.1	1.5	1	
	ME216	AMP	npn,PL,si	50	360	200	2	*20	–	.5	100	18	
	NS-661	NA	pnp,A,si	50	400	175	2.5	30	100	1	–	5	Industrial Type
	NS-665	NA	pnp,A,si	50	150	175	1	30	100	1	–	18	Industrial Type
	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	
A 26	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	
	MA882	MO	pnp,AJ,ge	50-120	200	100	2.67	*60	500	10	†1.0	5	†fab
	MA887	MO	pnp,AJ,ge	50-120	200	100	2.67	*50	500	15	†1.0	5	†fab
	2N654	MO	pnp,AJ,ge	50-125	200	100	2.67	*30	250	15	–	5	
	2N2706	MO	pnp,AJ,ge	50-150	200	100	2.66	*25	400	10	†3	5	†fab
	PA1001	AL	npn,DP,si	*50-150	–	200	2	*60	–	.010	–	18	
	40232	RCA	npn,P,si	50-180	500	175	.33	18	100	0.25	*60	–	
	BC 122	SA	npn,PE,si	50-400	75	125	5.0	20	50	0.01	250	–	
A 27	2N565	GI	pnp,AJ,ge	55	150	85	2.5	*30	300	5	1	–	
	2N566	GI	pnp,AJ,ge	55	120	85	2.0	*30	300	5	1	5	IND
	2N2717	GE	npn,PL,si	55	200	100	2.67	–	100	0.5	–	18	
	OC58	AMP	pnp,AJ,ge	55	20	75	1.5	7	5	1.5	1.6	–	Sub min case
	2N3394	GE	npn,PL,si	*55-110	200	100	2.67	25	100	0.1	–	98	Epoxy case
	MPS3394	MO	npn,EP,si	*55-110	310	135	2.81	25	100	0.1	–	92	
	MPS3397	MO	npn,EP,si	*55-500	310	135	2.81	25	100	0.1	–	92	
	MPS3398	MO	npn,EP,si	*55-800	310	135	2.81	25	100	0.1	–	92	
	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 28	2N736A	TI	npn,si	60	500	175	3.33	60	100	0.5	–	18	TR
	2N929	TI	npn,si	60	300	175	2	45	30	0.01	–	18	FA, GI, TR, AL, SPR, UC, MO
	2N957	FA	npn,DD,si	*60	800	150	6.5	20	–	1.0	250	18	TRWS, AMP
	2N1097	GE	pnp,AJ,ge	*60	175	–	2.9	*16	200	16	–	5	
	2N1098	GE	pnp,AJ,ge	*60	175	–	2.9	*16	200	16	–	5	
	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	
	2N1414	GE	pnp,AJ,ge	*60	200	85	3.33	*35	200	12	–	5	
	2N1566A	TI	npn,si	60	600	175	4	60	100	0.1	–	5	

(see pages 4-9 for explanation of company abbreviations.)

Audio *(continued)*

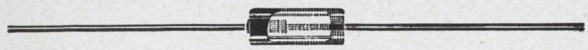
Cross Index Key	Type No.	Mfr.	Type	h_{fe} $*h_{FE}$	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_c (mA)	CHARACTERISTICS I_{co} (µA)	$f_{\alpha e}$ $*f_T$ (MHz)	Package Outline (TO-)	Remarks
A 29	2N2387	TI	npn,si	60	300	175	2	45	30	0.01	–	50	
	2N2600A	SSD	pnp,EP	*60	400	200	2.28	100	30	0.025	80	46	
	BCZ10	AMP	pnp,AJ,si	60	250	150	2	25'	50	0.1	1	1	
	BCZ11	AMP	pnp,AJ,si	60	250	150	2	25	50	0.1	3	1	
	OC60	AMP	pnp,AJ,ge	60	20	75	1.5	7	5	1.5	1.6	–	Sub min case
	S15660	FA	npn,DPE,si	*60	600	200	3.42	*40	1000	–	650	–	RO83 package
	SFT323	NUC	pnp,ge	*60	200	85	–	*24	250	15	–	1	
	SFT353	NUC	pnp,ge	60	200	85	–	*24	150	15	–	1	
	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	
A 30	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	
	MPS3721	MO	npn,EP,si	60-660	310	135	2.81	18	100	0.5	–	92	
	2N2430	AMP	npn,ge	*63	360	90	3.3	*32	30	–	–	1	
	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	
	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	
A 31	2N3062	CT	pnp,si	65	400	200	2.3	*90	100	.01	–	46	
	2N3063	CT	pnp,si	65	400	200	2.3	*90	100	.01	–	46	
	BCY40	AMP	pnp,AJ,si	*68	120	150	2	*32	250	.1	.85	5	
	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
	2N591	RCA	pnp,AJ,ge	70	50	71	–	32	20	7	0.7	1	
	2N647	RCA	pnp,AJ,ge	*70	100	71	–	25	50	14	–	1	LAN
	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
A 32	2N1594	TI	npn,si	70	125	87.5	2	40	25	1	–	–	TR
	2N3128	NA	npn,PL,si	70	150	150	1.2	20	100	.002	–	–	
	A1109	AL	npn,si	*70	–	150	–	*45	–	.10	–	18	
	2N1175A	MO	pnp,AJ,ge	*70-140	200	100	3.33	*35	200	12	–	5	
	2N1705	MO	pnp,AJ,ge	70-150	200	100	2.66	*18	400	10	†3	5	†fab
	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
	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
A 33	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	
	40253	RCA	pnp,AJ,ge	*75	650	90	10	*25	500	14 (max)	*1	1	
	OC74	AMP	pnp,AJ,ge	75	0.55	75	.66	20	300	10	1.5	1	
	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	
	2N2712	GE	npn,PL,si	*75-225	200	100	2.67	18	100	0.5	–	98	NUC
	2N2714	GE	npn,PEP,si	*75-225	200	100	2.67	18	200	0.5	–	98	
	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 34	2N3414	GE	npn,PE,si	*75-225	360	150	2.67	25	500	0.1	–	98	Epoxy case
	2N3416	GE	npn,PE,si	*75-225	360	150	2.67	50	500	0.1	–	98	Epoxy case
	MPS2712	MO	npn,EP,si	*75-225	310	135	2.81	18	100	0.5	–	92	
	MPS2716	MO	npn,EP,si	*75-225	310	135	2.81	18	25	0.5	–	92	
	2N336A	GE	npn,DG,si	76-333	500	175	3.33	45	25	.5	–	5	TR
	2N760	NA	npn,DM,si	76-333	500	200	2.5	45	100	0.2	–	18	TR, GI, AL
	2N760A	NA	npn,DM,si	76-333	500	200	2.5	60	100	0.1	–	18	TR, GI, AL
	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
A 35	2N740	TI	npn,si	80	500	175	3.33	80	50	1	–	18	TR, AL
	2N1415	GE	pnp,AJ,ge	*80	200	85	3.33	*35	200	12	–	5	
	2N1566	TI	npn,si	80	600	175	4	60	50	1	–	5	TRWS, TR
	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
	40261	RCA	pnp,DR,ge	80	80	85	1.2	*50	10	12 (max)	*40	1	
	OC59	AMP	pnp,AJ,ge	80	20	75	1.5	7	5	1.5	2.2	–	Sub min case
	2N543A	TR	npn,PL,si	80-200	200	175	1.2	50	25	.5	10	5	
	2N2245	NA	npn,DM,si	80-250	500	200	2.5	20	100	.01	–	18	Low Level

(see pages 4-9 for explanation of company abbreviations.)

Audio *(continued)*

Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_c (mA)	CHARACTERISTICS I_{co} (µA)	$f_{\alpha e}$ *f_T (MHz)	Package Outline (TO-)	Remarks
A 36	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	IEC, GME
	2N3060	CT	pnp,si	85	400	200	2.3	*70	100	.005	–	46	
	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	
	2N2431	AMP	pnp,ge	*90	1000	75	3.3	*32	1000	10	1.7	1	
	2N3058	CT	pnp,si	90	400	200	2.3	6	100	.0001	–	46	
A 37	OC75N	AMP	pnp,AJ,ge	90	110	75	0.45	30	10	–	–	1	
	2N2923	GE	npn,PL,si	90-180	200	100	2.67	25	100	0.5	–	98	IEC, GME
	2N3393	GE	npn,PL,si	*90-180	200	100	2.67	25	100	0.1	–	98	Epoxy case, GME
	MPS3393	MO	npn,EP,si	*90-180	310	135	2.81	25	100	0.1	–	92	
	40231	RCA	npn,P,si	90-300	500	175	.33	18	100	0.5	*60	–	
	40233	RCA	npn, F,si	90-300	500	175	.33	18	100	0.5	*60	–	
	2N3710	TI	npn,PE,si	*90-330	250	125	2.5	30	30	0.1	–	†	†Plastic
	MPS3710	MO	npn,EP,si	*90-330	310	135	2.81	30	30	0.1	–	92	
	MPS3396	MO	npn,EP,si	*90-500	310	135	2.81	25	100	0.1	–	92	
	2N120	TI	npn,si	99	150	175	1	*45	25	2	–	–	TR
A 38	2N336	TI	npn,si	99	150	175	1	*45	25	2	–	5	GE, TR
	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
	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	
	A307	AMP	npn,PL,si	100	360	200	2	*25	–	.01	100	18	
	ME213	AMP	npn,PL,si	100	360	200	2	*45	–	.1	100	18	
	ME217	AMP	npn,PL,si	100	360	200	2	*20	–	.5	100	18	
	ME900A	AMP	npn,PL,si	100	360	200	2	*40	–	.01	100	18	
A 39	ME901	AMP	npn,PL,si	100	360	200	2	*40	–	.01	100	18	
	ME901A	AMP	npn,PL,si	100	360	200	2	*40	–	.01	100	18	
	2N508A	MO	pnp,AJ,ge	*100-200	200	100	3.33	*30	200	7	–	5	
	2N3859	GE	npn,PEP,si	*100-200	200	100	2.67	30	100	0.5	–	98	
	2N3859A	GE	npn,PEP,si	100-200	200	100	2.67	60	100	0.1	–	98	
	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	
	MA883	MO	pnp,AJ,ge	100-225	200	100	2.67	*60	500	10	1.25	5	†fab
	MA888	MO	pnp,AJ,ge	100-225	200	100	2.67	*50	500	15	†1.25	5	†fab
A 40	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
	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	–	
	PA1000	AL	npn,DP,si	*100-300	–	200	2	*30	–	.010	–	18	
	2N3692	FA	npn,PL,si	*100-400	625	150	2	*35	50	.05	*200	–	RO97A package, CDC
	2N3707	TI	npn,PE,si	*100-400	250	125	2.5	30	30	0.1	–	†	†Plastic
	MPS3707	MO	npn,EP,si	*100-400	310	135	2.81	30	30	0.1	–	92	
	2N2716	GE	npn,PL,si	110	200	100	2.67	–	100	0.5	–	18	NUC, IEC, GME
A 41	40329	RCA	pnp,AJ,ge	120	125	100	2.8	*25	100	14 (max)	1.5	1	
	2N2171	MO	pnp,AJ,ge	120-310	500	100	6.7	*50	400	10	†7.5	5	†fab
	2N1926	GE	pnp,ge	*121	85	3.7	*60	500	10	–	–	5	
	2N1190	MO	pnp,AJ,ge	*125-300	200	100	2.67	*45	500	10	–	5	
	BC 107	SA	npn,PE,si	*125-500	260	175	5.0	45	100	0.0007	150	18	
	2N2903	AL	npn,DP,si	*125-625	600	200	3.5	*60	–	.010	–	5	Dual
	2N2903A	AL	npn,DP,si	*125-625	600	200	3.5	*60	–	.010	–	5	Dual
	2N2428	AMP	pnp,ge	130	500	75	0.3	32	100	–	1.7	1	
	AC 163	SA	pnp,AJ,ge	*130	900	90	20	24	200	10	2.3	1	
	2N2706	AMP	pnp,AJ,ge	*135	500	90	0.37	*32	200	–	2.5	1	
A 42	2N2707	AMP	ge	*135	500	90	0.37	*32	200	–	2.5	1	Matched NPN, PNP Pair
	AF 127	SA	pnp,AD,ge	140	60	75	2.5	32	10	1.2	75	18	
	2N569	GI	pnp,AJ,ge	150	150	85	2.5	*30	300	5	2	–	
	2N570	GI	pnp,AJ,ge	150	120	85	2.0	*30	300	5	2	5	IND
	2N930	TI	npn,si	150	300	175	2	45	30	0.01	–	18	FA, GI, TR, NUC, SPR, UC, MO
	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
	2N3129	NA	npn,PL,si	150	150	150	1.2	45	100	.002	–	–	
	40262	RCA	pnp,DR,ge	150	80	85	1.2	*50	10	12 (max)	*30	1	
	AC172	AMP	npn,AJ,ge	150	280	75	2.7	32	200	10	–	1	

(see pages 4-9 for explanation of company abbreviations.)



After 130,000,000 diodes

1-amp glass rectifiers come easy

The basic technology required for making silicon glass rectifiers has long since been proved out in ITT's diode operation. More than 130,000,000 diodes last year paved the way for 1966 1-amp glass rectifier capability that's already operating at better than a 1.2 million annual rate.

If you're using old-fashioned top-hats because delivery is slow on DO-29 glass rectifiers, make the switch now.

ITT offers immediate shipment of 200 to 1000 V, 1-amp glass rectifiers from factory stock or from ITT distributors' shelves. See how fast silicon glass rectifier delivery can be — call your ITT factory representative or any of ITT's semiconductor distributors throughout the United States today. ITT Semiconductors, a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida.

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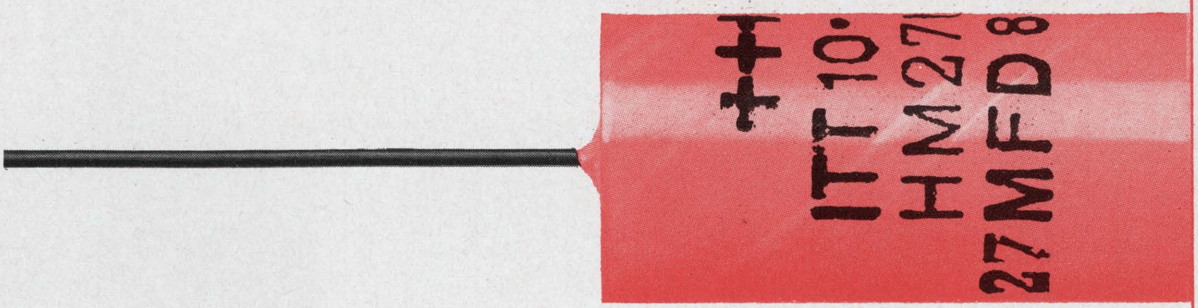
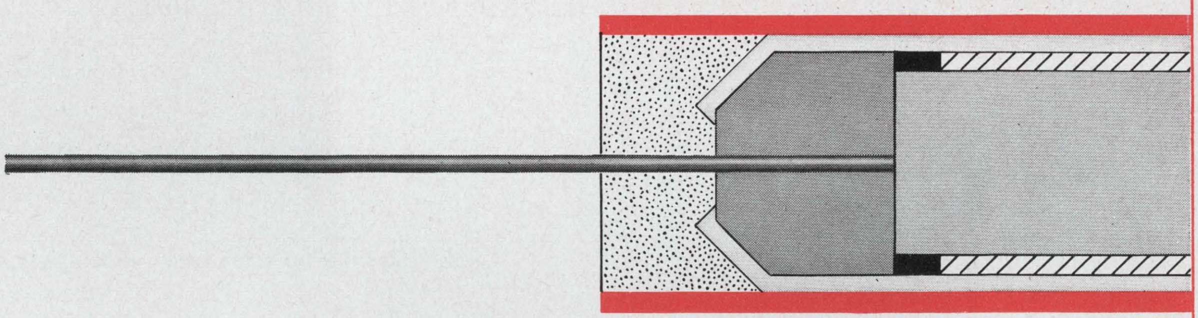
ON READER-SERVICE CARD CIRCLE 10

Audio *(continued)*

Cross Index Key	Type No.	Mfr.	Type	h_{fe} $*h_{FE}$	MAX. RATINGS P_c (mW)	T_j (^oC)	mW/^oC	V_{CEO} $*V_{CBO}$ (V)	I_c (mA)	CHARACTERISTICS I_{co} (μA)	$f_{\alpha e}$ $*f_T$ (MHz)	Package Outline (TO-)	Remarks
A 43	2N2924	GE	npn,PL,si	150-300	200	100	2.67	25	100	0.5	–	98	IEC, GME
	2N3392	GE	npn,PL,si	*150-300	200	100	2.67	25	100	0.1	–	98	Epoxy case, GME
	2N3860	GE	npn,PEP,si	*150-300	200	100	2.67	30	100	0.5	–	98	
	2N4086	GE	npn,PL,si	*150-300	200	100	2.67	12	100	0.1	–	98	
	MPS3392	MO	npn,EP,si	*150-300	310	135	2.81	25	100	0.1	–	92	
	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
	MPS3395	MO	npn,EP,si	*150-500	310	135	2.81	25	100	0.1	–	92	
A 44	2N2453	AL	npn,DP,si	*150-600	600	200	114	*60	9	.005	–	5	Dual
	2N2453A	AL	npn,DP,si	*150-600	600	200	1.14	*80	9	.005	–	5	Dual
	2N3061	CT	pnp,si	155	400	200	2.3	*70	100	.005	–	46	
	2N2613	RCA	pnp,AJ,ge	160	120	100	–	*30	50	5	10	1	
	2N3241	RCA	npn,PL,si	175	500	175	–	25	100	0.1	60	–	†fT
	2N3242	RCA	npn,PL,si	175	500	175	–	25	200	0.01	60	–	†fT
	2N3403	GE	npn,PE,si	*180-540	560	150	4.47	25	500	0.1	–	98	Epoxy case, heat clip
	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
A 45	2N3711	TI	npn,PE,si	*180-660	250	125	2.5	30	30	0.1	–	†	†Plastic
	MPS3711	MO	npn,EP,si	*180-660	310	135	2.81	30	30	0.1	–	92	
	2N1185	MO	pnp,AJ,ge	190-400	200	100	2.67	*45	500	10	–	5	
	MA884	MO	pnp,AJ,ge	190-400	200	100	2.67	*60	500	10	†1.75	5	†fab
	MA889	MO	pnp,AJ,ge	190-400	200	100	2.67	*50	500	15	†1.75	5	†fab
	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	–	
	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	–	
A 46	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	
	2N3427	MO	pnp,AJ,ge	200-500	200	100	2.67	*45	500	3.0	6.0	5	
	MA1703	MO	pnp,AJ,ge	200-500	200	100	2.67	*25	500	3.0	†3.0	5	†fab
	MA1706	MO	pnp,AJ,ge	200-500	200	100	2.67	*15	500	15	†3.0	5	†fab
	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
	D16E7	GE	npn,PEP,si	*235-470	200	100	2.67	18	100	0.5	–	98	
	D16E9	GE	npn,PEP,si	*235-470	200	100	2.67	25	100	0.5	–	98	
A 47	ME495	AMP	npn,PL,si	*250	360	200	2	*40	–	1	–	18	
	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
	2N3900	GE	npn,PL,si	*250-500	200	100	2.67	18	100	0.1	–	98	
	2N4087	GE	npn,PL,si	250-500	200	100	2.67	12	100	0.1	–	98	
	2N4087A	GE	npn,PL,si	250-500	200	100	2.67	12	100	0.1	–	98	5 dB(max nf)
	ME213A	AMP	npn,PL,si	300	360	200	2	45	–	.1	100	18	
	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
A 48	2N3428	MO	pnp,AJ,ge	350-800	200	100	2.67	*45	500	3.0	8.0	5	
	MA1704	MO	pnp,AJ,ge	350-800	200	100	2.67	*25	500	3.0	†5.0	5	†fab
	MA1707	MO	pnp,AJ,ge	350-800	200	100	2.67	*15	500	15	†4.0	5	†fab
	2N3078	AMP	npn,PL,si	360	360	200	2.06	*80	50	.01	–	18	TR
	2N3390	GE	npn,PL,si	*400-800	200	100	2.67	25	100	0.1	–	98	Economy – Epoxy, NUC, IEC, GME
	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
	MA1702	MO	pnp,AJ,ge	500	200	100	2.67	*45	500	3.0	†7.0	5	†fab
	MA1705	MO	pnp,AJ,ge	500	200	100	2.67	*25	500	3.0	†6.0	5	†fab
	MA1708	MO	pnp,AJ,ge	500	200	100	2.67	*15	500	15	†5.0	5	†fab
A 49	2N3077	AMP	npn,PL,si	600	360	200	2.06	*80	50	.01	–	18	TR
	A520/A521	AMP	npn,PL,si	600	300	200	1.72	80	50	.005	60	5	6 lead diff amp
	S15650	FA	npn,DPE,si	*600	200	125	5	25	–	.050	40	–	RO110 package
	2N3395	GE	npn,PL,si	800	200	125	0.375	25	100	0.1	–	†	Economy – Epoxy, GME, IEC
	2N3396	GE	npn,PL,si	800	200	125	9.375	25	100	.1	–	†	Economy – Epoxy, GME, IEC
	2N3397	GE	npn,PL,si	800	200	125	0.375	25	100	0.1	–	†	Economy – Epoxy, GME, IEC
	2N3398	GE	npn,PL,si	1250	200	125	0.375	25	100	0.1	–	†	Economy – Epoxy, GME, IEC
	2N2785	GE	npn,PL,si	2000	1800	200	10	40	500	10	–	5	SPR
	2N997	TI	npn,si	*7000	500	175	3.33	40	300	0.01	–	18	(Darlington),FA, SPR
	2N35	–	pnp,AS,ge	–	50	–	–	*25	–	–	–	–	SY, GI

(see pages 4-9 for explanation of company abbreviations.)





Why ITT wet tantalum capacitors can't leak

Every ITT Red Cap© wet tantalum capacitor gets a "total stress" seal that, unlike the ordinary single-crimp seal, positively prevents electrolyte leakage. To accomplish this, ITT inserts a teflon end seal, then spins down the open end of the can until end seal, anode and insulating washer are under a predetermined compressive force.

Seal integrity is further insured by the addition of an epoxy end fill. Since the epoxy's expansion coefficient is less than that of the can, temperature cycling cannot relax the spun seal.

If you're tired of electrolyte leaks and the problems that go with them, here's an easy solution. Order the ones that can't leak — the Red Caps© — from your ITT Capacitor distributor or from ITT Semiconductors, a division of International Telephone and Telegraph Corporation, 3301 Electronics Way, West Palm Beach, Florida.

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SEMICONDUCTORS

FACTORIES IN PALO ALTO, CALIFORNIA; LAWRENCE, MASSACHUSETTS; WEST PALM BEACH, FLORIDA; HARLOW AND FOOTSCRAY, ENGLAND; FREIBURG AND NURENBERG, GERMANY.

ON READER-SERVICE CARD CIRCLE 11

Audio *(continued)*

Cross Index Key	Type No.	Mfr.	Type	h_{fe} *h_{FE}	MAX. RATINGS P_c (mW)	T_j (^oC)	mW/^oC	V_{CEO} *V_{CBO} (V)	I_c (mA)	CHARACTERISTICS I_{co} (μA)	f_{ae} *f_T (MHz)	Package Outline (TO-)	Remarks
A 50	2N331		pnp,AJ,ge	–	200	71	–	*30	–	16	–	5	MO, GI, IND
	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
	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
	FT4020	FA	pnp,DPE,si	–	500	200	2.8	45	200	10	0.7	–	Dual pnp
A 51	FT4021	FA	pnp,DPE,si	–	500	200	2.8	60	200	10	0.55	–	Dual pnp
	FT4022	FA	pnp, DPE,si	–	500	200	2.8	60	200	10	0.7	–	Dual pnp
	FT4023	FA	pnp,DPE,si	–	500	200	2.8	45	200	10	0.7	–	Dual pnp
	FT4024	FA	pnp,DPE,si	–	500	200	2.8	60	200	10	0.55	–	Dual pnp
	FT4025	FA	pnp, DPE,si	–	500	200	2.8	60	200	10	0.7	–	Dual pnp
	ME209	AMP	npn, PE, si	–	300	175	2	*10	–	.002	–	18	Chopper, Voff=250nV
	ME214	AMP	npn,PE,si	–	300	175	2	*45	–	.002	–	18	Chopper, Voff=500nV
	SP10801	FA	npn,DP,si	–	350	200	2	*45	–	–	–	89	
	SP10810	FA	pnp,DPE,si	–	350	200	2	*20	–	–	–	89	
	SP10811	FA	pnp,DPE,si	–	350	200	2	*20	–	–	100	89	

(see pages 4-9 for explanation of company abbreviations.)

Late-arrivals . . .

The following bipolar transistor families, manufactured by General Instrument, are epoxy encapsulated units (TO-18 cans) similar or equivalent in characteristics to their metal-can counterparts (for detailed information on device properties use the literature offering form and reader-service card, p. 4):

Audio and general purpose

2N2711 - 2N2716
2N2721 - 2N2726
2N3390 - 2N3398
2N3414 - 2N3416

High-frequency

2N3563 - 2N3566
2N3605 - 2N3607
2N3638 - 2N3645
2N3702 - 2N3711
2N3900 - 2N3905
2N3983 - 2N3985

High-level switching

2N4140 - 2N4143 (similar to 2N2221, 2N2222, 2N2906, 2N2907)
2N4227 - 2N4228 (direct equivalents of metal-can types)

new

solutions to tough meter applications

Simpson

INSTRUMENTS THAT STAY ACCURATE

NEW *contactless* meter relays (4½″)

Utter reliability... utter simplicity. Completely fail-safe circuitry insures 100% reliability. No limitation on pointer travel due to mechanical contacts. Model 3324XA meter relays are CONTACTLESS. An infinite life lamp and photo-conductors do the sensing. Solid state switching circuit and relay (10 amp, DPDT, 115 VAC) are contained internally on single control point units. Double control point models also available. Control point indication is within 2% of actual switching. Available THROUGH DISTRIBUTORS in ranges shown.

RANGE	Approx. Ohms	Single Control Cat. No.	Single Control Price	Double Control Cat. No.	Double Control Price
DC Microammeters					
0-50	3000	16451	$99.00	16470	$136.35
0-100	1300	16452	96.15	16471	133.65
0-200	570	16453	96.15	16472	133.50
0-500	220	16454	96.15	16473	133.50
DC Milliammeter					
0-1	80	16455	95.10	16474	132.45
DC Millivoltmeter					
0-50	10	16460	63.60	16480	137.25

NEW miniature edgewise meters (1½″)

Takes only *half the space* of a 2½″ Edgewise meter with little sacrifice in scale length. Movement is *self-shielded.* DC accuracy is ± 2% (F.S.); AC (rectifier type), ± 3% (F.S.) at 25°, 60 cycle sine wave. Dustproof case. Meter comes complete with bezel and mounting hardware. 20 Ranges are STOCKED (see sampling below). Contact your ELECTRONIC DISTRIBUTOR about Model 1521.

RANGE	Approx. Ohms	Cat. No.	Price
DC Voltometers			
0-150	1000 o/v	10358	$15.45
DC Milliammeters			
0-100	1.35	6817	15.90
DC Millivoltmeters			
0-50	10	0713	16.20
DC Microammeters			
0-25	3150	4552	23.40
AC Voltmeters			
0-150	1000 o/v	10415	20.10

For Complete Details, Request Bulletin 2073 and Meter Relay Reprint Article.

SIMPSON ELECTRIC COMPANY 5202 W. Kinzie Street, Chicago, Ill. 60644 • Phone: 312-379-1121
Export Dept.: 400 W. Madison Street, Chicago, Ill. 60606 • Cable, Amergaco
In Canada: Bach-Simpson Ltd., London, Ontario
In India: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

ON READER-SERVICE CARD CIRCLE 12

High-Frequency

Includes types ranging up to and above the vhf range. Listed in order of increasing $f_{\alpha e}$ or f_T.

					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	
	2N2946	CT	pnp, PE, si	*3	400	200	2.4	*40	100	*30-150	0.0005	*10	46	SPR
HF 3	SFT337	NUC	pnp,ge	3	150	80	–	*15	100	60	2.5	–	1	
	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,AL,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
HF 4	2N1090	RCA	npn,AJ,ge	5	120	85	–	*25	400	*30	8	*25	5	GI
	2N2945	SPR	pnp, PE, si	*5	400	200	2.4	*25	100	*40-250	0.0002	*10	46	
	FK3962	FA	pnp,DP,si	5.5	175	200	2	60	50	*300	–	*6	–	Hermet package
	FV3962	FA	pnp,DP,si	5.5	175	200	2	60	50	*300	–	*6	51	
	2N2276	SPR	pnp, AT, si	*6	150	140	1.3	*15	50	*15	0.003	*6.0	*18	Matched Pair 2N227
	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<50µ V
	3N91	SPR	pnp,PE,si	*6	300	200	1.7	30	20	–	0.01	8	18	Duet, Voff<100µ V
	3N92	SPR	pnp,PE,si	6	300	200	1.7	30	20	–	0.01	8	18	Duet, Voff<200µ V
	3N93	SPR	pnp,PE,si	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff < 50µ V
HF 5	3N94	SPR	pnp,PE,si	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff< 100µ V
	3N95	SPR	pnp,PE,si	*6	300	200	1.7	50	20	–	0.01	8	18	Duet, Voff<200µ V
	3N112	SPR	pnp,PE, si	*6	200	200	1.1	*50	20	1.5	.010	*10	90	Dual
	3N113	SPR	pnp,PE, si	*6	200	200	1.1	*50	20	1.5	.010	*10	90	Dual
	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
	FK3964	FA	pnp,DP,si	7	175	200	2	45	50	*500	–	*6	–	Hermet package
	FV3964	FA	pnp,DP,si	7	175	200	2	45	50	*500	–	*6	51	
	SA-313	SPR	pnp,SP,si	*7	150	140	1.3	20	50	*6	0.01	6	5	Symmetrical
	SA-314	SPR	pnp,SP,si	*7	150	140	1.3	15	50	*8	0.02	6	5	Symmetrical
HF 6	SA-316	SPR	pnp,SP,si	*7	150	140	1.3	10	50	*10	0.003	6	5	Symmetrical
	SA-413	SPR	pnp,SP,si	*7	150	140	1.3	20	50	*6	0.01	6	18	Symmetrical
	SA-414	SPR	pnp,SP,si	*7	150	140	1.3	15	50	*8	0.02	6	18	Symmetrical
	SA416	SPR	pnp,SP,si	*7	150	140	1.3	10	50	*10	0.003	6	18	Symmetrical
	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
	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	
HF 7	2N474A	TR	npn,PL,si	8	200	175	1.2	30	25	20-50	.5	*8	5	
	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	RCA	pnp,AJ,ge	8	150	85	–	*18	100	30	3	–	5	GI, 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	
	SA-312	SPR	pnp,SP,si	*8	150	140	1.3	10	50	*10	0.01	6	5	Symmetrical

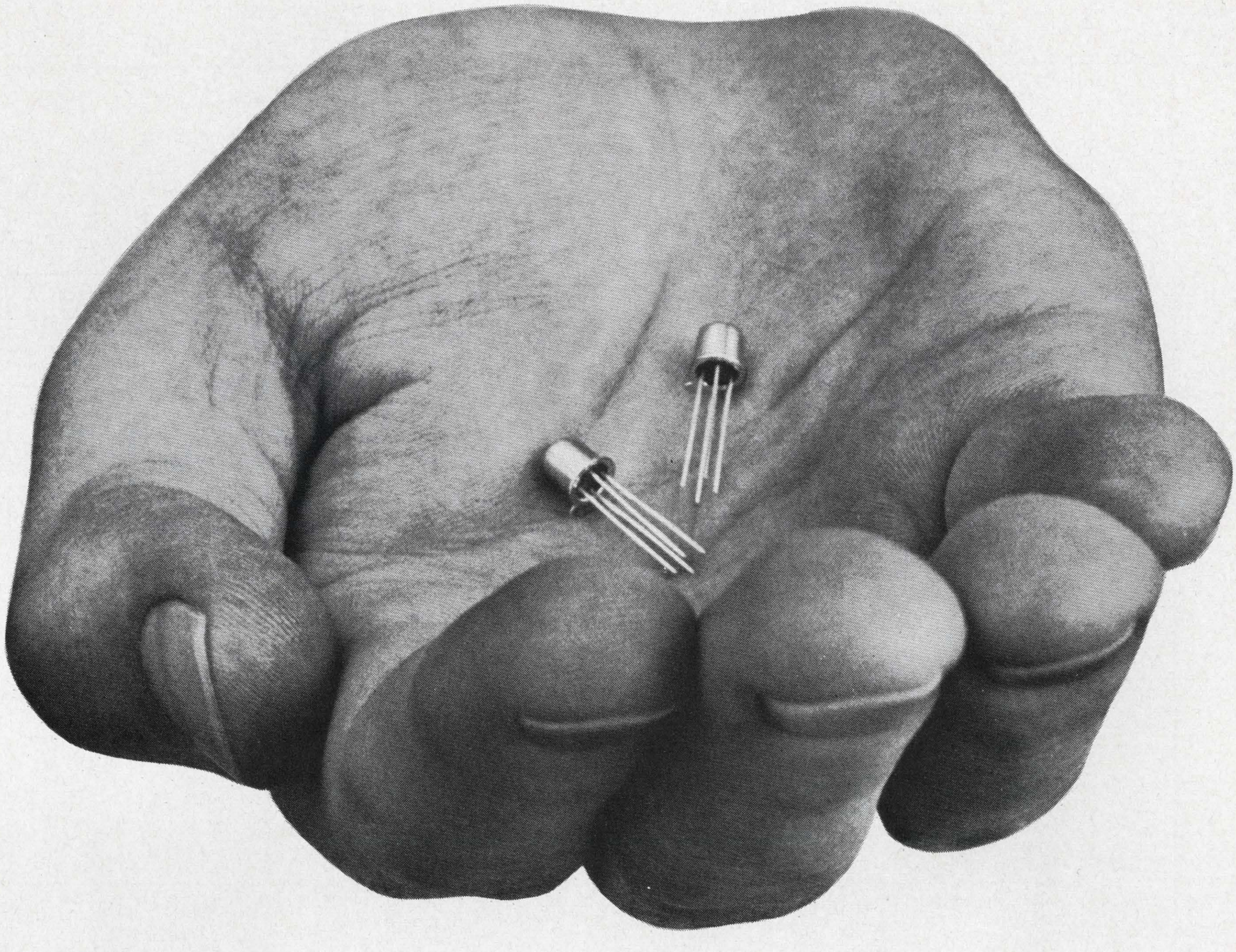
(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 8	SA-315	SPR	pnp,SP,si	*8	150	140	1.3	12	50	*10	0.01	6	5	Symmetrical
	SA-412	SPR	pnp,SP,si	*8	150	140	1.3	10	50	*30	0.01	6	18	Symmetrical
	SA-415	SPR	pnp,SP,si	*8	150	140	1.3	12	50	*10	0.01	6	18	Symmetrical
	2N447	GI	npn,AJ,ge	9	100	85	1.67	*15	–	50	6	*16	5	
	2N447A	GI	npn,AJ,ge	9	15	100	2	*25	–	85	4	*14	5	
	2N447B	GI	npn,AJ,ge	9	150	100	2	*25	–	150	4	*14	5	
	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
HF 9	2N542	TR	npn,PL,si	10	200	175	1.2	30	25	80-200	.5	*20	5	GE
	2N542A	TR	npn,PL,si	10	200	175	1.2	30	25	80-200	.5	*8	5	GE
	2N543	TR	npn,PL,si	10	200	175	1.2	50	25	80-200	.5	*20	5	GE
	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	60000	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
HF 10	2N3317	SPR	pnp,SPAT,si	*10	150	140	1.3	30	50	–	0.001	*9	18	Chopper
	2N3319	SPR	pnp,SP,si	*10	150	140	1.3	30	50	–	0.001	*9	18	Chopper
	SA-310	SPR	pnp,SP,si	*10	150	140	1.3	10	50	*30	0.01	6	5	Symmetrical
	SA-311	SPR	pnp,SP,si	*10	150	140	1.3	6	50	*15	0.01	6	5	Symmetrical
	SA-410	SPR	pnp,SP,si	*10	150	140	1.3	10	50	*30	0.01	6	18	Symmetrical
	SA-411	SPR	pnp,SP,si	*10	150	140	1.3	10	50	*30	0.01	6	18	Symmetrical
	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	18	Dual
	3N115	SPR	pnp,PE,si	*12	300	200	1.7	*30	20	3	.010	*10	18	Dual
HF 11	3N116	SPR	pnp, PE,si	*12	300	200	1.7	*30	20	3	.010	*10	18	Dual
	3N117	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	18	Dual
	3N118	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	18	Dual
	3N119	SPR	pnp,PE,si	*12	300	200	1.7	*50	20	3	.010	*10	18	Dual
	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
HF 12	2N496	*SPR	pnp,SPAT,si	*20	150	140	1.3	10	50	*25	0.1	*12	1	*PH orig. Reg.
	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	
	2N4138	TI	npn,PE,si	*20	300	175	2	30	100	50	0.01	*12	46	
	S15649	FA	npn,DP,si	*20	200	125	5	25	–	200-1000	3	4	–	R0110 package
	2N1411	SPR	pnp, MA, ge	*25	25	85	–	*5	50	*75	0.3	*3	24	PH, GI
	OC45	AMP	pnp, AJ, ge	*25	83	75	–	*15	5	75	0.5	–	–	
	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
HF 13	2N371	RCA	pnp,DR,ge	30	80	71	–	*24	10	80	10	–	7	
	2N372	RCA	pnpDR,ge	30	80	71	–	*24	10	80	10	–	7	
	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	
	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
HF 14	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, AMP
	2N1985	FA	npn,DP,si	*30	2000	150	0.016	25	–	60	1	*35	5	TRWS, CDC, AL, AMP
	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	
	2N3743	MO	pnp,AE,si	*30	5000	200	28.6	300	50	*25-250	0.3	*15	5	
	TN-55	SPR	npn,PE,si	30	800	200	4.57	30	800	100	.010	8	5	
	TN-56	SPR	npn,PE,si	30	500	200	2.86	30	800	100	.010	8	18	
	TN-57	SPR	npn,PE,si	30	800	200	4.57	*40	800	80	0.010	*8	5	
	TN-58	SPR	npn, PE, si	30	500	200	2.86	*40	800	80	0.010	*8	18	

(see pages 4-9 for explanation of company abbreviations.)

WHAT GIVES YOU AN UNNEUTRALIZED, 3-STAGE TV-IF WITH 90db STABLE GAIN, HAS LOW FEEDBACK CAPACITANCE, CUTS COMPONENT COSTS, MINIMIZES ALIGNMENT TIME AND HAS NEVER BEEN USED IN A SINGLE TV SET?



Integrated-Shield Transistors. How come they've never been used before? Simple. They've never been available before; they're brand new from Amperex.

Until now, the big problem in designing transistorized TV-IF's has been the transistor feedback capacitance. Amperex's breakthrough to integrated shielding has now produced the types A467 and A473 with feedback capacitance so low that the need for neutralizing the circuit is completely eliminated.

In the Amperex Integrated-Shielding process, we diffuse a special shield between the collector and the base lead "tab" to clamp the base at the emitter RF potential. In common emitter circuits of the type used in TV-IF amplifiers the net effect is the elimination of the major source of feedback capacitance: the capacity between the collector and the base-lead "tab." Thus the C_{re} for the type A467 is a low 150 mpf and only 220 mpf for the type A473.

Now you can build a three-stage, unneutralized video IF amplifier, using the A467 and two A473's to produce an overall minimum stable gain of 90db at 44mHz. The gain control range of the type A467 stage is 55db minimum; in the output stage the A473 will provide swings of 7.7 volts undistorted into 2700 ohms.

For complete data and application information, write: Amperex Electronic Corporation, Semiconductor and Special Purpose Tube Division, Slatersville, Rhode Island, 02876.

Type	f_T	C_{re}	AGC Range	45 Mc Useable Gain	10.7 Mc Useable Gain
A467	330 Mc	150 mpf	55 db	33 db	–
A473	550 Mc	230 mpf	–	34 db	36 db

Amperex®

ON READER-SERVICE CARD CIRCLE 13

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (µA)	C_{oe} *C_{ob} (pF)	Package Outline (TO-)	Remarks
HF 15	2N1524	RCA	pnp,DR,ge	33	80	71	–	*24	10	60	16	–	1	
	2N1525	RCA	pnp,DR,ge	33	80	71	–	*24	10	60	16	–	40	
	2N1526	RCA	pnp,DR,ge	33	80	71	–	*24	10	130	16	–	1	
	2N1527	RCA	pnp,DR,ge	33	80	85	–	*24	10	130	16	*2	40	
	2N1417	TR	npn,si	*34	150	150	1.25	15	–	60	0.05	*1.5	5	
	2N1418	TR	npn,si	*34	150	150	1.25	30	–	60	0.05	*1.5	5	
	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
	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
HF 16	2N843	TR	npn,PE,si	40	300	175	2	45	50	*45-150	1	*10	18	
	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	
	2N3565	FA	npn,PL,si	*40	500	125	5.0	25	–	*150-600	0.05	*4.0	–	CDC, IEC, GME
	2N3566	FA	npn,PL,si	*40	800	125	8.0	30	–	*400	0.05	25	–	CDC, IEC, GME
	2N3712	TI	npn,PL,si	*40	800	175	5.33	150	200	*30-150	0.1	9	5	Metal header, MO
HF 17	PADT50	AMP	pnp,PADT,ge	*40	6000	75	–	*70	700	40	–	–	3	
	2N128	*SPR	pnp,SBT,ge	45	25	85	0.82	*10	5	40	0.6	*2.5	24	*PH orig Reg
	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
	2N2510	AL	DP	45	1.2W	200	6.9	65	–	150	.005	*6	18	GI, TR, AMP, UC
	2N2511	AL	DP	45	1.2W	200	6.9	50	–	240	.005	*6	18	GI, TR, AMP, UC
	OC44	AMP	pnp,PADT,ge	*45	83	75	–	*15	5	100	0.5	–	–	Special Case
HF 18	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
	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	RCA	pnp, ge	*50	150	85	–	*13	100	*85	13	*12	18	SPR
	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
HF 19	2N1427	*SPR	pnp,MA,ge	*50	25	85	–	*6	50	120	0.5	*3.5	24	*PH orig Reg, GI
	2N1683	RCA	pnp,ge	*50	150	85	–	12	100	*50	3	*12	5	SPR
	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
	2N1893	FA	npn,si	50	3	200	0.017	80	0.5	*40-120	0.01	*15	5	RCA, TR, NA, TRWS
	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
HF 20	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.
	2N2223A	MO	npn,AE,si	*50	3000	200	17.2	60	500	*25-150	.01	*15	77	Diff. Amp.
	TI538	TI	pnp,PE	*50	200	125	2	32	50	25	0.1	*0.5	92	
	2N346	SPR	pnp,SBT,ge	60	20	55	1.33	*5	5	35	0.7	*3	24	*PH orig Reg
HF 21	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
	2N719	FA	npn, DD, si	*60	1.5W	175	10	*120	–	*40	0.01	*12	18	TRWS, CDC, TR, GI, AMP
	2N719A	FA	npn,DP,si	*60	1.8W	200	10.3	*120	–	*40	0.005	*12	18	TRWS, CDC, AMP, AL, GI, TR
	2N720A	FA	npn,DP,si	*60	1.8W	200	10.3	*120	–	*80	0.005	*12	18	TRWS, CDC, GI, AMP, AL, TR, RCA
	2N912	FA	npn,DP,si	*60	1800	200	10.3	60	–	45	0.005	*13	18	TRWS, CDC, AMP, AL
	2N1301	SPR	pnp, ge	*60	150	85	–	*13	100	30	3	–	5	

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (µA)	C_{oe} *C_{ob} (pF)	Package Outline (TO-)	Remarks
HF 22	2N1972	FA	npn,DD,si	*60	2.0	175	10	*60	–	*250	0.1	*25	5	TR, AMP, TRWS
	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.
	2N2060A	MO	npn,AE,si	*60	3000	200	17.2	60	500	*40-120	.002	*15	77	Diff. Amp.
	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	
	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
	2N3567	FA	npn,PE,si	*60	800	125	8.0	40	–	*80	0.05	*20	–	TEC, GME
HF 23	2N3568	FA	npn,PE,si	*60	800	125	8.0	60	–	*80	0.05	*20	–	
	2N3569	FA	npn,PE,si	*60	800	125	8.0	40	–	*150	0.05	*18	–	IEC, GME
	MM2483	MO	npn,EP,si	*60	1200	200	6.9	60	50	*40-120	.01	*6	18	
	MM2484	MO	npn,EP,si	*60	1200	200	6.9	60	50	*100-500	.01	*6	18	
	2N2483	FA	npn,DP,si	*69	1.2W	200	6.9	60	50	*280	0.0001	*3.5	18	AMP, GI, TR, AL, UC
	2N911	FA	npn,DP,si	*70	1800	200	10.3	60	–	70	0.005	*13	18	TRWS, CDC, AMP, AL
	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	
	2N1338	TRWS	npn,PL,si	*70	800	175	5.3	*80	300	*10-150	1	*10	5	
HF 24	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
	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
	2N2915	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*240	0.001	*5	5	GI, AL, UC, MO, SPR
	2N2916	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*450	0.001	*5	5	SPR, GI, AL, UC, MO
HF 25	2N2917	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*240	0.001	*5	5	SPR, GI, UC, RCA, AL, MO
	2N2918	FA	npn,DP,si	*70	1.5W	200	3.42	45	30	*450	0.001	*5	5	SPR, GI, UC, RCA, AL, MO
	2N2919	FA	npn,DP,si	*70	1.5W	200	3.42	60	30	*240	0.001	*5	5	SPR, GI, AL, UC, MO
	2N2920	FA	npn,DP,si	*70	1.5W	200	3.42	60	30	*450	0.001	*5	5	SPR, GI, AL, UC, MO
	2N2972	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	*5	18	GI, AL, UC, MO, SPR
	2N2973	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR
	2N2974	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	*5	–	GI, AL, UC, MO, SPR, VEC
	2N2975	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	5	18	GI, AL, UC, MO, SPR, VEC
	2N2976	FA	npn,DP,si	*70	750	200	1.71	45	30	*240	0.001	5	18	GI, AL, UC, MO, SPR
	2N2977	FA	npn,DP,si	*70	750	200	1.71	45	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR
HF 26	2N2978	FA	npn,DP,si	*70	450	200	1.71	60	30	*240	0.001	5	18	GI, AL, UC, MO, SPR, VEC
	2N2979	FA	npn,DP,si	*70	750	200	1.71	60	30	*450	0.001	*5	18	GI, AL, UC, MO, SPR, VEC
	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
	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
HF 27	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	
	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
	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
	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
HF 28	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
	2N720	FA	pnp,DD,si	*80	1.5W	175	10	*120	–	*80	0.01	12	18	TRWS, CDC, TR, GI, AMP, AL
	2N870	FA	npn, DP, si	*80	1.8W	200	10.3	60	–	*75	0.004	*13	18	TRWS, CDC, GI, AMP, AL
	2N910	FA	npn,DP,si	*80	1800	200	10.3	60	–	140	0.005	*13	18	TRWS, CDC, AMP, AL
	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
	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

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (µA)	C_{oe} *C_{ob} (pF)	Package Outline (TO-)	Remarks
HF 29	2N1973	FA	npn,DP,si	*80	3W	200	4.56	60	–	140	0.005	*13	5	TRWS, CDC, AL, AMP, TR
	2N2451	SPR	pnp,MAT,ge	*80	25	85	4.54	*6	50	40	5	6	24	
	2N2720	SSD	npn,PL	*80	600	200	3.4	60	50	*35	.010	–	5	Differential amp, AL, SPR
	2N2721	SSD	–	*80	600	200	3.4	60	50	*35	.010	*6	5	Differential amp, AL, SPR
	TI537	TI	pnp,PE	*80	200	125	2	32	50	45	0.1	*0.5	92	
	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	
HF 30	2N2602	SSD	pnp,PL	*90	400	200	2.3	60	50	*25	.025	*6	46	
	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	
	2N697	FA	npn,DD,si	*100	2.0W	175	13.3	*60	–	*75	0.01	*20	–	TRWS, MO, TR, GI, AMP, CDC, BE NA, RCA
	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, AMP, AL NA, RCA, AMP
	2N956	FA	npn, DP, si	*100	1.8W	200	10.3	*75	–	*130	0.003	*18	18	TRWS, CDC, MO, GI, AMP
HF 31	2N979	SPR	pnp,MD,ge	*100	60	100	0.8	*20	100	*70	1	*1.5	18	
	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
	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
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 orig 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
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
	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
HF 34	2N2591	SSD	pnp,PL	*100	400	200	2.3	60	50	*35	.025	*6	46	
	2N2722	SSD	npn,PL	*100	600	200	3.4	45	50	*60	.001	*6	5	Differential AMP, AL, SPR
	2N2895	RCA	npn,si	*100	1800	200	10.3	65	1000	*40-120	.002	*15	18	
	2N2896	RCA	npn,si	*100	1800	200	10.3	90	1000	*60-200	.01	*75	18	
	2N2897	RCA	npn,si	*100	1.8W	200	10.3	45	1a	*50-200	.05	*15	18	
	2N2898	RCA	npn,si	*100	1800	200	10.3	65	1000	*40-120	.002	*75	46	
	2N2899	RCA	npn,si	*100	1800	200	10.3	90	1000	*60-200	.01	*15	46	
	2N2900	RCA	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	
HF 35	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, GME
	2N3703	TI	pnp,PL,si	*100	300	125	3	25	200	*50-150	0.1	*12	–	Plas IEC, GME
	2N3704	TI	npn,EP,si	*100	300	150	3	20	800	*90-330	0.1	12	–	Plas IEC, GME
	2N3705	TI	npn,EP,si	*100	300	150	3	30	800	*45-165	0.1	12	–	Plas IEC, GME
	2N3706	TI	npn,EP,si	*100	300	150	3	20	800	*30-660	0.1	12	–	Plas IEC, GME
	2N3798	MO	pnp,AE,si	*100	1200	200	6.9	60	50	*150-450	.01	*4	18	
	2N3799	MO	pnp,AE,si	*100	1200	200	6.9	60	50	*300-900	.01	*4	18	
	2N3800	MO	pnp,AE,si	*100	360	200	2.06	60	50	*150-450	.01	*4	71	Dual

(see pages 4-9 for explanation of company abbreviations.)

WHICH BRANCH

OF THE PNP SILICON TRANSISTOR FAMILY TREE

P N P

ARE YOU CONCERNED WITH?

PNP LOW LEVEL LOW NOISE	PNP MEDIUM POWER	PNP INTEGRATED CHOPPERS	PNP DIFFUSED EPITAXIAL	PNP DIFFERENTIAL AMPLIFIERS
$I_{CBO} < 1$ nA h_{FE} (10 μA-5V) 100-300 NF 3 db	BV_{EBO}, $BV_{CEO} > 60V$ h_{FE} (.1mA to 100mA) >100 $t_{TCT} < 100$ N SEC	$BV_{EE} > 50V$ $V_O < 50\mu V$ $I_{EEO} < 1$ nA	BV_{CBO}, BV_{CEO}, $BV_{EBO} > 50V$ $h_{FE} > 50$ $I_{CBO} < 10$ nA	$h_{FE} > 100$ $\frac{h_{FE1}}{h_{FE2}}$ 10% V_{BE1}-$V_{BE2} = \pm 3$ mV
2N2603 2N2604 2N2605 2N3544 2N3548 2N3549	2N2485A 2N2486A 2N2904A – 2N2907A 2N3502 – 2N3505	3N90 – 3N95 3N114 – 3N119	2N328A 2N329A 2N2944 2N2945 2N2946 2N3857 2N3058 – 2N3065	NS7200 NS7201 2N3502 2N3503 2N3504 2N3505 2N3800 – 2N3811

NSC-130

Whichever branch of PNP's you are concerned with, before you specify a **brand** CHECK THE NSC LINE. Write for spec sheets on any of these devices—or better yet, the NSC Composite Catalog.

NSC
NATIONAL SEMICONDUCTOR CORPORATION
DANBURY, CONN.

ON READER-SERVICE CARD CIRCLE 14

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 36	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.
	2N3806	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Dual; Low Profile Can
	2N3807	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Dual; Low Profile Can
	2N3808	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Diff. Amp.; Low Profile Can
	2N3809	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Diff. Amp.; Low Profile Can
	2N3810	MO	pnp,AE,si	*100	600	200	3.4	60	50	*150-450	.01	*4	77 mod	Diff. Amp.; Low Profile Can
HF 37	2N3811	MO	pnp,AE,si	*100	600	200	3.4	60	50	*300-900	.01	*4	77 mod	Diff. Amp.; Low Profile Can
	40084	RCA	npn,si	*100	1.8W	200	10	40	1a	*50-250	0.25	15	18	
	40354	RCA	npn,si	*100	500	175	3.3	*150	50	–	.005 (max)	2.8	–	
	FT34A	FA	npn,DPE,si	100	–	200	.0286	*150	–	*120	–	1.2	59	
	FT34B	FA	npn,DPE,si	100	–	200	.0286	*120	–	*300	–	1.2	59	
	NS1355	NA	npn,PL,si	*100	600	200	3.5	40	100	*30-100	.025	*7	18	VHF 400mW @ 70Hz
	MCS2135	MO	npn,AE,si	*100	150	125	1.5	60	50	*100-300	.01	*3	–	
	MCS2136	MO	npn,AE,si	*100	150	125	1.5	60	50	*250-750	.01	*3	–	
	MCS2137	MO	pnp,AE,si	*100	150	125	1.5	60	50	*100-300	.02	*3	–	
	NS1356	NA	npn,PL,si	*100	800	200	4.5	40	100	*30-100	.025	*7	5	VHF 400mW @ 70 Hz
HF 38	MCS2138	MO	pnp,AE,si	*100	150	125	1.5	60	50	*250-750	.02	*3	–	
	TI411	TI	npn,EP, si	*100	300	150	2.4	30	800	*180-660	0.1	*12	–	Plas IEC, GME
	TN-53	SPR	npn,PE, si	100	800	200	4.57	45	800	*50	.010	8	5	
	TN-54	SPR	npn, PE,si	100	800	200	2.86	45	800	*50	.010	8	5	
	TN-59	SPR	npn,PE,si	100	800	200	4.57	30	800	*100	.020	8	5	
	TN-60	SPR	npn, PE, si	100	500	200	2.86	30	800	*100	.020	8	18	
	TN-61	SPR	npn,PE,si	100	800	200	4.57	30	800	30	.020	8	5	
	TN-62	SPR	npn,PE,si	100	500	200	2.86	30	800	30	.020	8	18	
	TN-63	SPR	npn,PE,si	100	800	200	4.57	20	800	20	0.1	8	5	
	TN-64	SPR	npn,PE,si	100	500	200	2.86	20	800	20	0.1	8	18	
HF 39	TN-237	SPR	npn, PE, si	100	800	200	4.57	*35	800	30	1	*8	5	
	TN-238	SPR	npn, PE,si	100	500	200	2.86	*35	800	30	1	*8	18	
	2N1253	FA	npn,DD,si	*110	2.0W	175	13.3	*30	–	*45	0.1	*30	5	AL, NA
	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
	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
HF 40	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	
	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	
	2N2838	MO	pnp,EP,si	*120	1.8W	200	10.3	35	800	*75-225	–	*25	18	
	2N2943	SPR	pnp,ED,ge	*120	150	100	2	*30	100	*50	–	*2.5	9	
	2N1710	TRWS	npn,PL,si	*>120	15000	175	100	*60	2000	4.0	50	*40	8	
	2N768	*SPR	pnp,MD,ge	*124	35	100	0.467	*12	100	*40	1	*1.6	18	*PH orig Reg
HF 41	2N2592	SSD	pnp,PL	*125	400	200	2.3	60	50	*70	.025	*6	46	
	40340	RCA	npn,si	*125	70W	200	400	–	10A	–	*100	*120	60	Vcev= 60; overlay type
	40341	RCA	npn,si	*125	70W	200	400	–	10A	–	*100	*85	60	Vcev = 80; overlay type
	SFT443A	NUC	npn,si	*125	12,000	–	–	80	–	*15	10	20	60	
	2N2193A	GE	npn,PE,si	*130	2.8W	200	1.6	50	1A	*40-120	.01	*20	5	CDC, GI, FA, NA, MO, AL
	2N2194A	GE	npn,PE,si	*130	2.8W	200	16	40	1A	*20-60	.010	*20	5	CDC, FA, GI, NA, MO, AL
	2N2195A	GE	npn,PE,si	*130	2.8W	200	16	25	1A	20	0.01	*20	5	CDC, FA, GI, MO, AL
	2N2243A	GE	npn,PE,si	*130	2.8W	200	16	80	1a	*40-120	.01	*20	5	GI
	2N2350A	GE	npn,PE,si	*130	5,000	200	28.5	25	1,000	*20	.01	*20	46	
	2N2351A	GE	npn,PE,si	*130	5,000	200	28.5	50	1,000	*40-120	.01	*20	46	NA
HF 42	2N2352A	GE	npn,PE,si	*130	5,000	200	28.5	40	1,000	*20-60	.01	*20	46	NA
	2N2353A	GE	npn,PE,si	*130	5,000	200	28.5	25	1,000	*20	.01	*20	46	NA
	2N2364A	GE	npn,PE,si	*130	5,000	200	28.5	80	1,000	*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)
	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)
	2N1177	RCA	pnp,DR,ge	140	80	71	–	*30	10	100	12	–	45	LAN

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 43	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	
	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
HF 44	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
	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
	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
HF 45	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	
	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	.050	*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, GME
HF 46	2N3763	MO	pnp,AE,si	*150	4000	200	22.8	60	1500	*20-80	–	*15	5	Icex=0.1
	2N3765	MO	pnp,AE,si	*150	2000	200	11.4	60	1500	*20-80	–	*15	46	Icex=0.1
	2N3818	MO	npn,EP,si	*150	25000	175	167	*60	2000	*5-50	1	*40	60	
	SFT440	NUC	npn,si	*150	12,000	–	–	80	1000	*10	10	15	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	1.2 W	200	6.85	60	50	*300	–	*6	18	
	2N3963	FA	pnp,DP,si	160	1.2 W	200	6.85	80	50	*300	–	*6	18	
	2N3964	FA	pnp,DP,si	160	1.2 W	200	6.85	45	50	*500	–	*6	18	
	2N3965	FA	pnp,DP,si	160	1.2 W	200	6.85	60	50	*500	–	*6	18	
	40263	RCA	pnp, DR, ge	160	120	100	2.66	*20	50	12	10	–	1	
HF 47	2N2525	TRWS	npn,PL,si	*162	16000	200	91.43	80	1000	2.23	–	*25	–	
	A301	AMP	npn,PL,si	*165	300	175	2	*40	40	*600	.5	11	18	
	2N2913	FA	npn,DP,si	*170	1.5W	200	3.42	45	30	*240	0.001	*5	5	SPR, GI, AL, UC, MO
	2N735A	SSD	npn,PL	*175	500	200	2.85	60	50	*30	.005	*6	18	TR
	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
HF 48	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	
	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
	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
	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	
HF 49	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	–	*15	5	Icex=0.1
	2N3764	MO	pnp,AE,si	*180	2000	200	11.4	40	1500	*30-120	–	*15	46	Icex=0.1
	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

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $^*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^†I_{CEX}$ (µA)	C_{oe} $^*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 50	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
	2N752	NA	npn,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
	2N869	FA	pnp,DP,si	*200	1.2W	200	6.86	18	–	*60	0.005	*60	18	MO
	2N1962	SY	npn,PE,si	200	400	175	–	*40	200	*20-80	0.25	3.0	46	
	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	
HF 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	60	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	–	TI, VEC
	2N2904	MO	pnp,AE,si	*200	3W	200	17.2	40	600	*40-120	.02	*8	5	GI, TR, SPR, AL
	2N2904A	MO	pnp,AE,si	*200	3W	200	17.2	60	600	*40-120	.01	*8	5	GI, TR, SPR, AL
HF 52	2N2905	MO	pnp,AE,si	*200	3W	*100	200	40	600	100-300	.02	*8	5	GI, TR, SPR, AL
	2N2905A	MO	pnp,AE,si	*200	3W	200	17.2	60	600	100-300	.01	*8	5	GI, TR, SPR, AL
	2N2906	MO	pnp,AE,si	*200	1.8W	*100	10.3	40	600	40-120	.02	*8	18	TR, SPR, AL
	2N2906A	MO	pnp,AE,si	*200	1.8W	200	10.3	60	600	*40-120	0.01	*8	18	GI, TR, SPR, AL
	2N2907	MO	pnp,AE,si	*200	1.8W	200	10.3	40	600	*100-300	.02	*8	18	GI, TR, SPR, AL
	2N2907A	MO	pnp,AE,si	*200	1.8W	200	10.3	60	600	*100-300	.01	*8	18	GI, TR, SPR, AL
	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
	2N3134	MO	pnp,AE,si	*200	3W	200	17.3	35	600	*100-300	.05	*10	5	SPR
HF 53	2N3135	MO	pnp,AE,si	*200	1.8W	200	10.3	35	600	*40-120	0.05	*10	18	SPR
	2N3136	MO	pnp,AE,si	*200	1.8W	200	10.3	35	600	*100-300	.05	*10	18	SPR
	2N3229	RCA	npn,si	*200	17.5W	200	100	60	2.5A	–	0.1	*20	60	15W (min.)@ 50MHz
	2N3252	MO	npn AE,si	*200	5W	200	28.6	*30	–	*30-90	.5	*12	5	NA
	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	
	2N3324	MO	pnp,EM,ge	*200	300	100	4	*35	100	*30-200	10	*3	18	
	2N3325	MO	pnp,EM,ge	*200	300	100	4	*35	100	*30-200	10	*3	18	
	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	
HF 54	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	
	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
HF 55	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
	2N3692	FA	npn,PL,si	*200	625	150	2	*35	50	*100-400	.05	.5-35	–	R097A package, CDC
	2N3693	FA	npn,DP,si	200	500	125	5	45	–	*40	5	–	–	R0110 package
	2N3694	FA	npn,DP,si	200	500	125	5	45	–	*100	5	–	–	R0110 package
	2N3701	FA	npn,DPE,si	200	1.8 W	200	10.3	80	1000	*120	10	–	18	
	2N3766	FA	npn,DPE,si	200	1.8 W	200	10.3	80	1000	*300	10	–	18	
	2N4125	MO	pnp,AE,si	*200	310	135	2.81	30	200	*50-150	.05	*4.5	92	
	A415	AMP	npn,PL,si	*200	165	175	1.1	*50	30	*125	.010	–	72	Cre=0.55 pf.
	A1590	AMP	npn,si	200	165	175	1.1	*50	30	*125	.010	–	72	Cre=0.55 pf.
HF 56	FT4017	FA	pnp,DPE,si	*200	1.1 W	200	.0062	80	200	*100-500	.010	–	–	Dual pnp
	FT4018	FA	pnp,DPE,si	*200	1.1 W	200	.0062	60	200	*100-600	.010	–	–	Dual pnp
	MPS706	MO	npn,EP,si	*200	500	125	5	*25	–	*20	0.5	*6	92	
	MPS2923	MO	npn,EP,si	*200	200	100	2.67	25	100	235-470	0.5	*12	92	
	MPS2924	MO	npn,EP,si	*200	200	100	2.67	25	100	150-300	0.5	*12	92	
	MPS2925	MO	npn,EP,si	*200	200	100	2.67	25	100	90-180	0.5	*12	92	
	SFT445	NUC	npn,si	*200	3	–	–	*80	–	*10	1	8	5	
	TN-81	SPR	npn, PE,si	200	800	200	4.57	20	800	*50	0.1	*8	5	
	UD-3005	SPR	npn,PE,si	200	350	200	–	*60	600	*100-300	0.010	*8	85	npn Quad
	UD-3006	SPR	pnp,PE,si	200	350	200	–	*60	600	*100-300	0.010	*8	85	pnp Quad

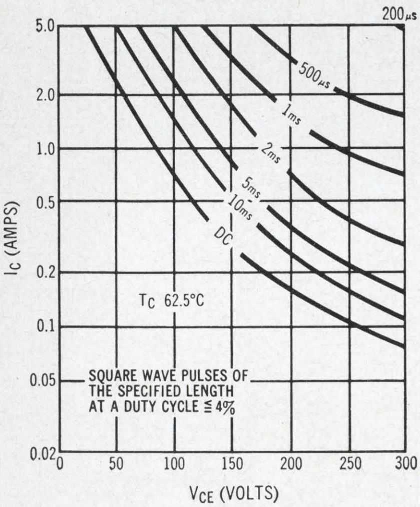
(see pages 4-9 for explanation of company abbreviations.)

Who could build a better silicon power transistor than our DTS-423?

We could. Meet DTS-431.

PARAMETER	MAXIMUM	TYPICAL	MINIMUM
V_{CEO}	400V		
V_{CBO}	400V		
V_{CEO} (sus)		370	325
I_C	5A		
I_B	2.0A		
Junction Temperature	150° C		−65° C
h_{FE} (I_C=2.5A V_{CE}=5V)	35		15
h_{FE} (I_C=3.5A V_{CE}=5V)			10

TYPICAL SWITCHING TIMES:
Rise time —0.40 Microseconds
Storage time—0.45 Microseconds
Fall time —0.35 Microseconds



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Introducing the DTS-431, the newest addition to Delco Radio's line of high voltage silicon power transistors. It offers you a number of distinct design advantages over the DTS-423, including an even higher current capability.

What's more, the DTS-431 permits you to design with complete freedom within the rated specifications, for its safe operating data is not based on mere probability. Sustaining voltage (VCEO SUS) tests are performed on every DTS-431 we make. Not just a sample. Every one.

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ON READER-SERVICE CARD CIRCLE 15

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 57	UD-3007	SPR	npn, pnp, PE, si	200	350	200	–	*60	600	*100-300	0.010	*8	85	Complementary Quad
	WS154	WH	–	*200	–	–	–	–	–	30	–	–	–	Quad
	AF 106	SA	pnp,MS,ge	220	60	90	2.5	18	10	*50	0.5	–	18	
	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
	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	AMP, TR, AL, UC
HF 58	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
	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
	2N2218	MO	npn,PE,si	*250	3W	175	20	30	–	*40-120	0.01	8	5	GI, FA, SPR, TR, NA, TRWS, AL, AMP
	2N2218A	MO	npn,AE,si	*250	3W	175	20	40	–	40-120	.01	*8	5	SPR, TR, NA, AL
	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	1.71	*20	50	10-200	0.1	*2	18	AL
HF 59	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
	2N3502	FA	pnp,PE,si	*250	3W	200	17.2	60	600	*70	0.00005	4.5	5	TI
	2N2219	MO	npn,PE,si	*250	3W	175	20	30	–	*100-300	0.01	8	5	GI, FA, SPR, TR, NA, TRWS, AL, AMP
	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
HF 60	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
	2N2221A	MO	npn,AE,si	*250	1.8W	175	12	40	–	40-120	.01	*8	18	GI, SPR, TR, NA, AL
	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
	2N2273	MO	pnp,EM,ge	*250	150	100	2	15	100	*20-75	10	*3.5	18	
	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	
	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
HF 61	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
	2N2538	MO	npn,AE,si	*250	3W	200	17.2	30	–	*100-300	.25	*8	5	GI, NA, SPR
	2N2539	MO	npn,AE,si	*250	1.8W	200	10.3	30	–	*501.50	.25	*8	18	GI, NA, SPR
	2N2540	MO	npn,AE,si	*250	1.8W	200	10.3	30	–	*100/300	.25	*8	18	GI, NA, SPR
	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
	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
HF 62	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
	2N3115	MO	npn,AE,si	*250	1.8W	175	12	20	600	*40-120	.025	*8	18	GI, SPR, TRWS
	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	
	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	
HF 63	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	
	2N3284	MO	pnp,EM,ge	*250	100	100	1.33	*25	50	10-200	10	*1.5	18	
	2N3285	MO	pnp,EM,ge	*250	100	100	1.33	*20	50	5-200	10	*1.5	18	
	2N3286	MO	pnp,EA,ge	*250	100	100	1.33	*20	50	5-200	10	*1.5	18	
	2N3291	MO	npn,E, si	*250	300	200	1.71	*25	50	10-200	0.1	*2	18	AL
	2N3503	FA	pnp,PE,si	*250	3W	200	17.2	60	600	*70	0.00007	4.5	5	TI
	2N3504	FA	pnp,PE,si	*250	1.3W	200	2.28	45	600	*70	0.00005	*4.5	18	TI
	2N3505	FA	pnp,PE,si	*250	1.3W	200	2.28	45	600	*70	0.00005	*4.5	18	TI
	2N2656	TRWS	npn,PL,si	*>250	1200	200	6.86	*25	200	160	0.5	*5	18	KSC

(see pages 4-9 for explanation of company abbreviations.)

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 64	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	
	2N3905	MO	pnp,AE,si	*250	310	135	2.81	40	200	*50-150	†.05	*4.5	92	
	2N3946	MO	npn,AE,si	*250	1200	200	6.9	40	200	*50-150	†.01	*4	18	
	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	
	2N930A	SSD	npn,PL	*275	500	200	2.85	45	50	*150	.002	*6	18	AMP, AL
HF 65	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	
	AF 109	SA	pnp,MS,ge	280	60	90	2.5	18	12	*100	1.0	–	18	agc pre-stages
	FT4019	FA	pnp,DPE,si	*280	1.1 W	200	.0062	45	200	*250-600	.010	–	–	Dual pnp
	2N784	SY	npn,EP,si	300	300	175	–	*30	200	*25-150	.25	3.5	18	FA
	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
	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	
HF 66	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
	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
	2N2222A	MO	npn,AE,si	*300	1.8W	175	12	40	–	*100-300	.01	*8	18	GI, SPR, TR, NA, TRWS
HF 67	2N2318	GI	npn,si	*300	360	175	2.0	15	–	*40	.050	*5	18	STC
	2N2319	GI	npn,si	*300	300	175	1.7	15	–	*40	.050	*5	46	STC
	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	
	2N2382	MO	pnp,EM,ge	*300	750	100	10	20	500	*40	1	*3.5	5	
	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	–	*2.5	18	
	2N2796	SPR	pnp,ED,ge	*300	75	100	1	*20	100	*60	–	*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	–	
HF 68	2N3043	SPR	npn,PE,si	*300	1.4W	200	9.33	45	30	*100-300	0.01	*8		Flat Pack
	2N3249	MO	pnp,AE,si	*300	1.2W	200	6.9	12	–	*100-300	–	*8	18	
	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	
	2N3282	MO	pnp,EM,ge	*300	100	100	1.33	15	50	*10-100	5	*1.2	18	
	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	
HF 69	2N3854	GE	npn,PE,si	*300	200	100	2.67	18	100	*35-70	0.5	*2.5	98	
	2N3854A	GE	npn,PEP,si	*300	200	100	2.67	30	100	*35-70	0.5	*2.5	98	
	2N3904	MO	npn,AE,si	*300	310	135	2.81	40	200	*100-300	*.05	*4	92	
	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	
	40292	RCA	npn,si	*300	23.2W	200	132	–	1.25A	–	*250	*30	60	Vces=90; overlay type
	A467	AMP	npn,PL,si	*300	150	175	1.0	*40	25	*60	.001	–	72	Cre=.015 pf
HF 70	ED-322	SPR	pnp,ge	*300	75	100	1.0	15	100	*50	–	*3	18	Hi Rel 2N2795
	MM709	MO	npn,AE,si	*300	750	200	4.3	8	100	*15-120	.015	*3	52	
	TI408	TI	npn,PL,si	*300	200	125	2	12	30	*15	0.5	2.2	-	Plast IEC, GME
	TI409	TI	npn,PL,si	*300	200	125	2	12	30	*15	0.5	2.2	–	Plast IEC, GME
	2N503	*SPR	pnp,MD,ge	320	25	85	0.5	*20	50	4.2	3	2	9	*PH orig. Reg.
	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, TI
	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

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 71	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
	2N2256	MO	npn,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	
	2N2259	MO	pnp,ME,ge	*320	300	100	4	7	100	*50	3	*4	18	
	2N834/46	SY	npn,EP,si	*350	400	200	–	*40	200	*25	0.5	4	46	GI, NA
HF 72	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, MP, TR, GI, AMP, SPR, NUC, MO
	2N984	SPR	pnp,MD,ge	*350	60	100	0.8	*15	100	*70	1	*1.9	18	
	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
	2N2845	FA	npn,PE,si	*350	1.2W	200	6.9	30	–	*60	0.04	*6	18	SPR, NA
	2N2846	FA	npn,PE,si	*350	3W	200	17.2	30	–	*60	0.04	*6	5	SPR, NA
	2N2847	FA	npn,PE,si	*350	1.2W	200	6.9	20	–	*60	0.04	*6	18	SPR, NA
	2N2848	FA	npn,PE,si	*350	3W	200	17.2	20	–	*60	0.04	*6	5	SPR, NA, RCA, NUC
HF 73	2N2894	FA	pnp,PE,si	*350	1.2W	200	6.85	12	–	*75	5	*3.3	18	TI
	2N2955	MO	pnp,EM,ge	*350	300	100	4	*40	100	*20/60	–	*2.5	18	
	2N3009	FA	npn, PE, si	*350	1200	200	6.85	*40	200	*15	–	*5	52	
	2N3287	MO	npn,E,si	*350	300	200	1.71	20	50	*15-150	0.010	*1.1	18	
	2N3288	MO	npn,E,si	*350	300	200	1.71	20	50	*15-150	0.010	*1.5	18	
	2N3855	GE	npn,PE,si	*350	200	100	2.67	18	100	*60-120	0.5	*2.5	98	
	2N3855A	GE	npn,PEP,si	*350	200	100	2.67	30	100	*60-120	0.5	*2.5	98	
	40282	RCA	npn,si	*350	23.2W	200	015	18	2a	–	* 250	*45	60	
HF 74	MPS834	MO	npn,EP,si	*350	500	125	5	30	200	*25	0.5	*4	92	
	2N741	MO	pnp,DM,ge	*360	300	100	2	*15	100	*25	.2	*6	18	SY, TI
	2N741A	MO	pnp,DM,ge	*360	300	100	2	*20	100	*25	.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	
	2N2956	MO	pnp,EM,ge	*375	300	100	4	*40	100	*40-120	10	*2.5	18	
	2N3856A	GE	npn,PEP,si	*375	200	100	2.67	30	100	*100-200	0.5	*2.5	98	
	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
	2N706B	MO	npn,EP,si	*400	1W	175	6-7	*25	–	*20-60	0.005	*5	18	FA, SY, GI, TR, ITT
HF 75	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, RCA
	2N828	MO	pnp,EM,ge	*400	300	100	.4	*15	200	40	.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
	2N2096		pnp,ED,ge	*400	750	100	10	*25	500	*40	6	*15	31	MO
	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
HF 76	2N2100		pnp,ED,ge	*400	750	100	10	*40	500	*70	6	*15	9	MO
	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	
	2N3280	MO	pnp,EM,ge	*400	100	100	1.33	20	50	*10-70	5	*1.2	18	
	2N3299	FA	npn,PE,si	*400	3W	200	17.2	30	–	*75	0.0002	*6.0	5	
	2N3300	FA	npn,PE,si	*400	3W	200	17.2	30	–	*220	0.0002	*6.0	5	
	2N3301	FA	npn,PE,si	*400	1.8W	200	10.3	30	–	*75	0.0002	*6.0	18	
	2N3302	FA	npn,PE,si	*400	1.8W	200	10.3	30	–	*220	0.0002	*6.0	18	
HF 77	2N3327	NSC	npn	400	20W	200	134	65	2.0a	*10	500mA	*30	60	
	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	
	2N3632	RCA	npn,si	*400	23W	200	130	40	3A	–	250	*20	60	RCA "Overlay" emitter type, MO, VEC
	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

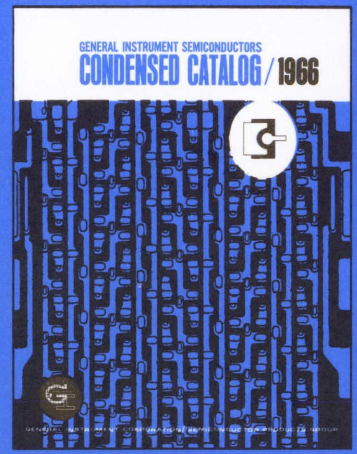
(see pages 4-9 for explanation of company abbreviations.)

GENERAL INSTRUMENT SEMICONDUCTORS

CONDENSED CATALOG / 1966

GENERAL INSTRUMENT CORPORATION / SEMICONDUCTOR PRODUCTS GROUP

INTRODUCTION



From the simplest diode . . .

to the most complex Microelectronics array

. . . That, in a few words, is an apt description of General Instrument's Semiconductor line. But it is by no means complete, because this line is characterized by several far-reaching technical developments which have had a profound effect on many segments of the electronic industry.

Two such developments are depicted on the cover of this publication: The enormously complex MOS array, for example, represents previously unimagined opportunity for the computer manufacturer. The idea of an entire computer on a single 80-by 58 mil chip is already entirely feasible. You'll find MOS arrays and field effect transistors listed on Page 4.

And, at the other end of the semiconductor spectrum, the simple diode has undergone an amazing evolution. The recent General Instrument announcement of the HERCULEADST.M. Beam-Lead Diode (listed on Page 10) has ushered in a new era in processing discrete semiconductors.

No bigger in its entirety than a typewriter period (it takes 4 million to make a pound), the HERCULEADS diode is practically indestructible — it can withstand impact shocks of 200,000 G's; is immune to the metallurgical "diseases" that plague conventional devices; and is completely "passivated" in the production process, so that it needs no hermetically sealed container to protect it from environmental effects.

These are just two of many technical achievements you'll find incorporated in General Instrument's semiconductor line. Glass-Amp® Rectifiers and Zener Diodes; Hybrid Micro-circuits; a new line of low-cost epoxy-packaged silicon transistors — they're all listed on the following pages in an easy-to-use format. Also, you'll find the numerical index beginning on Page 22 an additional convenience.

And it goes without saying, of course, that service from any of the General Instrument sales offices or authorized distributors throughout the country is no further away than your telephone.

CONTENTS

GENERAL INSTRUMENT

MOS SEMICONDUCTORS

MOS MICROCIRCUIT ARRAYS ($T_A = -55°C$ to $+85°C$)

SHIFT REGISTER, FLIP-FLOP CIRCUITS

TYPE	FUNCTION	CASE	FUNCTION DIAGRAM FIG. NO.	POWER CONSUMPTION (mW)	SUPPLY VOLTAGE (VOLTS)	SHIFT PULSE FREQUENCY (kHz)	INPUT CAPACITANCE (pf)	OUTPUT IMPEDANCE (KΩ)
[1]**MEM 3021**	21-Bit dc, 1φ clock	1	1	<200	—28 ±5%	dc to 500	2	<2
[2]**MEM 3020**	20-Bit Dynamic, 2φ clock	1	2	<200	—26 ±5%	dc to 1 Mc	2	<2
[3]**MEM 1005**	RST Flip-Flop	1	3	< 80	—28 ±5%	dc to 1 Mc	2	{ 2 @ "0" / 10 @ "1"

[1] Formerly MEM 501. [2] Formerly MEM 521. [3] Formerly MEM 529.

LOGIC CIRCUITS

TYPE	FUNCTION	CASE	FUNCTION DIAGRAM FIG. NO.	POWER CONSUMPTION (mW)	SUPPLY VOLTAGE (VOLTS)	PROPAGATION DELAY (nsec)	CAPACITANCE (pf)	FREQUENCY (kHz)
[1]**MEM1002**	Dual 3-Input NOR-Gate	1	4	30	—26 ±5%	500	3.0	dc to 500
MEM 1000	Dual Full Adder	7	5	25	—12 & 26 ±5%	500	3.0	dc to 500

[1] Formerly MEM 522.

SERIES SHUNT CHOPPER

TYPE	FUNCTION	CASE	OFFSET VOLTAGE	CLOCK φ	FRE-QUENCY (kHz)	SERIES SHUNT RESISTANCE RESISTANCE RATIO (TYP)	ON RESISTANCE PER UNIT (SERIES OR SHUNT) (Ω TYP)	OFF RESISTANCE PER UNIT (SERIES OR SHUNT) (Ω TYP)	SIGNAL VOLTAGE HANDLING RANGE (TYP)
[1]**MEM 2008**	Integrated Series Shunt Chopper Circuit (See Fig. 6)	4	0	1	100	200 DB	$6x10^{+3}$	10^{13}	1μV up to 10V

[1] Formerly MEM 590.

MULTIPLEXER CIRCUITS

TYPE	FUNCTION	CASE	OFF RESISTANCE (Ω TYP)	ON RESISTANCE (Ω TYP)	CAPACITANCE (pf) Cgd	BV_{DSS} (VOLTS)	BV_{GSS} (VOLTS)
[1]**MEM 2001**	See circuit diagram No. 7	7	10^{11}	500	1.1	—30	—25
MEM 2002	See circuit diagram No. 8	7	10^{11}	500	1.1	—30	—25
MEM 2003	See circuit diagram No. 9	8	10^{11}	500	1.1	—30	—25
MEM 2004	See circuit diagram No. 9	8	10^{11}	250	1.5	—30	±40
MEM 2004A	See circuit diagram No. 9	8	10^{11}	250	1.5	—30	—25
MEM 2005	See circuit diagram No. 10	7	10^{11}	500	1.1	—30	—25
MEM 2006	See circuit diagram No. 11	8	10^{11}	500	1.1	—30	—25
MEM 2007	See circuit diagram No. 11	8	10^{11}	250	1.5	—30	—25

[1]MEM 2001 thru MEM 2007 formerly MEM 5001 thru MEM 5007

MOS SILICON P-CHANNEL ENHANCEMENT MODE FIELD EFFECT TRANSISTORS ($T_A = 25°C$, body grounded)

TYPE	CASE	V_{GST} (VOLTS) MAX.	V_{GST} (VOLTS) MIN.	I_D (ON) (mA TYP)	I_{DSS} (nA TYP)	I_{GSS} (nA TYP)	BV_{DSS} (VOLTS)	BV_{GSS} (VOLTS)	Y_{fs} (μmho TYP)	Cgd (pf TYP)	r_{DS} ON (Ω TYP)
MEM 511	10	—3	—6	—6	.2	.05	—40	—30	2500	1.5	250
MEM 517	5	—2.5	—5	—60	.8	.05	—30	—25	12000	10	45
MEM 517A	6	—2.5	—5	—60	.8	.05	—30	—25	12000	16	45
MEM 517B	10	—2.5	—5	—60	.8	.05	—30	—25	12000	10	45
MEM 520	10	—3	—6	—6	.2	.001	—30	±40	2500	1.5	250
MEM 550	2	—3	—6	—3	.2	.05	—30	—25	2500	1.1	500
MEM 551	13	—3	—6	—3	.2	.001	—30	±40	2500	1.1	500

FUNCTION DIAGRAMS

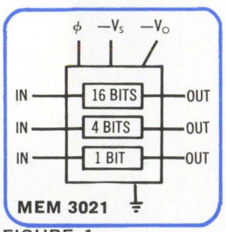


FIGURE 1

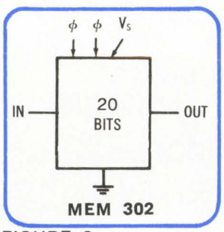


FIGURE 2

MULTIPLEXER CIRCUIT DIAGRAMS . . .

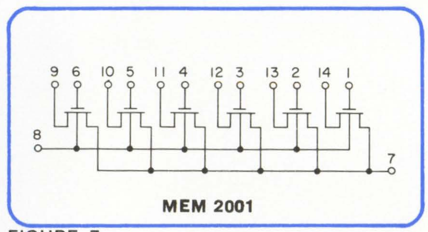


FIGURE 7

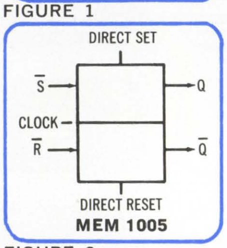


FIGURE 3

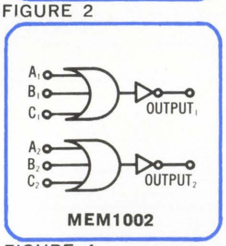


FIGURE 4

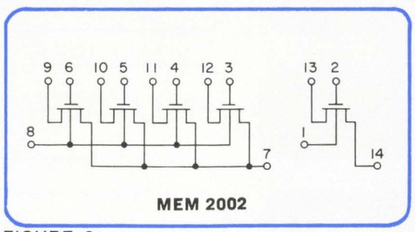


FIGURE 8

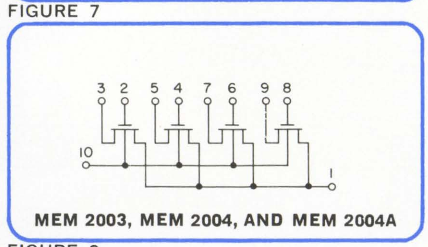


FIGURE 9

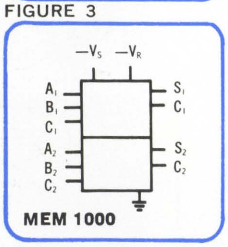


FIGURE 5

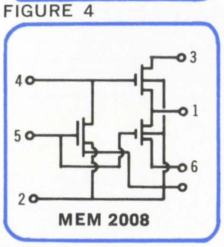


FIGURE 6

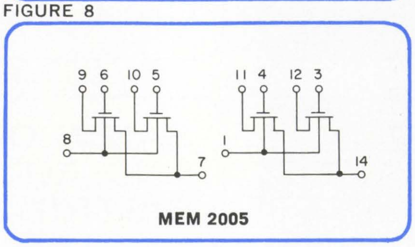


FIGURE 10

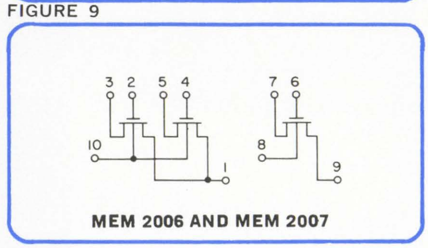


FIGURE 11

SEE PAGE 24 FOR CASE DRAWINGS

AMPLIFIERS

TYPE* ($T_A = 25°C$)	FUNCTION	CASE	Voltage Gain (db)	Input Impedance (K ohms)	Input Offset Voltage (mV)	Offset Voltage Drift ($\mu V/°C$)	Common-Mode Rejection (db)	Input Broadband Noise (μVrms)	Band Width (KHz)	Supply Voltages (Vdc)	Temp. Range °C
NC/PC-101	NANOCIRCUIT VIDEO AMPLIFIER	22 & 23	20	1.2	—	—	—	10	20,000	+6	—55 to +125
PC-200	OPERATIONAL AMPLIFIER GENERAL PURPOSE	24	73	100	1	5	80	5	15	±12	—55 to +125
PC-201	OPERATIONAL AMPLIFIER HIGH COMMON — MODE REJECTION	25	73	200	1	5	100	5	15	±12	—55 to +125
PC-210	OPERATIONAL AMPLIFIER LOW NOISE, WIDE B.W., H.V.	32	70	90	3	4	80	4	1,500	±18	—55 to +125
PC-212	OPERATIONAL AMPLIFIER LOW NOISE, WIDE B.W.	32	64	100	3	4	80	4	1,200	±12	—55 to +125
PC-250	OPERATIONAL AMPLIFIER ULTRA-HIGH (MOS) INPUT IMPEDANCE	26	50	10^{14}(ohms)	50	500	42	—	30	±12	—55 to +85
PC-251	OPERATIONAL AMPLIFIER ULTRA-HIGH (MOS) INPUT IMPEDANCE SHORT CIRCUIT PROOF	26	50	10^{14}(ohms)	50	500	42	—	30	±12	—55 to +85

POWER SUPPLY VOLTAGE REGULATORS**

TYPE* ($T_A = 25°C$)	FUNCTION	CASE	Output Voltage (Vdc)	Load Regulation %	Line Regulation %	Ripple Rejection μout/μin	Output Impedance ohms	Temp. Coefficient mV/°C	Power Dissipation 25°C (mW)	Temp. Range °C
PC-501	12 V OVERLOAD PROTECTION	18	+12V	.025	0.5	.03	0.1	0.3	500	—55 to +125
PC-503		18	—12V	.025	0.5	.03	0.1	0.3	500	—55 to +125
PC-502	24 V OVERLOAD PROTECTION	18	+24V	.05	0.5	.06	0.2	1.5	500	—55 to +125
PC-504		18	—24V	.05	0.5	.06	0.2	1.5	500	—55 to +125
NC/PC-511	12 V GENERAL PURPOSE APPLICATION	19 & 20	+12V	.025	0.5	.03	0.1	0.3	500	—55 to +125
NC/PC-513		19 & 20	—12V	.025	0.5	.03	0.1	0.3	500	—55 to +125
PC-512	24 V GENERAL PURPOSE APPLICATION	20	+24V	.05	0.5	.06	0.2	1.5	500	—55 to +125
PC-514		20	—24V	.05	0.5	.06	0.2	1.5	500	—55 to +125
PC-521	6 V GENERAL PURPOSE APPLICATION	21	+6V	.07	0.4	.04	.05	0.3	500	—55 to +125
PC-523		21	—6V	.07	0.4	.04	.05	0.3	500	—55 to +125
†NCS-675A	†5 V GENERAL PURPOSE APPLICATION	14	+5V	.04	0.5	—	.005	5	500	—55 to +125

HIGH VOLTAGE ANALOG SWITCHES

TYPE ($T_A = 25°C$)	FUNCTION	CASE	Turn On Time (nsec)	Turn Off Time (nsec)	Offset Voltage (mV)	Turn On Voltage (Volts)	Repetition Rate (KHz)	Maximum Supply Voltage (Volts)	Maximum Analog Voltage (Volts)	Overshoot Voltage (Volts)
PC-401	SINGLE INPUT	12	50	200	20	3	200	+50	+35	2.5
PC-402	COMPLEMENTARY INPUT	13	50	200	20	3	200	+50	+35	2.5

HIGH-SPEED DIGITAL MULTICHIP MICROCIRCUITS

TYPE*	FUNCTION	CASE	TEMPERATURE RANGE —55°C to +125°C PROPAGATION DELAY @ 25°C (nsec TYP)	POWER DISSIPATION (mW TYP)	FANOUT (EACH OUTPUT)	SUPPLY VOLTAGE (VOLTS) V_{CC}	CLAMP VOLTAGE (VOLTS) V_{CL}	MAXIMUM REPETITION RATE (MHz)	LOGIC LEVELS (VOLTS)
BINARY CIRCUITS									
NC-8, PC-8	FLIP-FLOP	14 & 11	—	200	3 NORS and/or 5 NANDS	+12V	+4.2V	20	+.3V, +5V
NC-9, PC-9	STEERING GATE	15 & 27	—	—		+12V	+4.2V	20	+.3V, +5V
PC-13	RST FLIP-FLOP	16	—	200		+12V	+4.2V	20	+.3V, +5V
NOR-GATES									
NC-10	SINGLE 4-INPUT	17	8	170	4 NORS and/or 5 NANDS	+12V	+4.2V	12	+.3V, +5V
PC-10	SINGLE 6-INPUT	16	8	170		+12V	+4.2V	12	+.3V, +5V
PC-14	DUAL 3-INPUT	16	8	170		+12V	+4.2V	12	+.3V, +5V
NAND-GATES									
NC-11	SINGLE 4-INPUT	17	8	60	4 NORS and/or 5 NANDS	+12V	+4.2V	15	+.3V, +5V
PC-11	SINGLE 6-INPUT	16	8	60		+12V	+4.2V	15	+.3V, +5V
PC-15	DUAL 3-INPUT	16	8	60		+12V	+4.2V	15	+.3V, +5V
DELAY CIRCUITS									
NC-16, PC-16	SINGLE SHOT	14 & 29	—	200	3 NORS and/or 5 NANDS	+12V	+4.2V	10[1]	+.3V, +5V
PC-18	TRIGGERED SINGLE SHOT	30	—	200		+12V	+4.2V	10[1]	+.3V, +5V
TRIGGER CIRCUITS									
NC-17, PC-17	SCHMITT TRIGGER	14 & 31	—	200	3 NORS and/or 5 NANDS	+12V	+4.2V	5	+.3V, +5V
BUFFER AMPLIFIER									
NC-12, PC-12	NON-INVERTING AMPLIFIER	15 & 28	—	200	120 mA @ .3V 70 mA @ 5V[2]	+12V	+4.2V	12	+.3V, +5V

CUSTOM CIRCUITS: Complete facilities available to meet your special requirements.

* PC prefix indicates flat packs; NC indicates TO-5 package. † Specified with external pass transistor with 3 amp load.

** These units are self-contained voltage regulators and with an external pass transistor can regulate leads up to 10 amperes.

NOTE: [1] 60% maximum duty cycle. [2] With external 100 ohm resistor.

SEE PAGE 24 AND 25 FOR CASE DRAWINGS

TOP HAT TYPE RECTIFIERS

CASE 33

TYPE	PRV VOLTS	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz — A_{AV} @ T_A mA	°C	OPERATIONAL TEMP. RANGE MIN °C	MAX °C	STORAGE TEMP. RANGE MIN °C	MAX °C	MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED A_{PK}	MAXIMUM FORWARD VOLTAGE @ T_A 25°C AMB V_F V_{DC}	I_F mA_{DC}	MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE @ 25°C AMB V_R V_{DC}	I_R μA_{DC}
1N440	100	300	50	—55	150	—55	175	15	1.5	300	100	0.30
1N440B	100	750	50	—55	165	—55	175	15	1.5	750	100	0.30
1N441	200	300	50	—55	150	—55	175	15	1.5	300	200	0.75
1N441B	200	750	50	—55	165	—55	175	15	1.5	750	200	0.75
1N442	300	300	50	—55	150	—55	175	15	1.5	300	300	1.0
1N442B	300	750	50	—55	165	—55	175	15	1.5	750	300	1.0
1N443	400	300	50	—55	150	—55	175	15	1.5	300	400	1.5
1N443B	400	750	50	—55	165	—55	175	15	1.5	750	400	1.5
1N444	500	300	50	—55	150	—55	175	15	1.5	300	500	1.75
1N444B	500	650	50	—55	150	—55	175	15	1.5	650	500	1.75
1N445	600	300	50	—55	150	—55	175	15	1.5	300	600	2.0
1N445B	600	650	50	—55	150	—55	175	15	1.5	650	600	2.0
1N530	100	300	100	—55	100	—55	180	1.5	2.0	300	100	3.0
1N531	200	300	100	—55	100	—55	180	1.5	2.0	300	200	7.5
1N532	300	300	100	—55	100	—55	180	1.5	2.0	300	300	10.0
1N533	400	300	100	—55	100	—55	180	1.5	2.0	300	400	15.0
1N534	500	300	100	—55	100	—55	180	1.5	2.0	300	500	17.5
1N535	600	300	100	—55	100	—55	180	1.5	2.0	300	600	20.0
1N536	50	250	150	—65	175	—65	200	15	1.1	500	50	10
1N537	100	250	150	—65	175	—65	200	15	1.1	500	100	10
•1N538	200	250	150	—65	175	—65	200	15	1.1	500	200	10
1N539	300	250	150	—65	175	—65	200	15	1.1	500	300	10
•1N540	400	250	150	—65	175	—65	200	15	1.1	500	400	10
•1N547	600	250	150	—65	175	—65	200	15	1.1	500	600	10
•1N560	800	500	100	—55	175	—65	175	25	1.1	500	800	5
1N561	1000	500	100	—55	175	—65	175	25	1.1	500	1000	5
1N599	50	300	100	—55	150	—55	175	2	1.5	300	50	2.5
1N599A	50	300	100	—55	150	—55	175	2	1.5	300	50	1.0
1N600	100	300	100	—55	150	—55	175	2	1.5	300	100	2.5
1N600A	100	300	100	—55	150	—55	175	2	1.5	300	100	1.0
1N601	150	300	100	—55	150	—55	175	2	1.5	300	150	2.5
1N601A	150	300	100	—55	150	—55	175	2	1.5	300	150	1.0
1N602	200	300	100	—55	150	—55	175	2	1.5	300	200	2.5
1N602A	200	300	100	—55	150	—55	175	2	1.5	300	200	1.0
1N603	300	300	100	—55	150	—55	175	2	1.5	300	300	2.5
1N603A	300	300	100	—55	150	—55	175	2	1.5	300	300	1.0
1N604	400	300	100	—55	150	—55	175	2	1.5	300	400	2.5
1N604A	400	300	100	—55	150	—55	175	2	1.5	300	400	1.0
1N605	500	300	100	—55	150	—55	175	2	1.5	300	500	2.5
1N605A	500	300	100	—55	150	—55	175	2	1.5	300	500	1.0
1N606	600	300	100	—55	150	—55	175	2	1.5	300	600	2.5
1N606A	600	300	100	—55	150	—55	175	2	1.5	300	600	1.0
1N1095	500	250	135	—65	175	—65	200	15	1.1	500	500	10
1N1097	600	250	130	—65	175	—65	200	15	1.1	500	600	10
1N1100	100	250	150	—55	150	—55	180	15	1.2	750	100	0.1
1N1101	200	250	150	—55	150	—55	180	15	1.2	750	200	0.1
1N1102	300	250	150	—55	150	—55	180	15	1.2	750	300	0.1
1N1103	400	250	150	—55	150	—55	180	15	1.2	750	400	0.1
1N1104	500	250	150	—55	150	—55	180	15	1.2	750	500	0.1
1N1105	600	250	150	—55	150	—55	180	15	1.2	750	600	0.1
1N1169	400	300	100	—55	100	—55	180	35	1	300	400	100
1N1692	100	250	100	—55	115	—55	175	20	0.6	250	100	500
1N1693	200	250	100	—55	115	—55	175	20	0.6	250	200	500
1N1694	300	250	100	—55	115	—55	175	20	0.6	250	300	500
1N1695	400	250	100	—55	115	—55	175	20	0.6	250	400	500
1N1696	500	250	100	—55	115	—55	175	20	0.6	250	500	500
1N1697	600	250	100	—55	115	—55	175	20	0.6	250	600	500
1N1763	400	500	75	—65	100	—65	100	35	1	500	400	10
1N1764	500	500	75	—65	100	—65	100	35	1	500	500	10
PT505	50	1000	100	—55	125	—55	175	15	1.5	500	50	10
PT510	100	1000	100	—55	125	—55	175	50	1.5	500	100	10
PT515	150	1000	100	—55	125	—55	175	50	1.5	500	150	10
PT520	200	1000	100	—55	125	—55	175	50	1.5	500	200	10
PT525	250	1000	100	—55	125	—55	175	50	1.5	500	250	10
PT530	300	1000	100	—55	125	—55	175	50	1.5	500	300	10
PT540	400	1000	100	—55	125	—55	175	50	1.5	500	400	10
PT550	500	1000	100	—55	125	—55	175	50	1.5	500	500	10
PT560	600	1000	100	—55	125	—55	175	50	1.5	500	600	10
PT580	800	1000	50	—55	125	—55	175	50	1.5	500	800	10
S91	100	200	85	—55	185	—55	100	5	1.5	200	100	10
S91H	100	250	85	—55	125	—55	150	5	1.5	250	100	10
S92	200	200	85	—55	185	—55	100	5	1.5	200	200	10
S92H	200	250	85	—55	125	—55	150	5	1.5	250	200	10
S93	300	200	85	—55	185	—55	100	5	1.5	200	300	10
S93H	300	250	85	—55	125	—55	150	5	1.5	250	300	10

• Indicates MIL Type

SEE PAGE 25 FOR CASE DRAWINGS

Glass-Amp® RECTIFIERS

CASE 38

TYPE NUMBER	PRV VOLTS	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz AAV mA	@ TA °C	OPERATIONAL TEMP. RANGE MIN °C	MAX °C	STORAGE TEMP. RANGE MIN °C	MAX °C	MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED APK	MAXIMUM FORWARD VOLTAGE @ TA 25°C VF VDC	IF mADC	MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE 25°C AMB VR VDC	IR mADC	MAXIMUM REVERSE RECOVERY @ 25°C AMB REF. NOTE	µs	TYPICAL JUNCTION CAPACITANCE @ 25°C ★ INDICATES MAX VR VDC	CJ pF
G100B	100	1000	100	—65	175	—65	175	50	1.0	1000	100	10	—	—	—	—
1N4383	200	1000	100	—65	175	—65	175	50	1.0	1000	200	10	—	—	—	—
1N4384	400	1000	100	—65	175	—65	175	50	1.0	1000	400	10	—	—	—	—
1N4385	600	1000	100	—65	175	—65	175	50	1.0	1000	600	10	—	—	—	—
1N4585	800	600	100	—65	175	—65	175	50	1.0	1000	800	10	—	—	—	—
1N4586	1000	600	100	—65	175	—65	175	50	1.0	1000	1000	10	—	—	—	—
1N4250	800	500	55	—65	160	—65	200	10	2.0	500	800	10	—	—	—	—
1N4251	1000	500	55	—65	160	—65	200	10	2.0	500	1000	10	—	—	—	—
1N4252	1200	500	55	—65	160	—65	200	10	2.0	500	1200	10	—	—	—	—
1N4253	1500	500	55	—65	160	—65	200	10	2.0	500	1500	10	—	—	—	—
1N4254	1500	250	55	—65	160	—65	200	6.25	4.8	250	1500	10	—	—	—	—
1N4255	2000	250	55	—65	160	—65	200	6.25	4.8	250	2000	10	—	—	—	—
1N4256	2500	250	55	—65	160	—65	200	6.25	4.8	250	2500	10	—	—	—	—
1N4257	3000	250	55	—65	160	—65	200	6.25	4.8	250	3000	10	—	—	—	—
DG100J	1200	250	100	—55	150	—55	175	30	2.0	500	1200	5	—	—	—	—
DG100K	1600	250	100	—55	150	—55	175	30	2.0	500	1600	5	—	—	—	—
DG100M	2000	250	100	—55	150	—55	175	30	2.0	500	2000	5	—	—	—	—
KG100F	3000	150	50	—55	150	—55	175	20	5.0	500	3000	5	—	—	—	—
KG100G	4000	150	50	—55	150	—55	175	20	5.0	500	4000	5	—	—	—	—
KG100H	5000	150	50	—55	150	—55	175	20	5.0	500	5000	5	—	—	—	—

•Indicates MIL Type

Glass-Amp® FAST RECOVERY RECTIFIERS

CASE 38

1N5055	100	1.0	50	—55	125	—55	175	30	1.3	1000	100	5	1	.2	—4	35
1N5056	200	1.0	50	—55	125	—55	175	30	1.3	1000	200	5	1	.2	—4	35
1N5057	400	0.7	50	—55	125	—55	175	30	1.3	1000	400	5	1	.4	—4	23
1N5058	600	0.7	50	—55	125	—55	175	30	1.3	1000	600	5	1	.8	—4	23

Glass-Amp® CONTROLLED AVALANCHE RECTIFIERS

CASE 38

													AVALANCHE BREAKDOWN VOLTAGE RANGE MAX V	MIN V	MAXIMUM 10µs PULSE AVALANCHE POWER WATTS
AG100D	200	1000	50	—55	175	—55	175	50	1	1000	200	5	500	240	700
AG100G	400	1000	50	—55	175	—55	175	50	1	1000	400	5	750	450	700
AG100J	600	1000	50	—55	175	—55	175	50	1	1000	600	5	1000	675	700

FLANGELESS RECTIFIERS

CASE 36

1N2610	100	750	50	—65	175	—65	175	30	1.0	750	100	10	—	—	—	—
1N2611	200	750	50	—65	175	—65	175	30	1.0	750	200	10	—	—	—	—
1N2612	300	750	50	—65	175	—65	175	30	1.0	750	300	10	—	—	—	—
1N2613	400	750	50	—65	175	—65	175	30	1.0	750	400	10	—	—	—	—
1N2614	500	750	50	—65	175	—65	175	30	1.0	750	500	10	—	—	—	—
1N2615	600	750	50	—65	175	—65	175	30	1.0	750	600	10	—	—	—	—
1N2616	800	750	50	—65	175	—65	175	30	1.0	750	800	10	—	—	—	—
1N2617	1000	750	50	—65	175	—65	175	30	1.0	750	1000	10	—	—	—	—
•1N3189	200	1000	100	—65	175	—65	175	30	1.0	750	200	5	—	—	—	—
•1N3190	400	1000	100	—65	175	—65	175	30	1.0	750	400	5	—	—	—	—
•1N3191	600	1000	100	—65	175	—65	175	30	1.0	750	600	5	—	—	—	—

PLASTIC RECTIFIERS

CASE 37

1N2069	200	500	100	—65	100	—65	125	22	1.2	500	200	10	—	—	—	—
1N2070	400	500	100	—65	100	—65	125	22	1.2	500	400	10	—	—	—	—
1N2071	600	500	100	—65	100	—65	125	22	1.2	500	600	10	—	—	—	—
PA300	1000	500	50	—65	125	—65	150	15	1.5	500	1000	10	—	—	—	—
PA305	50	500	50	—65	125	—65	150	15	1.5	500	50	10	—	—	—	—
PA310	100	500	50	—65	125	—65	150	15	1.5	500	100	10	—	—	—	—
PA315	150	500	50	—65	125	—65	150	15	1.5	500	150	10	—	—	—	—
PA320	200	500	50	—65	125	—65	150	15	1.5	500	200	10	—	—	—	—
PA325	250	500	50	—65	125	—65	150	15	1.5	500	250	10	—	—	—	—
PA330	300	500	50	—65	125	—65	150	15	1.5	500	300	10	—	—	—	—
PA340	400	500	50	—65	125	—65	150	15	1.5	500	400	10	—	—	—	—
PA350	500	500	50	—65	125	—65	150	15	1.5	500	500	10	—	—	—	—
PA380	800	500	50	—65	125	—65	150	15	1.5	500	800	10	—	—	—	—

Note: 1. When switched from 1 ampere forward current to —30 volts.

SEE PAGE 25 FOR CASE DRAWINGS

STUD TYPE RECTIFIERS

CASE 34

TYPE	PRV VOLTS	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz AAV ° TC		OPERATIONAL TEMP. RANGE		STORAGE TEMP. RANGE		MAXIMUM FORWARD PEAK SURGE CURRENT 1∼, 60 Hz SUPERIMPOSED	MAXIMUM FORWARD VOLTAGE @ TA 25°C AMB		MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE @ 25°C AMB	
		mA	°C	MIN °C	MAX °C	MIN °C	MAX °C	APK	VF VDC	IF mADC	VR VDC	IR µADC
•1N253	100	1000	135	—55	150	—55	175	4.0	1.5	1000	175	10
•1N254	200	400	135	—55	150	—55	175	1.5	1.5	500	150	10
•1N255	400	400	135	—55	150	—55	175	1.5	1.5	500	350	10
•1N256	600	200	135	—55	150	—55	175	1.0	2.0	500	500	20
1N332	400	400	150	—55	175	—55	175	2.5	1.25	400	400	10
1N333	400	200	150	—55	175	—55	175	1.5	2.0	200	400	10
1N334	300	400	150	—55	175	—55	175	2.5	1.25	400	500	10
1N335	300	200	150	—55	175	—55	175	1.5	2.0	200	300	10
1N336	200	400	150	—55	175	—55	175	2.5	1.25	400	200	10
1N337	200	200	150	—55	175	—55	175	1.5	2.0	200	200	10
1N338	100	70	150	—65	175	—65	175	6.0	2.0	2000	100	10
1N339	100	400	150	—55	175	—55	175	2.5	1.25	400	100	10
1N340	100	200	150	—55	175	—55	175	1.5	2.0	200	100	10
1N341	400	400	150	—55	175	—55	175	2.5	1.25	400	400	10
1N342	400	200	150	—55	175	—55	175	1.5	2.0	200	400	10
1N343	300	400	150	—55	175	—55	175	2.5	1.25	400	300	10
1N344	300	200	150	—55	175	—55	175	1.5	2.0	200	300	10
1N345	200	400	150	—55	175	—55	175	2.5	1.25	400	200	10
1N346	200	200	150	—55	175	—55	175	1.5	2.0	200	200	10
1N347	100	70	150	—65	175	—65	175	6.0	2.0	2000	100	10
1N348	100	400	150	—55	175	—55	175	2.5	1.25	400	100	10
1N349	100	200	150	—55	175	—55	175	1.5	2.0	200	100	10
1N562	800	400	25 AMB	—55	150	—55	175	1.5	1.3	400	800	1.5
1N563	1000	400	25 AMB	—55	150	—55	175	1.5	1.3	400	1000	2.0
1N2026	50	1000	150	—65	175	—65	175	25	2.0	2000	50	10
1N2027	200	1000	150	—65	175	—65	175	25	2.0	2000	200	10
1N2028	300	1000	150	—65	175	—65	175	25	2.0	2000	300	10
1N2029	400	1000	150	—65	175	—65	175	25	2.0	2000	400	10
1N2030	500	1000	150	—65	175	—65	175	25	2.0	2000	500	10
1N2031	600	1000	150	—65	175	—65	175	25	2.0	2000	600	10

GLASS DIODES

CASE 35

TYPE	PRV VOLTS	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz AAV @ TA		OPERATIONAL TEMP. RANGE		STORAGE TEMP. RANGE		MAXIMUM FORWARD PEAK SURGE CURRENT 1∼, 60 Hz SUPERIMPOSED	MAXIMUM FORWARD VOLTAGE @ TA 25°C AMB		MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE @ 25°C AMB	
		mA	°C	MIN °C	MAX °C	MIN °C	MAX °C	APK	VF VDC	IF mADC	VR VDC	IR µADC
1N456	25	40	150	—65	175	—65	200	1	1.0	40	25	.025
1N456A	25	70	150	—65	175	—65	200	1	1.0	100	25	.025
•1N457	60	33	150	—65	175	—65	200	1	1.0	20	60	.025
1N457A	60	70	150	—65	175	—65	200	1	1.0	100	60	.025
•1N458	125	25	150	—65	175	—65	200	1	1.0	7	125	.025
1N458A	125	70	150	—65	175	—65	200	1	1.0	100	125	.025
•1N459	175	18	150	—65	175	—65	200	1	1.0	3	175	.025
1N459A	175	70	150	—65	175	—65	200	1	1.0	100	175	.025
1N461	25	27	150	—65	175	—65	200	1	1.0	15	175	.50
1N461A	25	70	150	—65	175	—65	200	1	1.0	100	25	.50
1N462	60	22	150	—65	175	—65	200	1	1.0	5	25	.50
1N462A	60	70	150	—65	175	—65	200	1	1.0	100	60	.50
1N463	175	13.5	150	—65	175	—65	200	1	1.0	1	60	.50
1N463A	175	70	150	—65	175	—65	200	1	1.0	100	175	.50
1N464	125	18	150	—65	175	—65	200	1	1.0	3	175	.50
1N464A	125	70	150	—65	175	—65	200	1	1.0	100	175	.50
1N482	36	100	25	—55	200	—55	200	1	1.1	100	30	.25
1N482A	36	200	25	—55	200	—55	200	2	1.0	100	30	.025
1N482B	36	200	25	—55	200	—55	200	2	1.0	100	30	.025
1N483	70	100	25	—55	200	—55	200	1	1.1	100	60	.25
1N483A	70	200	25	—55	200	—55	200	2	1.0	100	60	.025
•1N483B	70	200	25	—55	200	—55	200	2	1.0	100	60	.025
1N484	136	100	25	—55	200	—55	200	1	1.1	100	125	.25
1N484A	130	200	25	—55	200	—55	200	2	1.0	100	125	.025
1N484B	130	200	25	—55	200	—55	200	2	1.0	100	125	.025
1N485	180	100	25	—55	200	—55	200	1	1.1	100	175	.25
1N485A	180	200	25	—55	200	—55	200	2	1.0	100	175	.025
•1N485B	180	200	25	—55	200	—55	200	2	1.0	100	175	.025
1N486	225	100	25	—55	200	—55	200	1	1.1	100	225	.25
1N486A	225	200	25	—55	200	—55	200	2	1.0	100	225	.025
•1N486B	225	200	25	—55	200	—55	200	2	1.0	100	225	.025

•Indicates MIL Types

SEE PAGE 25 FOR CASE DRAWINGS

GLASS DIODES

CASE 35

TYPE	PRV VOLTS	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz — A_{AV} @ T_A mA	°C	OPERATIONAL TEMP. RANGE MIN °C	MAX °C	STORAGE TEMP. RANGE MIN °C	MAX °C	MAXIMUM FORWARD PEAK SURGE CURRENT 1~, 60 Hz SUPERIMPOSED APK	MAXIMUM FORWARD VOLTAGE @ T_A 25°C AMB V_F VDC	I_F mADC	MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE 25°C AMB V_R VDC	I_R µADC	MAXIMUM REVERSE RECOVERY @ 25°C AMB REF. NOTE	µs	TYPICAL JUNCTION CAPACITANCE @ 25°C * INDICATES MAX. V_R VDC	C_J pF
1N487	300	100	25	—65	200	—65	200	1.0	1.1	100	300	.25	—	—	—	—
1N487A	300	200	25	—65	200	—65	200	2.0	1.0	100	300	0.1	—	—	—	—
1N488	380	100	25	—65	200	—65	200	1.0	1.1	100	380	.25	—	—	—	—
1N488A	380	200	25	—65	200	—65	200	2.0	1.0	100	380	0.1	—	—	—	—
•1N645	225	150	150	—65	175	—65	200	5.0*	1.0	400	225	.025	—	—	4	20
1N646	300	150	150	—65	175	—65	200	5.0	1.0	400	300	0.2	—	—	—	—
•1N647	400	150	150	—65	175	—65	200	5.0*	1.0	400	400	.025	—	—	4	20
1N648	500	150	150	—65	175	—65	200	5.0	1.0	400	500	0.2	—	—	—	—
•1N649	600	150	150	—65	175	—65	200	5.0*	1.0	400	600	.050	—	—	4	20
1N881	200	50	25	—65	150	—65	200	0.5	1.0	50	200	20	—	—	—	—
1N882	300	50	25	—65	150	—65	200	0.5	1.0	50	300	20	—	—	—	—
1N883	400	50	25	—65	150	—65	200	0.5	1.0	50	400	20	—	—	—	—
1N884	500	50	25	—65	150	—65	200	0.5	1.0	50	500	20	—	—	—	—
1N885	600	50	25	—65	150	—65	200	0.5	1.0	50	600	20	—	—	—	—
1N886	700	50	25	—65	150	—65	200	0.5	1.0	50	700	20	—	—	—	—
1N887	800	50	25	—65	150	—65	200	0.5	1.0	50	800	20	—	—	—	—
1N888	900	50	25	—65	150	—65	200	0.5	1.0	50	900	20	—	—	—	—
1N889	1000	50	25	—65	150	—65	200	0.5	1.0	50	1000	20	—	—	—	—
1N890	70	100	25	—55	150	—55	175	0.5	1.0	20	70	.025	—	—	—	—

*At 150°C

FAST RECOVERY GLASS DIODES

CASE 35

TYPE	PRV VOLTS	mA	°C	OP MIN °C	OP MAX °C	STG MIN °C	STG MAX °C	APK	V_F VDC	I_F mADC	V_R VDC	I_R µADC	REF. NOTE	µs	V_R VDC	C_J pF
1N625	30	5	100	—80	150	—80	150	0.5	1.5	4	20	1	1	1.0	4.0	8.0
1N626	50	5	100	—80	150	—80	150	0.5	1.5	4	35	1	1	1.0	4.0	8.0
1N627	100	5	100	—80	150	—80	150	0.5	1.5	4	75	1	1	1.0	4.0	8.0
1N628	150	5	100	—80	150	—80	150	0.5	1.5	4	125	1	1	1.0	4.0	8.0
1N629	200	5	100	—80	150	—80	150	0.5	1.5	4	175	1	1	1.0	4.0	8.0
•1N643	175	40	25	—65	150	—65	150	0.5	1	10	100	1	2	0.3	10	*3
1N643A	175	40	25	—65	150	—65	150	0.5	1	100	100	1	2	0.3	10	*3
•1N658	100	200	25	—65	175	—65	200	0.6	1	100	50	.05	3	0.3	4.0	6.0
1N659	50	100	25	—65	175	—65	200	0.5	1	6	50	5	4	0.3	4.0	6.0
•1N660	100	100	25	—65	175	—65	200	0.5	1	6	100	5	4	0.3	4.0	6.0
•1N661	200	100	25	—65	175	—65	200	0.5	1	6	200	10	4	0.3	4.0	6.0
•1N662	85	100	25	—65	175	—65	200	0.5	1	10	{10 {50	{1 {20	5	0.5	4.0	6.0
•1N663	85	200	25	—65	175	—65	200	0.5	1	100	50	5	5	0.5	4.0	6.0
1N789	30	120	25	—65	150	—65	175	0.5	1	10	20	1	6	0.5	4.0	6.0
1N790	30	120	25	—65	150	—65	175	0.5	1	10	20	5	6	0.25	4.0	6.0
1N791	30	160	25	—65	150	—65	175	0.5	1	50	20	5	6	0.5	4.0	6.0
1N792	30	200	25	—65	150	—65	175	0.6	1	100	20	5	7	0.5	4.0	6.0
1N793	60	120	25	—65	150	—65	175	0.5	1	10	50	1	8	0.5	4.0	8.0
1N794	60	120	25	—65	150	—65	175	0.5	1	10	50	5	8	0.25	4.0	8.0
1N795	60	160	25	—65	150	—65	175	0.5	1	50	50	5	8	0.5	4.0	8.0
1N796	60	200	25	—65	150	—65	175	0.6	1	100	50	5	9	0.5	4.0	8.0
1N797	120	120	25	—65	150	—65	175	0.5	1	10	100	1	8	0.5	4.0	8.0
1N798	120	120	25	—65	150	—65	175	0.5	1	10	100	5	8	0.25	4.0	8.0
1N799	120	160	25	—65	150	—65	175	0.5	1	50	100	5	8	0.5	4.0	8.0
1N800	120	200	25	—65	150	—65	175	0.6	1	100	100	5	9	0.5	4.0	8.0
1N801	150	120	25	—65	150	—65	175	0.5	1	10	125	1	8	0.5	4.0	8.0
1N802	150	160	25	—65	150	—65	175	0.5	1	50	125	5	8	0.5	4.0	8.0
1N803	200	120	25	—65	150	—65	175	0.5	1	10	125	5	8	0.5	4.0	8.0
1N804	200	160	25	—65	150	—65	175	0.5	1	50	125	10	8	0.5	4.0	8.0
1N891	50	200	25	—65	175	—65	200	0.6	1	50	50	0.1	3	.3	4.0	8.0
1N892	100	200	25	—65	175	—65	200	0.6	1	50	100	0.1	3	.3	4.0	8.0
1N893	200	200	25	—65	175	—65	200	0.6	1	50	200	0.1	3	.3	4.0	8.0

"W" SINGLE PHASE BRIDGE

CASE 41

TYPE	PRV VOLTS	mA	°C	OP MIN °C	OP MAX °C	STG MIN °C	STG MAX °C	APK	V_F VDC	I_F mADC	V_R VDC	I_R µADC	REF. NOTE	µs	V_R VDC	C_J pF
W005	50	1000	100	—55	125	—55	150	50	1.0	1000	50	10	—	—	—	—
W02	200	1000	100	—55	125	—55	150	50	1.0	1000	200	10	—	—	—	—
W04	400	1000	100	—55	125	—55	150	50	1.0	1000	400	10	—	—	—	—
W06	600	1000	100	—55	125	—55	150	50	1.0	1000	600	10	—	—	—	—

Notes:
1. To 400K ohms minimum measured in modified IBM "Y" test circuit when switched from 30mA forward current to —35 volts.
2. To 200K ohms when switched from 5mA forward current (1 µs pulse) to —40 volts in JAN 256 circuit.
3. To 80K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.
4. To 400K ohms when switched from 35mA forward current to —35 volts in JAN 256 circuit.
5. To 100K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.
6. To 200K ohms when switched from 5mA forward current to —20 volts in JAN 256 circuit.
7. To 100K ohms when switched from 5mA forward current to —20 volts in JAN 256 circuit.
8. To 200K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.
9. To 100K ohms when switched from 5mA forward current to —40 volts in JAN 256 circuit.

• Indicates MIL types.

SEE PAGE 25 FOR CASE DRAWINGS

GLASS DIODES CAPSIL® — CASE 35

TYPE	MAXIMUM WORKING VOLTS @ 25°C	NOMINAL CAPACITANCE @ —4 VOLTS DC, 25°C	CAPACITANCE RANGE @ —4 VOLTS DC, 25°C	OPERATIONAL TEMP. RANGE		STORAGE TEMP. RANGE		MIN. Q @ 50 MHz, —4 VOLTS DC, 25°C	Q @ 50 MHz, AND MAX. WORKING VOLTAGE 25°C
	VOLTS DC	pF	pF	MIN °C	MAX °C	MIN °C	MAX °C	Q	Q
CS7	25	7	5.6-8.4	—65	175	—65	200	20	50
CS10	25	10	8.0-12.0	—65	175	—65	200	20	50
CS12	25	12	9.6-14.4	—65	175	—65	200	20	50
CS15	25	15	12.0-18.0	—65	175	—65	200	20	50
IN3945	25	20	18.0-22.0	—65	175	—65	200	7	—
CS20	25	20	16.0-24.0	—65	175	—65	200	20	50
CS27	25	27	21.6-32.4	—65	175	—65	200	18	45
CS30	25	30	24.0-36.0	—65	175	—65	200	18	45
CS33	25	33	26.4-39.6	—65	175	—65	200	18	45
IN954	25	35	28.0-42.0	—65	175	—65	200	7	20
CS40	25	40	32.0-48.0	—65	175	—65	200	18	45
CS47	25	47	37.6-56.4	—65	175	—65	200	18	45
IN3628	15	50	47.0-53.0	—65	175	—65	200	30	—
IN955	25	50	40.0-60.0	—65	175	—65	200	7	20
IN3488	15	56	50.4-61.6	—65	175	—65	200	7	—
CS56	15	56	44.8-67.2	—65	175	—65	200	16	25
CS68	15	68	54.4-81.6	—65	175	—65	200	16	30
IN3947	9	70	56.0-84.0	—65	175	—65	200	9	—
IN3946	9	71	62.5-79.5	—65	175	—65	200	7	—
CS82	15	82	65.6-98.4	—65	175	—65	200	14	25
CS100	15	100	80.0-120.0	—65	175	—65	200	12	20

ULTRA-FAST PLANAR COMPUTER DIODE — CASE 40

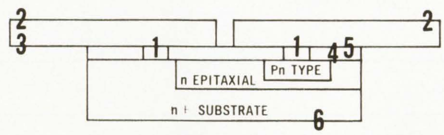
TYPE	PRV	MAXIMUM AVERAGE RECTIFIED CURRENT ½ WAVE, RES. LOAD 60 Hz		OPERATIONAL TEMP. RANGE		STORAGE TEMP. RANGE		MAXIMUM FORWARD PEAK SURGE CURRENT 1 ~ 60 Hz SUPERIMPOSED	MAXIMUM FORWARD VOLTAGE @ T_A = 25°C AMB		MAXIMUM REVERSE CURRENT @ RATED DC BLOCKING VOLTAGE 25°C		MAXIMUM REVERSE RECOVERY @ 25°C AMB		TYPICAL JUNCTION CAPACITANCE @ 25°C	
		A_{AV} @ T_A														
	VOLTS	mA	°C	MIN °C	MAX °C	MIN °C	MAX °C	A_{PK}	V_F VDC	I_F mADC	V_R VDC	I_R µADC	REF. NOTE	ns	V_R VDC	C_J pF
GP101A	10	100	25	—65	175	—65	200	1	1	20	10	.05	1	2	0	2
GP101B	10	100	25	—65	175	—65	200	1	1	20	10	.05	1	2	0	4
GP102A	20	100	25	—65	175	—65	200	1	1	20	10	.05	1	2	0	2
GP102B	20	100	25	—65	175	—65	200	1	1	20	10	.05	1	2	0	4
GP103A	30	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	2
GP103B	30	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	4
GP104A	40	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	2
GP104B	40	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	4
GP105A	50	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	2
GP105B	50	100	25	—65	175	—65	200	1	1	20	20	.05	1	2	0	4

Note 1—When switched from 10 mA forward current to —6V in special computer test circuit. Recovery to 1 mA through loop impedance 100 ohms.

HERCULEADS*...The Ultimate Diode  actual size

General Instrument's HERCULEADS beam-lead diode is a self-contained diode package with total environmental immunity — the smallest discrete diode available — and it is virtually indestructable.

1 Special low resistance contact area.
2 Gold leads.
Lead mass large relative to mass of diode.
Both leads on same face of chip.
3 Bonding area external to active device.
4 Junction completely shielded by leads.
5 Oxide-passivation.
6 Silicon Chip

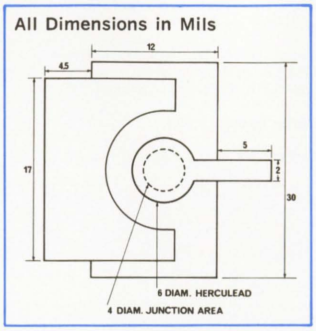


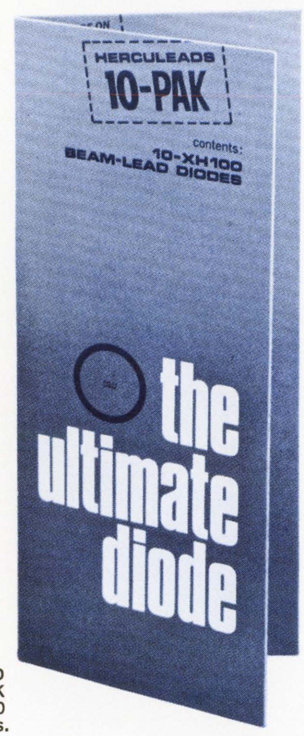
Electrical Specifications for XH100 SERIES at 25°C.

PRV 90V
I_f .... 40 mA @ 1V
I_r .... 2nA @ —40V
C .... 2.4 pf @ 0V
t_{rec} .... 4 ns, 10ma, I_f to —40V

*Trade Mark

OUTLINE DRAWING





The HERCULEADS* BEAM-LEAD DIODE is sold as a 10-PAK package containing 10-XH100 beam-lead diodes.

SEE PAGE 25 FOR CASE DRAWINGS

ZENER VOLTAGE REGULATOR DIODES

200 mW TYPES — CASE 39

TYPE	POWER RATING — mW	NOTES	ZENER VOLTS @ IZT — VOLTS	TEST CURRENT IZT — mA	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ IZT — OHMS	@ IZK — OHMS	TEST CURRENT IZK — mA	REVERSE CURRENT @ 25°C IR — µA	@ VR — VOLTS
1N225	200	2	7.5-10	0.2				0.5	6.8
1N226	200	2	9-12	0.2				0.5	8.2
1N227	200	2	11-14.5	0.2				0.5	10
1N228	200	2	13.5-18	0.2				0.5	12
1N229	200	2	17-21	0.2				0.5	15
1N230	200	2	20-27	0.2				0.1	18
1N231	200	2	25-32	0.2				0.1	22
1N232	200	2	30-39	0.2				0.1	27
1N233	200	2	37-45	0.2				0.1	33
1N234	200	2	43-54	0.2				0.1	39
1N235	200	2	52-64	0.2				0.1	47
1N236	200	2	62-80	0.2				1	56
1N237	200	2	75-100	0.2				1	68
1N238	200	2	90-120	0.2				1	82
1N239	200	2	110-145	0.2				1	100
1N465	200	3	2-3.2	5		60	10	75	1
1N466	200	3	3-3.9	5		55	10	50	1
1N467	200	3	3.7-4.5	5		45	10	5	1
1N468	200	3	4.3-5.4	5		35	10	5	1.5
1N469	200	3	5.2-6.4	5		20	10	5	1.5
1N470	200	3	6.2-8.0	5		10	10	5	3.5
1N471	200	2	3-3.9	5		65	10	50	1
1N472	200	2	3.7-4.5	5		60	10	5	1
1N473	200	2	4.3-5.4	5		50	10	5	1.5
1N474	200	2	5.2-6.4	5		40	10	5	1.5
1N475	200	2	6.2-8.0	5		25	10	5	3.5

250 mW TYPES — CASE 39

TYPE	POWER RATING — mW	NOTES	ZENER VOLTS @ IZT — VOLTS	TEST CURRENT IZT — mA	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ IZT — OHMS	@ IZK — OHMS	TEST CURRENT IZK — mA	REVERSE CURRENT @ 25°C IR — µA	@ VR — VOLTS
1N702	250	4	2-3.2	5		60	10	75	1
1N703	250	4	3-3.9	5		55	10	50	1
1N704	250	4	3.7-4.5	5		45	10	5	1
1N705	250	4	4.3-5.4	5		35	10	5	1.5
1N706	250	4	5.2-6.4	5		30	10	5	1.5
1N707	250	4	6.2-8.0	5		10	10	5	3.5
1N708	250	4	5.6	25	3.6				
1N709	250	4	6.2	25	4.1				
1N710	250	4	6.8	25	4.7				
1N711	250	4	7.5	25	5.3				
1N712	250	4	8.2	25	6				
1N713	250	4	9.1	12	7				
1N714	250	4	10	12	8				
1N715	250	4	11	12	9				
1N716	250	4	12	12	10				
1N717	250	4	13	12	11				
1N718	250	4	15	12	13				
1N719	250	4	16	12	15				
1N720	250	4	18	12	17				
1N721	250	4	20	4	20				
1N722	250	4	22	4	24				
1N723	250	4	24	4	28				
1N724	250	4	27	4	35				
1N725	250	4	30	4	42				
1N726	250	4	33	4	50				
1N727	250	4	36	4	60				
1N728	250	4	39	4	70				
1N729	250	4	43	4	84				
1N730	250	4	47	4	98				
1N731	250	4	51	4	115				
1N732	250	4	56	4	140				
1N733	250	4	62	2	170				
1N734	250	4	68	2	200				
1N735	250	4	75	2	240				
1N736	250	4	82	2	280				
1N737	250	4	91	1	340				
1N738	250	4	100	1	400				
1N739	250	4	110	1	490				
1N740	250	4	120	1	570				
1N741	250	4	130	1	650				

• Indicates MIL Type.

Notes: 1. Unless otherwise specified in notes, dynamic impedance is measured by superimposing alternating current equal to 10% of the direct current IZT or IZK.
2. 10% tolerance: suffix A = 5%, Double anode type.
3. 10% tolerance: suffix A =5%, suffix B = 1%.
4. 10% tolerance: suffix A = 5%.
5. 10% tolerance: suffix A = 5%. For dynamic impedance superimpose 1mA ac upon IZT
6. 10% tolerance.
7. 20% tolerance: suffix A = 10%, suffix B = 5%.

250 mW TYPES Cont'd — CASE 39

TYPE	POWER RATING — mW	NOTES	ZENER VOLTS @ IZT — VOLTS	TEST CURRENT IZT — mA	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ IZT — OHMS	@ IZK — OHMS	TEST CURRENT IZK — mA	REVERSE CURRENT @ 25°C IR — µA	@ VR — VOLTS
1N742	250	4	150	1	860				
1N743	250	4	160	1	970				
1N744	250	4	180	1	1200				
1N745	250	4	200	1	1400				
1N761	250	6	4.3-5.4	10	40				
1N762	250	6	5.2-6.4	10	18				
1N763	250	6	6.2-8.0	10	7				
1N764	250	6	7.5-10	10	12				
1N765	250	6	9-12	5	45				
1N766	250	6	11-14.5	5	55				
1N767	250	6	13.5-18	5	70				
1N768	250	6	17-21	5	100				
1N769	250	6	20-27	5	150				
1N3477	250	4	2.2	5	60				

400 mW TYPES — CASE 39

TYPE	POWER RATING — mW	NOTES	ZENER VOLTS @ IZT — VOLTS	TEST CURRENT IZT — mA	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ IZT — OHMS	@ IZK — OHMS	TEST CURRENT IZK — mA	REVERSE CURRENT @ 25°C IR — µA	@ VR — VOLTS
•1N746A	400	5	3.3	20	28			5	1.0
•1N747A	400	5	3.6	20	24			5	1.0
•1N748A	400	5	3.9	20	23			5	1.0
•1N749A	400	5	4.3	20	22			5	1.0
•1N750A	400	5	4.7	20	19			10	2.0
•1N751A	400	5	5.1	20	17			10	2.0
•1N752A	400	5	5.6	20	11			10	3.0
•1N753A	400	5	6.2	20	7			10	4.0
•1N754A	400	5	6.8	20	5			5	5.0
•1N755A	400	5	7.5	20	6			5	6.0
•1N756A	400	5	8.2	20	8			5	6.5
•1N757A	400	5	9.1	20	10			5	7.0
•1N758A	400	5	10	20	17			5	8.0
•1N759A	400	5	12	20	30			5	9.0
1N957	400	7	6.8	18.5	4.5	700	1.0		
1N958	400	7	7.5	16.5	5.5	700	0.5		
1N959	400	7	8.2	15	6.5	700	0.5		
1N960	400	7	9.1	14	7.5	700	0.5		
1N961	400	7	10	12.5	8.5	700	0.25		
•1N962B	400	7	11	11.5	9.5	700	0.25		
•1N963B	400	7	12	10.5	11.5	700	0.25		
•1N964B	400	7	13	9.5	13	700	0.25		
•1N965B	400	7	15	8.5	16	700	0.25		
•1N966B	400	7	16	7.8	17	700	0.25		
•1N967B	400	7	18	7.0	21	750	0.25		
•1N968B	400	7	20	6.2	25	750	0.25		
•1N969B	400	7	22	5.6	29	750	0.25		
•1N970B	400	7	24	5.2	33	750	0.25		
•1N971B	400	7	27	4.6	41	750	0.25		
•1N972B	400	7	30	4.2	49	1000	0.25		
•1N973B	400	7	33	3.8	58	1000	0.25		
•1N974B	400	7	36	3.4	70	1000	0.25		
•1N975B	400	7	39	3.2	80	1000	0.25		
•1N976B	400	7	43	3.0	93	1500	0.25		
•1N977B	400	7	47	2.7	105	1500	0.25		
•1N978B	400	7	51	2.5	125	1500	0.25		
•1N979B	400	7	56	2.2	150	2000	0.25		
•1N980B	400	7	62	2.0	185	2000	0.25		
•1N981B	400	7	68	1.8	230	2000	0.25		
•1N982B	400	7	75	1.7	270	2000	0.25		
•1N983B	400	7	82	1.5	330	3000	0.25		
•1N984B	400	7	91	1.4	400	3000	0.25		
•1N985B	400	7	100	1.3	500	3000	0.25		
•1N986B	400	7	110	1.1	750	4000	0.25		
•1N987B	400	7	120	1.0	900	4500	0.25		
•1N988B	400	7	130	.95	1100	5000	0.25		
•1N989B	400	7	150	.85	1500	6000	0.25		
•1N990B	400	7	160	.80	1700	6500	0.25		
•1N991B	400	7	180	.68	2200	7100	0.25		
•1N992B	400	7	200	.65	2500	8000	0.25		

SEE PAGE 25 FOR CASE DRAWINGS

ZENER VOLTAGE REGULATOR DIODES

1 WATT FLANGELESS TYPES — CASE 36

TYPE	POWER RATING (Watts)	NOTE	ZENER VOLTS @ I_{ZT} (VOLTS)	TEST CURRENT I_{ZT} (mA)	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ I_{ZT} (OHMS)	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ I_{ZK} (OHMS)	TEST CURRENT I_{ZK} (mA)	REVERSE CURRENT @ 25°C I_R (μA)	@ V_R (VOLT)
•1N3021	1	1	11	23	8	700	0.25	10	SEE NOTE 2
•1N3022	1	1	12	21	9	700	0.25	10	
•1N3023	1	1	13	19	10	700	0.25	10	
•1N3024	1	1	15	17	14	700	0.25	10	
•1N3025	1	1	16	15.5	16	700	0.25	10	
•1N3026	1	1	18	14	20	750	0.25	10	
•1N3027	1	1	20	12.5	22	750	0.25	10	
•1N3028	1	1	22	11.5	23	750	0.25	10	
•1N3029	1	1	24	10.5	25	750	0.25	10	
•1N3030	1	1	27	9.5	35	750	0.25	10	
•1N3031	1	1	30	8.5	40	1000	0.25	10	
•1N3032	1	1	33	7.5	45	1000	0.25	10	
•1N3033	1	1	36	7	50	1000	0.25	10	
•1N3034	1	1	39	6.5	60	1000	0.25	10	
•1N3035	1	1	43	6	70	1500	0.25	10	
•1N3036	1	1	47	5.5	80	1500	0.25	10	
•1N3037	1	1	51	5	95	1500	0.25	10	
•1N3038	1	1	56	4.5	110	2000	0.25	10	
•1N3039	1	1	62	4	125	2000	0.25	10	
•1N3040	1	1	68	3.7	150	2000	0.25	10	
•1N3041	1	1	75	3.3	175	2000	0.25	10	
•1N3042	1	1	82	3	200	3000	0.25	10	
•1N3043	1	1	91	2.8	250	3000	0.25	10	
•1N3044	1	1	100	2.5	350	3000	0.25	10	
•1N3045	1	1	110	2.3	450	4000	0.25	10	
•1N3046	1	1	120	2	550	4500	0.25	10	
•1N3047	1	1	130	1.9	700	5000	0.25	10	
•1N3048	1	1	150	1.7	1000	6000	0.25	10	
•1N3049	1	1	160	1.6	1100	6500	0.25	10	
•1N3050	1	1	180	1.4	1200	7000	0.25	10	
•1N3051	1	1	200	1.2	1500	8000	0.25	10	

•Available in MIL Type.

Note: 1. 20% tolerance: suffix A = 10%, suffix B = 5%.
2. $V_R = V_Z \times [100 - (\%\ \text{tolerance})] \times 0.8 \times 1/100$

1 WATT Glass-Amp® — CASE 38

TYPE	POWER RATING (Watts)	NOTE	ZENER VOLTS @ I_{ZT} (VOLTS)	TEST CURRENT I_{ZT} (mA)	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ I_{ZT} (OHMS)	MAXIMUM DYNAMIC IMPEDANCE (See Note 1) @ I_{ZK} (OHMS)	TEST CURRENT I_{ZK} (mA)	REVERSE CURRENT @ 25°C I_R (μA)	@ V_R (VOLT)
1N4162	1	1	10	25	7	700	0.25	10	SEE NOTE 2
1N4163	1	1	11	23	8	700	0.25	5	
1N4164	1	1	12	21	9	700	0.25	5	
1N4165	1	1	13	19	10	700	0.25	5	
1N4166	1	1	15	17	14	700	0.25	5	
1N4167	1	1	16	15.5	16	700	0.25	5	
1N4168	1	1	18	14	20	750	0.25	5	
1N4169	1	1	20	12.5	22	750	0.25	5	
1N4170	1	1	22	11.5	23	750	0.25	5	
1N4171	1	1	24	10.5	25	750	0.25	5	
1N4172	1	1	27	9.5	35	750	0.25	5	
1N4173	1	1	30	8.5	40	1000	0.25	5	
1N4174	1	1	33	7.5	45	1000	0.25	5	
1N4175	1	1	36	7.0	50	1000	0.25	5	
1N4176	1	1	39	6.5	60	1000	0.25	5	
1N4177	1	1	43	6.0	70	1500	0.25	5	
1N4178	1	1	47	5.5	80	1500	0.25	5	
1N4179	1	1	51	5.0	95	1500	0.25	5	
1N4180	1	1	56	4.5	110	2000	0.25	5	
1N4181	1	1	62	4.0	125	2000	0.25	5	
1N4182	1	1	68	3.7	150	2000	0.25	5	
1N4183	1	1	75	3.3	175	2000	0.25	5	
1N4184	1	1	82	3.0	200	3000	0.25	5	
1N4185	1	1	91	2.8	250	3000	0.25	5	
1N4186	1	1	100	2.5	350	3000	0.25	5	
1N4187	1	1	110	2.3	450	4000	0.25	5	
1N4188	1	1	120	2.0	550	4500	0.25	5	
1N4189	1	1	130	1.9	700	5000	0.25	5	
1N4190	1	1	150	1.7	1000	6000	0.25	5	
1N4191	1	1	160	1.6	1100	6500	0.25	5	
1N4192	1	1	180	1.4	1200	7000	0.25	5	
1N4193	1	1	200	1.2	1500	8000	0.25	5	

SEE PAGE 25 FOR CASE DRAWINGS

GERMANIUM COMPUTER TRANSISTORS/INTERMEDIATE TO HIGH CURRENT/MEDIUM SPEED D.C. SWITCHING

RATINGS AT 25°C AMBIENT TEMPERATURE (UNLESS OTHERWISE SPECIFIED)

TYPE	Polarity P-PNP N-NPN	Case	MAXIMUM RATINGS @ 25°C: Pc @25°C mW	VCBO Volts	VEBO Volts	VCEO *VCES #VCER +VCEX Volts	ICBO: VCB Volts	Max. µA	STATIC FORWARD CURRENT TRANSFER RATIO (hFE) TEST CONDITIONS: Ic mA	VCE Volts	LIMITS: Min.	Max.	Alpha Cutoff Frequency fhfb Min. MHz	Collector Capacity Cobo Max. pF
2N315A	P	6	150	30	20	20	5	2	100	0.2	20	50	θ5	θ14
2N316	P	6	100	20	20	10	5	2	200	0.2	20	50	θ12	θ14
2N316A	P	6	150	30	20	15	5	2	200	0.2	20	50	θ12	θ14
2N356	N	6	100	20	20	18	5	5	100	0.25	20	50	θ3	θ14
2N356A	N	6	150	30	20	20	5	5	100	0.25	20	50	θ3	θ14
2N357A	N	6	150	30	20	20	5	5	200	0.25	25	75	θ6	θ14
2N358	N	6	100	20	20	12	5	5	300	0.25	20	50	θ9	θ14
•2N358A	N	6	150	30	20	15	5	5	300	0.25	25	75	θ9	θ14
2N377A	N	6 (G.B.)	150	40	15	+40	1.0	5	200	0.75	20		θ6	20
2N388A	N	6 (G.B.)	150	40	15	#20	1.0	5	200	0.75	30		5	20
•2N396A	P	6 (G.B.)	200	30	20	20	20	6	200	0.35	15	150	5	20
2N579	P	6	150	20	12		12	5	400	0.3	20		5	
2N580	P	6	150	20	20		12	5	400	0.3	30		10	
•2N1306	N	6 (G.B.)	150	25	25		25	6	200	0.35	20		10	20
•2N1307	P	6 (G.B.)	150	30	25		25	6	200	0.35	20		10	20

COMPUTER TRANSISTORS/MEDIUM CURRENT FOR MEDIUM SPEED D.C. SWITCHING

•2N404	P	6	150	25	12		12	5					4	20
•2N404A	P	6	150	40	25		12	5					4	20
2N438A	N	6 (G.B.)	150	30	25	25	25	10	50	1.0	20		2.5	20
2N439A	N	6	150	30	25	25	25	10	50	1.0	30		5	20
2N440A	N	6	150	30	25	15	25	10	50	1.0	40		10	20
2N444A	N	6	150	40	10	25	5	4	20	0.25	20	40	0.5	θ14
2N445A	N	6	150	30	10	18	5	4	20	0.25	40	160	2	θ14
2N446A	N	6	150	30	10	15	5	4	20	0.25	60	250	5	θ14
2N447A	N	6	150	30	10	12	5	4	20	0.25	80	300	9	θ14
2N519A	P	6	150	25	10	18	5	2	20	0.25	20	50	0.5	θ14
2N520A	P	6	150	25	10	15	5	2	20	0.25	40	170	3	θ14
2N521A	P	6	150	25	10	12	5	2	20	0.25	60	250	8	θ14
2N522A	P	6	150	25	10	10	5	2	20	0.25	80	320	15	θ14
2N523A	P	6	150	20	10	6	5	2	20	0.25	100	400	21	θ14
2N585	N	6	150	25	20		2.5	6	20	0.2	20		3	20

MEDIUM POWER ALLOY JUNCTION TRANSISTORS FOR SWITCHING AND AMPLIFIER APPLICATIONS

2N597	P	6	250	45	45	*40	1.5	5	100	1.0	40		3	20
•2N598	P	6	250	35	30	*35	1.5	5	100	1.0	70	225	5fT	20
•2N599	P	6	250	30	20	*20	1.5	5	100	1.0	100		10fT	20
•2N600	P	Fig. 12	750	35	30	*35	1.5	5	100	1.0	70	225	5fT	20
2N601	P	Fig. 12	750	30	20	*20	1.5	5	100	1.0	100		10fT	20
2N2648	P	6 (G.C.)	300	35	30	10	15	5	1.0A	0.5	80	500	10fT	30

HIGH VOLTAGE TRANSISTORS FOR NIXIE AND OTHER NEON TUBE DRIVERS

2N398A	P	6	150	105	50	*105	2.5	14	5	0.35	20			
•2N1310	N	6	150	90	20		5	7	5	0.25	20		θ1.0	θ11
2N1311	N	6	150	75	20		5	7	5	0.25	15		θ1.5	θ11
2N1312	N	6	150	50	20		5	7	5	0.25	15		θ1.5	θ11
2N1408	P	6	150	50	10		5	7						θ35

BILATERAL TRANSISTORS FOR CORE AND DRUM MEMORY ADDRESSING CHOPPER SERVICE

									IB					
2N594	N	6	150	20	20	20	5	5	1.0	0.2	20		1.5	θ15
2N595	N	6	150	20	20	15	5	5	1.0	0.2	35		3	θ15
2N596	N	6	150	20	20	10	5	5	1.0	0.2	50		5	θ15

AUDIO TRANSISTORS FOR AUDIO AND LOW SPEED COMPUTER APPLICATIONS

TYPE	Polarity P-PNP N-NPN	Case	MAXIMUM RATINGS @ 25°C: Pc @ 25°C mW	VCBO Volts	VEBO Volts	VCEO Volts	ICBO: VCB Volts	Max. µA	A.C. CURRENT GAIN COMMON EMITTER (hfe) CONDITIONS: Ic mA	VCE Volts	Freq. kHz	LIMITS: Min.	Max.	ALPHA CUTOFF Frequency fhfb Min. MHz
•2N331	P	6	150	30	12				1	6	1	30	70	0.4
•2N464	P	6	150	45	12	40	20	15	1	6	1	14		θ0.7
•2N465	P	6	150	45	12	30	20	15	1	6	1	27		θ0.8
•2N466	P	6	150	35	12	20	20	15	1	6	1	56		θ1.0
•2N467	P	6	150	35	12	15	20	15	1	6	1	112		θ1.2

Notes: θTypical Values
• Available to Military Specifications
G.B. - Base Connected to Case
G.C. - Collector Connected to Case

SEE PAGE 24 FOR CASE DRAWINGS

SILICON TRANSISTORS

TYPE	CASE	POLARITY P—PNP N—NPN	P_C @ 25°C mW	MAXIMUM RATINGS @ 25°C V_{CBO} VOLTS	V_{EBO} VOLTS	$+V_{CER}$ VOLTS	FORWARD CURRENT TRANSFER RATIO (h_{FE}) I_C mA	MIN.	MAX.	V_{BE} I_C mA	VOLTS MAX.	V_{CE} (SAT) I_C mA	VOLTS MAX.	GAIN BAND-WIDTH f_T MIN. MHz	COLLECTOR CAPACITY C_{ob} MAX. pF
HIGH SPEED SWITCHES															
2N706	9	N	300	25	3	+20	10	20		10	0.9	10	0.6	200	6
2N706A	9	N	300	25	5	15 +20	10	20	60	10	0.9	10	0.6	200	5
2N706B	9	N	300	25	5	15 +20	10	20	60	10	0.9	10	0.4	200	5
2N708	9	N	360	40	5	15 +20	10	30	120	10	0.8	10	0.4	300	6
2N743	9	N	300	20	5	12	10	20	60	10	0.85			280	5
2N744	9	N	300	20	5	12	10	40	120	10	0.85			280	5
2N753	9	N	300	25	5	15 +20	10	40	120	10	0.9	10	0.6	200	5
2N834	9	N	300	40	5		10	25		10	0.9	10	0.25	350	4
2N835	9	N	300	25	3	20	10	20		10	0.9	10	0.3	300	4
LOW LEVEL, LOW NOISE AMPLIFIER															
2N929	9	N	300	45	5	45	0.01	40	120	10	1.0	10	1.0	30	8
2N929A	9	N	300	60	6	45	0.01	40	120	10	0.9	10	0.5	45	6
2N930	9	N	500	45	5	45	0.01	100	300	10	1.0	10	1.0	30	8
2N930A	9	N	500	60	6	45	0.01	100	300	10	0.9	10	0.5	45	6
2N2483	9	N	360	60	6	60	0.01	40	120	0.1	0.7	1.0	0.35	60	6
2N2484	9	N	360	60	6	60	0.01	100	500	0.1	0.7	0.1	0.35	60	6
CORE DRIVER															
2N2537	6	N	800	60	5	30 +40	500	20		500	2.6	500	1.6	250	8
2N2538	6	N	800	60	5	30 +40	500	30		500	2.6	500	1.6	250	8
2N2539	9	N	500	60	5	30 +40	500	20		500	2.6	500	1.6	250	8
2N2540	9	N	500	60	5	30 +40	500	30		500	2.6	500	1.6	250	8
GENERAL PURPOSE, MEDIUM SPEED, MEDIUM POWER AMPLIFIER AND SWITCHES															
2N696	6	N	600	60	5	+40	150	20	60	150	1.3	150	1.5	40	35
2N697	6	N	600	60	5	+40	150	40	120	150	1.3	150	1.5	50	35
2N698	6	N	800	120	7	60 +80	150	20	60	150	1.3	150	5	40	15
2N699	6	N	600	120	5	+80	150	40	120	150	1.3	150	5	50	20
2N718	9	N	400	60	5	+40	150	40	120	150	1.3	150	1.5	50	35
2N718A	9	N	500	75	7	32 +50	150	40	120	150	1.3	150	1.5	60	25
2N721	9	P	400	50	5	35 +50	150	20	45	150	1.3	150	1.5	50	45
2N722	9	P	400	50	5	35 +50	150	30	90	150	1.3	150	1.5	60	45
2N1131	6	P	600	50	5	35 +50	150	20	45	150	1.3	150	1.5	50	45
2N1132	6	P	600	50	5	35 +50	150	30	90	150	1.3	150	1.5	60	45
2N1613	6	N	800	75	7	+50	150	40	120	150	1.3	150	1.5	60	25
2N1711	6	N	800	75	7	+50	150	100	300	150	1.3	150	1.5	70	25
2N1893	6	N	800	120	7	80 +100	150	40	120	150	1.3	150	5	50	15
2N2192	6	N	800	60	5	40	150	100	300	150	1.3	150	0.35	50	20
2N2192A	6	N	800	60	5	40	150	100	300	150	1.3	150	0.25	50	20
2N2192B	6	N	800	60	5	40	150	100	300	150	1.3	150	0.18	50	20
2N2193	6	N	800	80	8	50	150	40	120	150	1.3	150	0.35	50	20
2N2193A	6	N	800	80	8	50	150	40	120	150	1.3	150	0.25	50	20
2N2193B	6	N	800	80	8	50	150	40	120	150	1.3	150	0.18	50	20
2N2217	6	N	800	60	5	30	150	20	60	150	1.3	150	0.4	250	8
2N2218	6	N	800	60	5	30	150	40	120	150	1.3	150	0.4	250	8
2N2218A	6	N	800	75	6	40	150	40	120	150	1.2	150	0.3	250	8
2N2219	6	N	800	60	5	30	150	100	300	150	1.3	150	0.4	250	8
2N2219A	6	N	800	75	6	40	150	100	300	150	1.2	150	0.3	300	8
2N2220	9	N	500	60	5	30	150	20	60	150	1.3	150	0.4	250	8
2N2221	9	N	500	60	5	30	150	40	120	150	1.3	150	0.4	250	8
2N2221A	9	N	500	75	6	40	150	40	120	150	1.2	150	0.3	250	8
2N2222	9	N	500	60	5	30	150	100	300	150	1.3	150	0.4	250	8
2N2222A	9	N	500	75	6	40	150	100	300	150	1.2	150	0.3	300	8
2N2303	6	P	600	50	5	35 +50	150	75	200	150	1.3	150	1.5	60	45
2N2837	9	P	500	50	5	35	150	30	90	150	1.3	150	0.4	120	25
2N2838	9	P	500	50	5	35	150	75	225	150	1.3	150	0.4	120	25
2N2904	6	P	600	60	5	40	150 500	40 20	120	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2904A	6	P	600	60	5	60	150 500	40 40	120	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2905	6	P	600	60	5	40	150 500	100 30	300	150 [illegible]	1.3 2.6	150 500	0.4 1.6	200	8
2N2905A	6	P	600	60	5	60	150 500	100 50	300	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2906	9	P	400	60	5	40	150 500	40 20	120	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2906A	9	P	400	60	5	60	150 500	40 40	120	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2907	9	P	400	60	5	40	150 500	100 30	300	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N2907A	9	P	400	60	5	60	150 500	100 50	300	150 500	1.3 2.6	150 500	0.4 1.6	200	8
2N3133	6	P	600	50	4	35	150	40	120	150	1.5	150	0.6	200	10
2N3134	6	P	600	50	4	35	150	100	300	150	1.5	150	0.6	200	10
2N3135	9	P	400	50	4	35	150	40	120	150	1.5	150	0.6	200	10
2N3136	9	P	400	50	4	35	150	100	300	150	1.5	150	0.6	200	10

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EPOXY ENCAPSULATED TRANSISTORS

CASE 42

TYPE*	POLARITY N—NPN P—PNP	V_{CBO} VOLTS	V_{CEO} VOLTS	V_{EBO} VOLTS	h_{FE} @ V_{CE}	V_{CE} VOLTS	I_C mA	h_{fe} @ V_{CE}	V_{CE} VOLTS	I_C mA	f_t MHz	C_{ob} pF	@ V_{CB} VOLTS	V_{CE} (SAT) VOLTS	@ I_C mA	I_B mA	P_D mW
2N2711	N	18	18	5.0	30-90	4.5	2	30-120	4.5	2	—	4.5-12	10	—	—	—	200
2N2712	N	18	18	5.0	75-125	4.5	2	80-300	4.5	2	—	4.5-12	10	—	—	—	200
2N2713	N	18	18	5.0	30-90	4.5	2	30-120	4.5	2	—	—	—	.30	50	3	200
2N2714	N	18	18	5.0	75-225	4.5	2	80-300	4.5	2	—	—	—	.30	50	3	200
2N2715	N	18	18	5.0	30-90	4.5	2	30-120	4.5	2	—	5.0	10	—	—	—	200
2N2716	N	18	18	5.0	75-225	4.5	2	80-300	4.5	2	—	5.0	10	—	—	—	200
2N2921	N	25	25	5.0	—	—	—	35-70	10	2	—	4.5-12	10	—	—	—	200
2N2922	N	25	25	5.0	—	—	—	55-110	10	2	—	4.5-12	10	—	—	—	200
2N2923	N	25	25	5.0	—	—	—	90-180	10	2	—	4.5-12	10	—	—	—	200
2N2924	N	25	25	5.0	—	—	—	150-300	10	2	—	4.5-12	10	—	—	—	200
2N2925	N	25	25	5.0	—	—	—	235-470	10	2	—	4.5-12	10	—	—	—	200
2N2926	N	18	18	5.0	—	—	—	35-470	10	2	—	4.5-12	—	—	—	—	200
2N3390	N	25	25	5.0	400-800	4.5	2	400-1250	—	—	—	4.5-10	10	—	—	—	200
2N3391	N	25	25	5.0	250-500	4.5	2	250-800	—	—	—	4.5-10	10	—	—	—	200
2N3391A	N	25	25	5.0	250-500	4.5	2	250-800	—	—	—	4.5-10	10	—	—	—	200
2N3392	N	25	25	5.0	150-300	4.5	2	150-500	—	—	—	4.5-10	10	—	—	—	200
2N3393	N	25	25	5.0	90-180	4.5	2	90-400	—	—	—	4.5-10	10	—	—	—	200
2N3394	N	25	25	5.0	55-110	4.5	2	55-300	—	—	—	4.5-10	10	—	—	—	200
2N3395	N	25	25	5.0	150-500	4.5	2	150-800	—	—	—	4.5-10	10	—	—	—	200
2N3396	N	25	25	5.0	90-500	4.5	2	90-800	—	—	—	4.5-10	10	—	—	—	200
2N3397	N	25	25	5.0	55-500	4.5	2	55-800	—	—	—	4.5-10	10	—	—	—	200
2N3398	N	25	25	5.0	55-800	4.5	2	55-1250	—	—	—	4.5-10	10	—	—	—	200
2N3414	N	25	25	5.0	75-225	4.5	2	75	—	—	—	—	—	.30	50	3	360
2N3416	N	50	50	5.0	75-225	4.5	2	75	—	—	—	—	—	.30	50	3	360
2N3563	N	30	12	4.0	20-200	10	8	20-250	10	8	600-1500	1.7	10	—	—	—	200
2N3564	N	30	15	4.0	20-500	10	15	—	—	—	400-1200	3.5	10	.30	20	2	200
2N3565	N	30	25	6.0	150-600	10	1	120-750	5	1	40-240	4.0	5.0	—	—	—	200
2N3566	N	40	30	5.0	150-600	10	10	—	—	—	40-240	25	10	1.0	100	10	300
2N3605	N	18	14	5.0	30	1	10	—	—	—	300	6.0	10	.25	10	1	200
2N3606	N	18	14	5.0	30	1	10	—	—	—	300	6.0	10	.25	10	1	200
2N3607	N	18	14	5.0	30	1	10	—	—	—	300	6.0	10	.25	10	1	200
2N3638	P	25	25	4.0	30	1	50	25	10	10	100	20	10	1.0	300	30	300
2N3638A	P	50	50	4.0	30-180	1	50	25	10	10	100	10	10	1.0	300	30	300
2N3641	N	60	30	5.0	40-120	10	150	—	—	—	250	8.0	10	.22	150	15	350
2N3643	N	60	30	5.0	100-300	10	150	—	—	—	250	8.0	10	.22	150	15	350
2N3644	P	45	45	5.0	100-300	10	150	—	—	—	200	8.0	10	.25	50	2.5	300
2N3645	P	60	60	5.0	100-300	10	150	—	—	—	200	8.0	10	.25	50	2.5	300
2N3662	N	18	12	3.0	20	10	8	—	—	—	700-2100	.8-1.7	10	—	—	—	200
2N3663	N	30	12	3.0	20	10	8	—	—	—	700-2100	.8-1.7	10	—	—	—	200
2N3691	N	35	20	4.0	40-160	1	10	40-200	10	5	200-500	.5-3.5	10	.70	10	1	200
2N3692	N	35	20	4.0	100-400	1	10	100-560	10	5	200-500	.5-3.5	10	.70	10	1	200
2N3702	P	40	25	5.0	60-300	5	50	—	—	—	100	12	10	.25	50	5	300
2N3703	P	50	30	5.0	30-150	5	50	—	—	—	100	12	10	.25	50	5	300
2N3704	N	50	30	5.0	100-300	3	50	—	—	—	100	12	10	.60	100	5	360
2N3705	N	50	30	5.0	50-150	2	50	—	—	—	100	12	10	.80	100	5	360
2N3706	N	40	20	5.0	30-600	2	50	—	—	—	100	12	10	1.0	100	5	360
2N3707	N	30	30	6.0	100-400	5	.1	100-550	5	.1	—	—	—	1.0	10	5	250
2N3708	N	30	30	6.0	45-660	5	1	45-800	5	1	—	—	—	1.0	10	5	250
2N3709	N	30	30	6.0	45-165	5	1	45-250	5	1	—	—	—	1.0	10	5	250
2N3710	N	30	30	6.0	90-330	5	1	90-450	5	1	—	—	—	1.0	10	5	250
2N3711	N	30	30	6.0	180-600	5	1	180-800	5	1	—	—	—	1.0	10	5	250
2N3721	N	18	18	5.0	—	—	—	60-660	10	2	—	4.5-12	10	—	—	—	200
2N3793	N	40	20	5.0	20-120	10	10	—	—	—	100-600	10	10	.40	10	1	250
2N3794	N	40	20	5.0	100-600	10	10	—	—	—	100-600	10	10	.40	10	1	250
2N3825	N	30	15	4.0	20	10	2	—	—	—	200-800	3.5	10	.25	2	2	250
2N3828	N	40	40	3.0	30-200	20	12	—	—	—	200-500*	2.5-5	20	—	—	—	300
2N3843A	N	30	30	4.0	20-40	4.5	2	—	—	—	60-230	2-4	10	—	—	—	200
2N3844A	N	30	30	4.0	35-70	4.5	2	—	—	—	90-250	2-4	10	—	—	—	200
2N3845A	N	30	30	4.0	60-120	4.5	2	—	—	—	126-290	2-4	10	—	—	—	200
2N3858	N	30	30	4.0	60-120	4.5	2	—	—	—	90-250	2-4	10	—	—	—	200
2N3859	N	30	30	4.0	100-200	4.5	2	—	—	—	90-250	2-4	10	—	—	—	200
2N3860	N	30	30	4.0	150-300	4.5	2	—	—	—	90-250	2-4	10	—	—	—	200
2N3900	N	18	18	5.0	250-500	4.5	2	170-800	4.5	2	—	4.5-12	10	—	—	—	200
2N3900A	N	18	18	5.0	250-500	4.5	2	170-800	4.5	2	—	4.5-12	10	—	—	—	200
2N3903	N	60	40	6.0	50-150	1	10	50-200	10	1	250	4.0	5.0	.30	50	5	310
2N3904	N	60	40	6.0	100-300	1	10	100-400	10	1	300	4.0	5.0	.30	50	5	310
2N3905	P	40	40	5.0	50-150	1	10	50-200	10	1	200	4.5	5.0	.40	50	5	310
2N3906	P	40	40	5.0	100-300	1	10	100-400	10	1	250	4.5	5.0	.40	50	5	310
2N3983	N	30	12	3.0	30	10	4	—	—	—	500-1800	.7-1.6	10	—	—	—	200
2N3984	N	30	12	3.0	20	10	4	—	—	—	400-1800	.7-1.6	10	—	—	—	200
2N3985	N	30	12	3.0	20	10	4	—	—	—	300-1800	.7-2.2	10	—	—	—	200
2N4140	N	60	30	5.0	40-120	10	150	—	—	—	250	8.0	10	.40	150	15	300
2N4141	N	60	30	5.0	100-300	10	150	—	—	—	250	8.0	10	.40	150	15	300
2N4142	P	60	40	5.0	40-120	10	150	—	—	—	200	8.0	10	.40	150	15	300
2N4143	P	60	40	5.0	100-300	10	150	—	—	—	200	8.0	10	.40	150	15	300
2N4227	N	60	30	5.0	75-150	10	150	—	—	—	250	8.0	10	.40	150	15	300
2N4228	P	60	40	5.0	75-150	10	150	—	—	—	200	8.0	10	.40	150	15	300

*All devices are in a TO-18 type epoxy package.

SEE PAGE 25 FOR CASE DRAWINGS

GERMANIUM FAST RECOVERY DIODES

CASE 35

TYPE (@ 25°C)	MIN. PIV (Volt)	MINIMUM FORWARD CURRENT (mA) @ +1.0 VOLT	MAXIMUM REVERSE CURRENT IR @ VR		IR @ VR @ TEMP.			REVERSE RECOVERY IF	IR	VR	LEVEL I	LIMIT	LEVEL II	LIMIT	REVERSE RECOVERY CIRCUIT
			(µa)	(V)	(µa)	(V)	(°C)	(mA)	(mA)	(Volts)	(KΩ)	nsec	(KΩ)	nsec	
1N60	30		67	10				5	1.0		∞	80			Tektronix "S" Unit
1N191	90	5.0	25	10, 55°C	125	50	55	30		35	50	500	400	3500	IBM-Y Ckt
1N192	70	5.0	25	10, 55°C	250	50	55	30		35	50	500	200	3500	IBM-Y Ckt
1N276	100	40	100	50	100	10	75	5		40	80	300			JAN 256
1N480	90	5.0	50	20, 60°C	125	50	60	30		35	50	500	400	3500	JAN 256
1N490	90	5.0	100	20, 60°C	250	50	60	30		35	50	500	200	3500	JAN 256
1N631	90		20	10	120	60	Fwd. Recovery @ 50mA; 100KC <3.5 Volts								
1N770	25	15mA @ 0.5V			40	10	40	5		10	15	350	50	700	IBM-Y Ckt
1N777	70	100	25	10, 55°C	125	50	55	30		40	50	500	400	3500	IBM-Y Ckt
1N994	8	10	30	6				10		6	2	2			Sampling Scope
1N995	15	10mA @ .5V	10	6				10		6	2	6			Sampling Scope
1N996	25	40mA @ .8V	15	15				5		10	20	300			JAN 256
1N3203	40	35mA @ .5V	50	25	20	5	55	20		4	16	300			IBM-Y Ckt
1N3467	15	20mA @ .5V	15	10				10		6	1	2			Sampling Scope
1N3468	15	20mA @ .5V	60	10				10		6	1	2			Sampling Scope
1N3592	30	2mA @ .35V 15mA @ .5V	4	4.5	20	20		2	0.2		∞	40			Tektronix "S" Unit
1N3666	80	200mA .5-1.0V	10 25	20 50	150	20	70	30		10	20	300			JAN 256
1N3773	25	2mA @ .35V 15mA @ .5V	4	3	20	20		2	0.2		∞	40			Tektronix "S" Unit
1N4008	25	10mA @ .5V	100	20	25	12	45	10	1.0		∞	70			Tektronix "S" Unit
1N4381	25	2mA .25-.35V	100 2	20 3				2	0.2		∞	100			Tektronix "S" Unit
DR211	75	200	100	50				5		40	50	300			JAN 256
DR362	50	100	50	20				40		10	20	300			JAN 256
DR401	60	20mA @ .5V	25	10, 50°C	125	50	50	30		35	50	500	400	2000	IBM-Y Ckt
DR402	60	20mA @ .5V	50	10, 50°C	250	50	50	30		35	50	500	200	2000	IBM-Y Ckt
DR403	60	20mA @ .5V	20	10	100	50		5		40	80	300			IBM-Y Ckt
DR404	60	20mA @ .5V	20	10	100	50		5		40	50	300			IBM-Y Ckt
DR407	75	5.0	12	6	20	10	55	5		10	50	500	500	3500	JAN 256
DR408	60	200	20	10	100	50		5		40	80	300			IBM-Y Ckt
DR419	25, 55°C	10mA @ .5V	20	3				30		5	25	1000			JAN 256
DR422	75	50	300	50				5		40	50	3000			JAN 256
DR437	75	40mA @ .5V	20	4, 55°C	50	10	55	30		10	10	500	50	2000	JAN 256
DR459	15	10mA @ .5V	200	10				5		6	20	200			JAN 256
DR481	40	100	200	20				5		20	50	1000			JAN 256
DR482	60	100	20	40				25		35	40	400			JAN 256
DR498	20	10mA @ .37V	10	10				5		20	40	300			JAN 256
DR500	50	20	12.5	25				5		40	500	500			JAN 256
GD400	15	10mA @ .5V	3	5				10		6	2.0	10			Sampling Scope
GD401	15	10mA @ .5V	5	5				10		6	2.0	10			Sampling Scope
GD402	45	10mA @ .5V	5	10	15	30		10	2.0		∞	80			Tektronix "S" Unit
GD403	35	10mA @ .5V	10	10				10	2.0		∞	80			Tektronix "S" Unit
GD404	35	10mA @ .5V	6	10	10	20		10	2.0		∞	60			Tektronix "S" Unit
GD405	35	10mA @ .5V	10	10	40	20		10	2.0		∞	60			Tektronix "S" Unit
GD406	60	10mA @ .5V	5	10	20	30		10	2.0		∞	125			Tektronix "S" Unit
GD407	50	10mA @ .5V	10	10	30	30		10	2.0		∞	125			Tektronix "S" Unit
GD408	75	10mA @ .5V	6	10	50	50		30		35	50	400			JAN 256
GD409	60	10mA @ .5V	10	10	100	50		30		35	50	400			JAN 256
GD410	135	10mA @ .5V	30	40	65	40		30		35	50	750			JAN 256
GD411	100	10mA @ .5V	100	100	100	80		30		35	50	750			JAN 256

ABSOLUTE MAXIMUM RATINGS FOR ALL TYPES

OPERATING TEMPERATURE	−65°C to +90°C	SURGE CURRENT (ONE SEC)	400mA
STORAGE TEMPERATURE	100°C	CONT. POWER DISSIPATION @ 25°C	80mW
LEAD TEMPERATURE 1/16" ± 1/32" FROM CASE FOR 10 SECONDS	230°C	DERATING FACTOR	10mW/10°C ABOVE 25°C
		AVERAGE RECTIFIED CURRENT	50mA (Typ.)

SEE PAGE 25 FOR CASE DRAWINGS

GERMANIUM DIODES

MEDIUM VOLTAGE GERMANIUM DIODES — CASE 35

TYPE (@ 25°C)	MIN. PIV (Volt)	MINIMUM FORWARD CURRENT (mA) @ +1.0 VOLT	MAXIMUM REVERSE CURRENT IR @ VR (µa)	(V)	IR @ VR @ TEMP. (µa)	(V)	(°C)
1N34A	75	5.0	30	10	500	50	
1N48	85	4.0	833	50			
1N51	50	4.0	1677	50			
1N54	85	4.0	150	50			
1N54A	75	5.0	7	10	100	50	
1N56A	50	15	300	30			
1N66	60	5.0	50	10	800	50	
1N69	75	5.0	850	50	50	10	
1N69A	75	5.0	500	50	30	10	
1N90	75	5.0	800	50			
1N95	75	10	800	50			
1N96	75	20	800	50			
1N96A	75	40	500	50			
1N108	65	50	200	50			
1N116	75	5.0	100	50			
1N117	75	10	100	50			
1N118	75	20	100	50			
1N118A	75	40	100	50			
1N126	75	5.0	50	10	850	50	
1N128	50	3.0	10	10			
1N281	75	100	30	10	500	50	
1N287	60	20	1500	50			
1N288	85	40	350	50			
1N289	85	20	50	50			
1N292	75	100	200	50			
1N294	70	5.0	10	10	800	50	
1N294A	70	5.0	10	10	800	50	
1N295	50	—	200	10			
1N298A	85	30mA @ 2.0 Volts			250	40	50
1N498	60	100	25	40			
1N499	75	100	30	50			
1N500	80	100	40	60			
1N632	90	7.0	20	10	120	60	
1N636	60	2.5	10	10			
1N772	80	100	50	50	500	80	
1N772A	80	200	50	50	500	80	
1N773	75	100	10	10	100	50	
					500	75	
1N773A	75	200	10	10	100	50	
					500	75	
1N774	70	100	15	10	150	50	
					500	70	
1N774A	70	200	15	10	150	50	
					500	70	
1N775	70	100	20	10	250	50	
					500	70	
1N909	60	10mA 0.35-0.37	10	10			
1N3465	60	200	20	45			
1N3753	55	150	5	10			
1N3769	90	25mA @ 0.5 Volts	5	5	20	65	
DR128	60	40	100	50			
DR207	75	20	50	50			
DR213	75	100	20	50	2	10	
DR283	75	100					
DR291	60	50	100	25			
DR295	60	1mA @ 0.35 Volts	4	2	50	50	
DR302	80	400	100	50			
DR303	60	400	50	50			
DR307	60	200	50	20			
DR308	80	200	10	10	50	50	
DR309	80	400	10	10	50	50	
DR313	80	100	2	10	20	50	
DR314	80	100	50	50			
DR317	80	50	50	50			
DR318	60	50	2	10			
DR319	60	50	5	10			
DR323	80	100			200	50	75
DR324	80	100			500	50	75
DR325	60	100	75	10	250	50	
DR326	60	100	250	50			
DR328	80	300	100	50			
DR329	60	300	50	20			
DR330	80	300	10	10	50	50	
DR338	75	40	100	50			
DR351	50	200			1500	30	50
DR352	50	10mA @ 0.35 Volts			300	30	50
DR366	75	50	100	50			
DR385	50	10mA @ 0.37 Volts	10	10			
DR389	60	200	50	50			
DR463	85	300	100	10	500	50	

HIGH VOLTAGE GERMANIUM DIODES — CASE 35

TYPE (@ 25°C)	MIN. PIV (Volt)	MINIMUM FORWARD CURRENT (mA) @ +1.0 VOLT	MAXIMUM REVERSE CURRENT IR @ VR (µa)	(V)	IR @ VR @ TEMP. (µa)	(V)	(°C)
1N34	100	8.5	15	10	800	50	
1N38	120	4.0	6	3	500	100	
1N38A	120	4.0	6	3	500	100	
1N55	170	3.0	300	100	800	150	
1N55A	170	4.0	500	150			
1N55B	190	5.0	500	150			
1N57	100	3.6	300	75			
1N58	115	5.0	800	100			
1N58A	120	4.0	600	100			
1N61	140	5.0	300	100	700	125	
1N62	120	5.0					
1N63	125	4.0	50	50			
1N67	100	4.0	5	5	50	50	
1N67A	100	4.0	5	5	50	50	
1N68	120	3.0	625	100			
1N68A	130	3.0	625	100			
1N70	100	3.0	25	10	300	50	
1N88	110	2.5	100	50			
1N89	100	3.5	8	5	100	50	
1N97	100	10	8	5	100	50	
1N98	100	20	8	5	100	50	
1N98A	100	40	8	5	100	50	
1N99	100	10	5	5	50	50	
1N100	100	20	5	5	50	50	
1N100A	100	40	5	5	50	50	
1N102	125	15	3	25			
1N127	125	3.0	25	10	300	50	
1N198	100	4.0	10	10	250	50	75
			50	50			
1N270	100	200	100	50			
1N277	120	100	75	10, 75°C			
1N290	120	5.0	100	100			
1N291	120	40	100	100			
1N297	100	3.5	10	5	100	50	
1N310	130	40	20	20	100	100	
1N313	125	40	10	20			
1N501	100	100	40	80			
1N502	120	100	50	100			
1N633	120	125	40	20	180	90	
1N634	115	50	45	45	100	100	
1N771	100	100	25	50	500	100	
1N771A	100	200	25	50	500	100	
1N771B	100	400	25	50	500	100	
DR209	125	40	100	100			
DR272	150	400	20	100			
DR292	120	4.0	200	100			
DR301	100	400	100	50			
DR304	190	200	500	150			
DR305	100	200	100	50			
DR306	100	200	100	50			
DR310	120	100	50	100			
DR311	120	100	100	100			
DR312	100	100	5	10	20	100	
DR315	120	50	50	100			
DR316	100	50	100	100			
DR321	100	200			125	50	75
DR327	100	300	100	50			
DR336	120	4.0	8	5	100	50	
DR337	100	40	5	5	50	50	
DR379	150	200			50	20	50

LOW VOLTAGE GERMANIUM DIODES — CASE 35

TYPE (@ 25°C)	MIN. PIV (Volt)	MINIMUM FORWARD CURRENT (mA) @ +1.0 VOLT	MAXIMUM REVERSE CURRENT IR @ VR (µa)	(V)	IR @ VR @ TEMP. (µa)	(V)	(°C)
1N56	40	15	300	30			
1N64	20	—	100	10			
1N107	15	150	200	10			
1N279	40	100	200	20			
1N308	10	300	500	8			
1N309	40	100	100	20			
1N497	30	100	20	20			
1N776	30	50	200	10	500	30	
1N910	40	10mA 0.35-0.37	10	10			
1N911	30	10mA 0.34-0.37	10	10			
1N3466	40	200	15	30			
1N4502	20, 55°C	3mA 0.3 Volts	10	6	80	6	55
DR365	20	10mA 0.4 Volts	60	6			
DR427	20	50	500	10			
DR434	30	10mA 0.37 Volts	10	10			
DR435	20	10mA 0.37 Volts	10	10			
DR464	12	50	100	5			

SEE PAGE 25 FOR CASE DRAWINGS

General Instrument maintains complete facilities for design fabrication and testing of virtually any type of solid state assembly . . . and at prices that can save substantial sums for the user who may be faced with a heavy investment to produce these assemblies "in house." You will find examples of GI's capability in the wide range of standard devices shown here.

HIGH VOLTAGE RECTIFIER CARTRIDGES

- **HIGH TEMPERATURE TYPES**

Data Sheet No. RB1163
Type 1N1731A-1N1734A, 1N2382A to 1N2384A
PRV 1.5 kV to 10 kV
I_0 to 350 mA

- **GENERAL PURPOSE TYPES**

Data Sheet No. RB1152
1—Pigtail
2—Ferrule
3—Fuse Clip Mounting
All styles — PRV 1kV to 30 kV
I_0 to 350 mA

- **FAST SWITCHING TYPES**

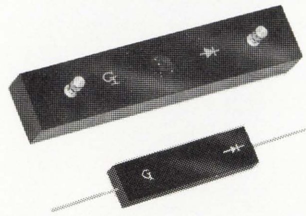
To 50 KC
All Styles
PRV 1kV to 10 kV
I_0 to 300 mA
Consult factory for data sheet.

- **MINIATURE TYPES**

PRV to 10 kV
I_0 to 100 mA
Consult factory for data sheet.

HIGH VOLTAGE RECTIFIER BLOCKS

- **GLASS-AMP HV BLOCKS**



Featuring
Controlled Avalanche Design
PRV 1kV to 18 kV
I_0 to 1.0 Amperes
Data Sheet No. RB1165

SOLID STATE TUBE REPLACEMENTS

1N570/6X4 Tube Replacement

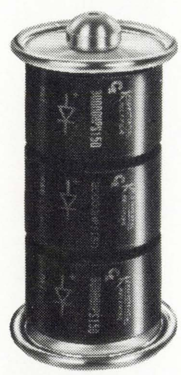
1N1262
4.8 Volt Tube Replacement

PRV 1500 V @ 75 mA FW   PRV 25,000 V @ 500 mA HW
All intermediate types — Data Sheet SPR 3

KILOPOTENTIAL RECTIFIERS

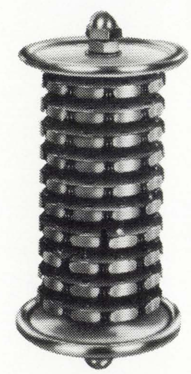
- **R-C COMPENSATED ASSEMBLIES**

Standard Puck Modules



PRV 20 to 200 kV
I_0 to 150 mA
Data Sheet No. RB3002-1
I_0 to 300 mA
Data Sheet No. RB3002-2

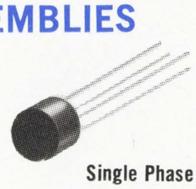
Custom Board Assemblies



PRV 20 to 200 kV oil immersed
I_0 to 1.0 Amperes
Consult Factory for data sheet

GENERAL PURPOSE RECTIFIER ASSEMBLIES

- **1.5 AMP FULL WAVE RECTIFIERS**



Single Phase Bridge

Center Tap & Doubler

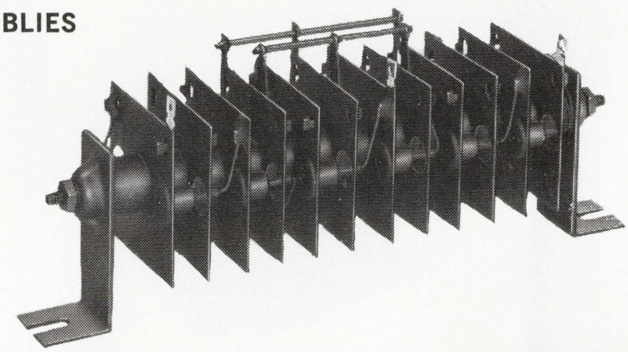
- **3.0 AMP FULL WAVE RECTIFIERS — STUD TYPE**

Center Tap & Doubler

Single Phase Bridge

- **1.5 AMP TO 9.0 AMP OPEN FIN ASSEMBLIES**

All Configurations shown on
Data Sheet No. RB1176

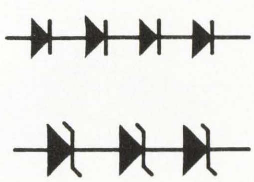


CUSTOM SOLID STATE ASSEMBLIES

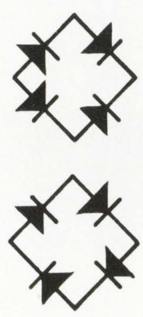
G. I. offers a complete custom packaging facility including:

- Custom molding of shell and welded devices
- Component interconnection by welding and soldering
- Specialized test facilities

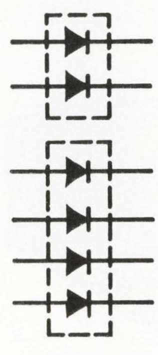
Zener Diodes & Controlled Forward Diodes

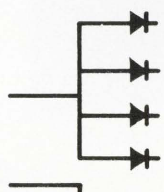


Modulator Bridge & Ring Assemblies

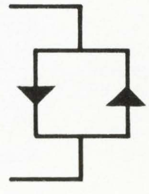


Matched Pair Modules





Logic Gates



Limiters

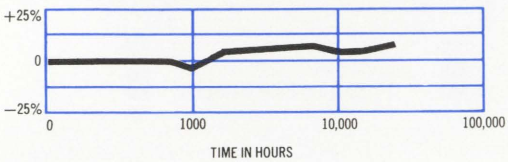
SELENIUM RECTIFIER ASSEMBLIES

TRI-AMP POWER ASSEMBLIES

General Instrument Tri-Amp Selenium Power Rectifier Assemblies are completely unaffected by aging — a unique advantage which brings to the user reliability previously considered unattainable. In addition, they incorporate a true P-N diffused junction and safely withstand large transients.

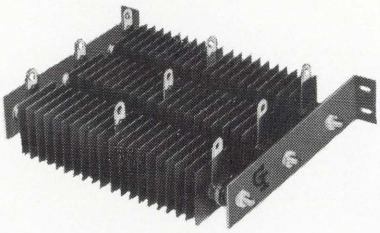
Standard Power Assemblies use cells manufactured with the Tri-Amp process. As shown in the life test curve, Tri-Amp **does not age!**

LIFE CURVE PERCENT CHANGE IN FORWARD VOLTAGE DROP



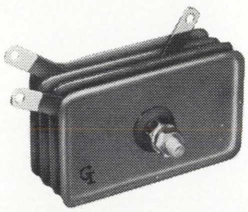
- **A COMPLETE RANGE OF ASSEMBLIES ARE AVAILABLE FOR EVERY APPLICATION**

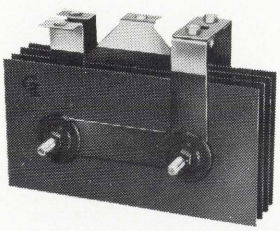
Typical Units:
Three Phase Bridge For Elevator Control Panel. 260 V. AC 3.3 A. DC.



Center Tap Fast Battery Charger using Heat Sink Backing Plate. 26 V. AC 100 A. DC. Fan Cooled.

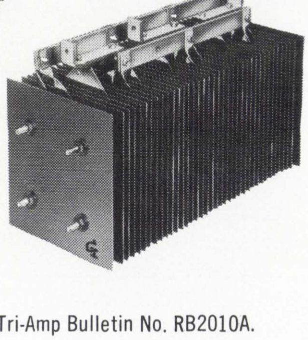
Single Phase Bridge with Special Edge Protection for unusual moisture and vibration conditions. 26 V. AC 10A. DC.





Single Phase Bridge Typical Cathodic Protection Unit. 26 V. AC 24 A. DC.

Three Phase Bridge Welding Stack 78 V. AC 400 A. DC. Fan Cooled.



NOTE:
For detailed information, see Tri-Amp Bulletin No. RB2010A.

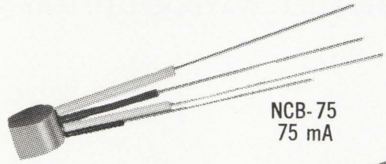
LOW COST MINIATURE BRIDGE ASSEMBLIES

Ideal for use in control equipment, AC-DC motors, and small battery chargers. These miniature assemblies are available in bridge, doubler and center-tap configurations.

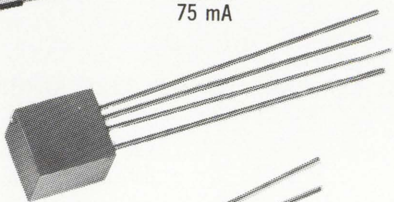
NOTE: All Miniature Bridge Assembly photos are actual size.

- **LOW VOLTAGE**

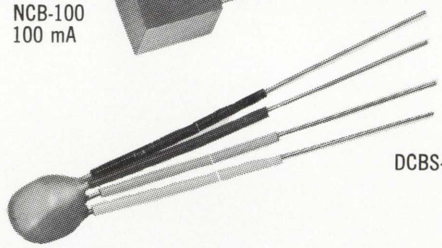
RMS = 26V Max.
PRV = 50V Max.



NCB-75
75 mA



NCB-100
100 mA

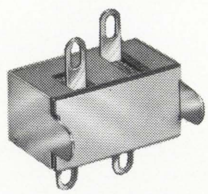


DCBS-100

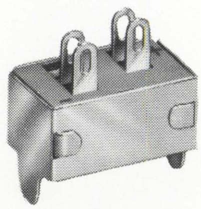
NCB-300
300 mA

See Bulletin No. RB-2019.

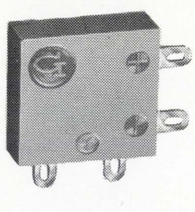
- **LINE VOLTAGE**



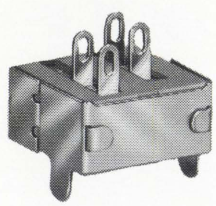
TLB-1
125 mA



TLB-2
125 mA



150 mA



100 mA
RMS = 260V Max.

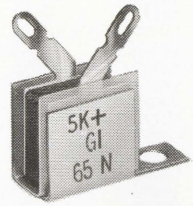
See Bulletin No. RB2015A

ASSEMBLIES FOR RADIO AND TV APPLICATIONS

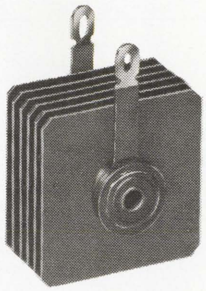
General Instrument Selenium Assemblies have accumulated millions of hours of reliable performance in home entertainment products throughout the world. This "extra" quality is something you get free everytime you specify GI.

• RADIO/PHONO

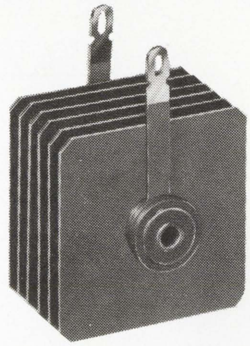
Voltage—380V PRV
130 RMS



GI65N
65 mA DC



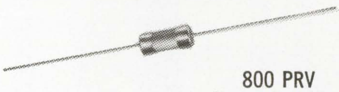
11GA300
300 mA DC



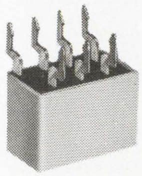
16GA500
500 mA DC

See Bulletin No. RB-2017

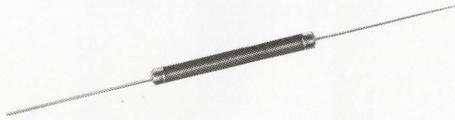
• COLOR TELEVISION



800 PRV
Boost Rectifier



TVC 3
4 Diode
Convergence
Rectifier



6500 PRV
Focus Cartridge

• TRANSISTORIZED TELEVISION

High Voltage Rectifier
to 30,000 PRV

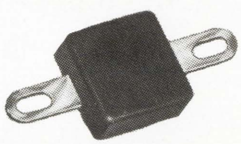
HIGH VOLTAGE INDUSTRIAL CARTRIDGES

PRV 1 through 25 KV
DC Current .4 to 30 mA

See Bulletin No. RB-2002A

LOW COST—LOW VOLTAGE DIODES

An ideal answer to your high volume, mass production requirements where economy as well as dependability are major considerations.

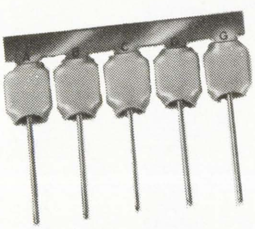


ZIP DIODE

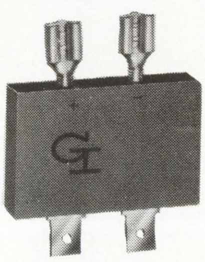
PRV to 50V
DC Current to 150 mA

See Bulletin No. RB-2020

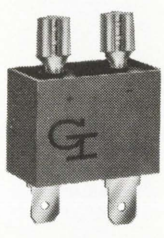
CUSTOM MINIATURE ASSEMBLIES



4 Diodes with 1 Common Electrode
PRV to 50 V DC
Current to 150 mA



ERMS = 26 Max.
Idc = 500 mA



ERMS = 130V Max.
Idc = 125 mA

NUMERICAL INDEX

PRODUCT FAMILY IDENTIFICATION CODES

CS	CAPSIL® Voltage Variable Capacitor Diode	**MD**	Micro Diode	**ST**	Silicon Transistor
GD	Germanium Diode	**MOS**	MOS Microcircuit	**STE**	Epoxy Silicon Transistor
GR	Glass-Amp® Silicon Rectifier	**RB**	Rectifier Bridge (Selenium)	**TR**	Tube Replacement
GT	Germanium Transistor	**SB**	Stabistor	**ZD**	Zener Voltage Regulator Diode
GZ	Glass-Amp® Zener Voltage Regulator Diode	**SD**	Silicon Diode	**K —**	Before product identification code indicates encapsulated assembly or epoxy package.
MC	Microcircuit	**SR**	Silicon Rectifier		

Type No.	Prod. Code	Page No.
1N3043	ZD	12
1N3044	ZD	12
1N3045	ZD	12
1N3046	ZD	12
1N3047	ZD	12
1N3048	ZD	12
1N3049	ZD	12
1N3050	ZD	12
1N3051	ZD	12
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1N3190	SR	7
1N3191	SR	7
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1N3465	GD	17
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1N3468	GD	16
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MEM3021	MOS	4
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NC10	MC	5
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PA340	SR	7
PA350	SR	7
PA380	SR	7
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PC10	MC	5
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PC12	MC	5
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PC14	MC	5
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S91H	SR	6
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S92H	SR	6
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LOS ANGELES—Kierulff Electronics, Inc., (213) 685-5511
SAN DIEGO—Milo of California, Inc., (714) BE 2-8951

COLORADO—DENVER
Industrial Electronic Sales Co., (303) 757-1261

FLORIDA
MELBOURNE—Electronic Wholesalers, Inc., (305) PA 3-1441
MIAMI—Electronic Wholesalers, Inc., (305) OX 6-1620

GEORGIA—ATLANTA
Southeastern Radio Parts Co., (401) JA 4-7536

ILLINOIS—CHICAGO AREA
CHICAGO—Newark Electronics Corp., (312) ST 2-2944
FRANKLIN PARK—Avnet Corp., (312) 678-8160
SCHILLER PARK—Pace Electronic Supplies Inc., (312) 678-6310

INDIANA—INDIANAPOLIS
Graham Electronic Supply, Inc., (317) ME 4-8486

IOWA—CEDAR RAPIDS
Deeco, Inc., (319) EM 5-7551

LOUISIANA—BATON ROUGE
Southern Radio Supply Co., (504) 355-0396

MARYLAND-WASHINGTON, D.C.
BALTIMORE—Electronic Wholesalers, Inc. (301) 945-3400
Radio Electric Service Co. of Baltimore, Inc. (301) LA 9-3835
BETHESDA—Empire Electronics Supply Co., (301) OL 6-3300
HYATTSVILLE—Milgray Washington, Inc., (301) UN 4-6330
WASHINGTON, D.C.—Electronic Wholesalers, Inc., (202) 483-5200

MASSACHUSETTS
BURLINGTON—Avnet Corp., (617) 272-3060
CAMBRIDGE—R & D Electronics Supply Co., Inc., (617) UN 8-6644
NEWTON—The Greene-Shaw Co., (617) WO 9-8900

MICHIGAN—KALAMAZOO
Electronic Supply Corp., (616) WO 5-1241

MISSOURI
KANSAS CITY—Walters Radio Supply Co., Inc., (816) 531-7015
UNIVERSITY CITY—Olive Industrial Electronics, Inc., (314) VO 3-7800

NEW JERSEY—CAMDEN
General Radio Supply, (609) 964-8560

NEW MEXICO—ALBUQUERQUE
Electronic Parts Co., Inc., Albuquerque (505) 265-8401

NEW YORK (METROPOLITAN AREA)
YONKERS—Delburn Electronics, (914) 423-2800
NEW YORK—Milgray Electronics, Inc., (212) YU 9-1600
Terminal Hudson Electronics, Inc., (212) CH 3-5200

NEW YORK STATE
BINGHAMTON—Stack Industrial Electronics, (607) RA 3-6326

NEW YORK STATE—(Continued)
BUFFALO—Summit Distributors, (716) TT 4-3450

NORTH CAROLINA—WINSTON SALEM
Electronic Wholesalers, Inc., (919) 725-8711

OHIO—CINCINNATI
Newark-Herrlinger Electronics Corp., (513) 421-5282

OKLAHOMA—TULSA
Radio, Inc., (918) LU 7-9124

PENNSYLVANIA
PHILADELPHIA—Herbach & Rademan, Inc., (215) LO 7-4309
Milgray Delaware Valley, Inc., (215) WA 3-2210

TENNESSEE
KNOXVILLE—McClung Appliances, (615) 524-1811
NASHVILLE—Electra Distributing Co., (615) AL 5-8444

TEXAS
ARLINGTON—Beta Electronics, Inc., (214) TA 1-1120
DALLAS—Contact Electronics, Inc., (214) ME 1-9530
Solid State Electronics, (214) 352-2601
EL PASO—McNicol, Inc., (915) 566-2936
FT. WORTH—Scooters Radio Supply Co., (817) ED 6-7448
HOUSTON—Busacker Electronic Equipment Co., (713) JA 6-4661

UTAH—SALT LAKE CITY
Kimball Electronics, Inc., (810) 328-2075

VIRGINIA
CHARLOTTESVILLE—Virginia Radio Supply Co., Inc., (703) 296-4184
NORFOLK—Priest Electronics, Inc., (703) 855-0141

WASHINGTON-OREGON—SEATTLE
Seattle Radio Supply, Inc., (206) MA 4-2341

WISCONSIN—MILWAUKEE
Electronic Expeditors, Inc., (414) UP 1-3000

SALES OFFICES

EASTERN AREA

AREA HEADQUARTERS
General Instrument Corporation
235 Passaic St., Newark, N.J. 07104
Tel.: (201) 485-0072; TWX: 201-621-8041

General Instrument Corporation
2021 Clinton Ave., W., Huntsville, Ala. 35805
Tel.: (205) 536-9671

General Instrument Corporation
608 Ferry Blvd., Stratford, Conn. 06497
Tel.: (203) 378-2992

General Instrument Corporation
2435 Virginia Ave., N.W.,
Washington, D.C. 20037
Tel.: (202) 965-3712; TWX: 202-965-0474

General Corporation
1520 Edgewater Drive, Orlando, Fla.
Tel.: (305) 241-3384; TWX: 305-275-0424

General Instrument Corporation
Southwest Park, Westwood, Mass. 02181
Tel.: (617) 329-1480; TWX: 617-326-9332

Harries-Kershaw
15 Canterbury Lane, East Aurora, N.Y. 14052
Tel.: (716) 652-1221

Henry Reid Associates, Inc.
530 Main Street, Fort Lee, New Jersey
Tel.: (201) 944-9323

C. H. Newson Assoc., Inc.
627 Bethlehem Pike, Philadelphia, Pa. 19118
Tel.: (215) 248-3377

CENTRAL AREA

AREA HEADQUARTERS
General Instrument Corporation
6054 W. Touhy Ave., Chicago, Illinois 60648
Tel.: (312) 774-7800; TWX: 312-265-1424

Jerry Vrbik Co.
2818 "A" Ave., N.E., Cedar Rapids, Iowa 52402
Tel.: (319) 365-0461; TWX: 319-552-7118

G & H Sales
16815 James Couzens Highway,
Detroit, Michigan 48235
Tel.: (313) 342-4747

Hamilton, Graydon, Flemmer Inc.
Hamilton Rd., Hopkins, Minn.
Tel.: (612) 941-1120; TWX: 612-292-4013

Hyde Electronics Co.
5206 Constitution Ave., N.E.,
Albuquerque, New Mexico
Tel.: (505) 265-8895

G & H Sales
P.O. Box 37416, Cincinnati, Ohio 45237
Tel.: (513) 761-6185; TWX: 513-577-1239

G & H Sales
P.O. Box 7013, Cranwood Station,
Cleveland 28, Ohio
Tel.: (212) 621-3242

G & H Sales
137 Lakeview Ave., Dayton 59, Ohio
Tel.: (513) 885-3181

Ammon & Champion
5545 East Skelly Drive/Suite #5,
Tulsa, Oklahoma 74114
Tel.: (918) 627-7670; TWX: 918-627-6033

Ammon & Champion
P.O. Box 35263, Blanton Tower 628,
Dallas, Texas 75235
Tel.: (214) 357-8441; TWX: 214-899-8306

Ammon & Champion
115-14 Burdine, Houston, Texas 77035
Tel.: (713) 729-1233; TWX: 713-571-3133

WESTERN AREA

AREA HEADQUARTERS
General Instrument Corporation
6108 W. Venice Blvd., Los Angeles, Calif. 90034
Tel.: (213) 933-7261; TWX: 213-937-2187

General Instrument Corporation
647 Veterans Blvd., Redwood City, Calif. 94063
Tel.: (415) 365-1920 Suite No. 1

Vistronics
5957 Fairmont Ext., San Diego 20, Calif.
Tel.: (714) 283-3946

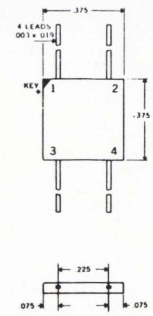
Electronic Component Sales Inc.
2340 W. Main St., Littleton, Colo. 80120
Tel.: (303) 798-8481; TWX: 303-798-8114

Bill Waddell Co.
10211 N.E. 31st Place, Bellevue, Wash.
Tel.: (206) 822-9629; TWX: 206-999-1875

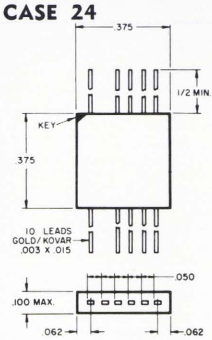
GENERAL INSTRUMENT CORPORATION
SEMICONDUCTOR PRODUCTS GROUP

Cat. No. GIC-1000

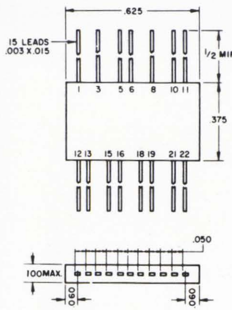
CASE DRAWINGS

CASE 23


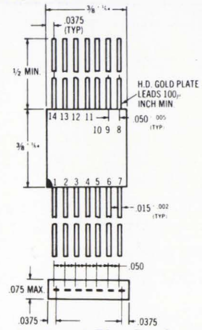
4-Lead Flat Pack

CASE 24


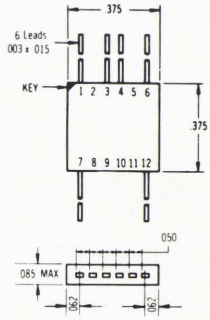
10-Lead Flat Pack*

CASE 25


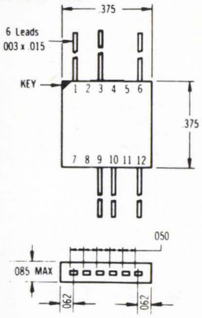
15-Lead Flat Pack

CASE 26


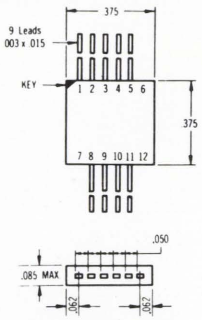
14-Lead Flat Pack

CASE 27


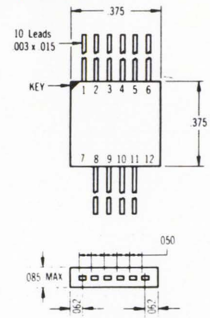
6-Lead Flat Pack

CASE 28


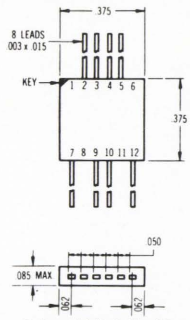
6-Lead Flat Pack

CASE 29


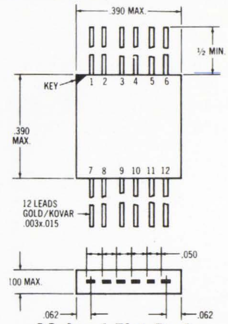
9-Lead Flat Pack

CASE 30


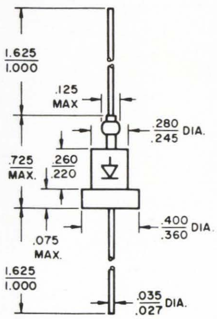
10-Lead Flat Pack

CASE 31


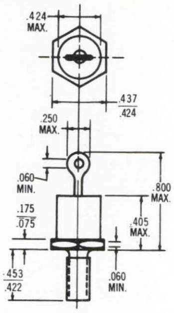
8-Lead Flat Pack

CASE 32


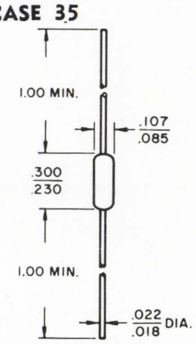
12-Lead Flat Pack

CASE 33


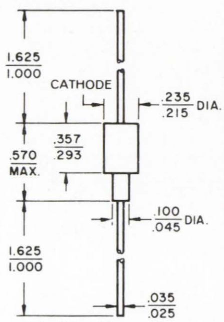
DO-1

CASE 34


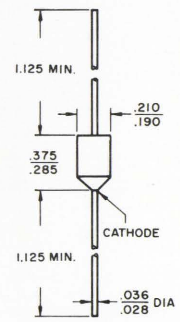
DO-4

CASE 35


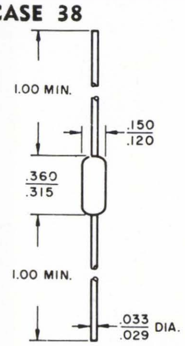
DO-7 (Glass)

CASE 36


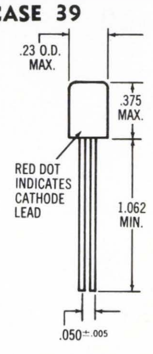
DO-13 (Flangeless)

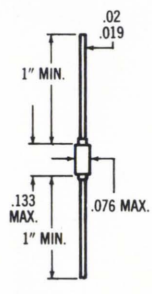
CASE 37


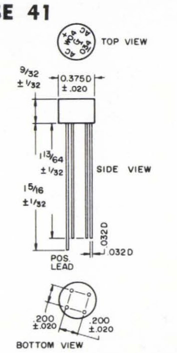
DO-27

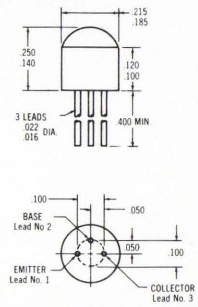
CASE 38


DO-29 (Glass-Amp)

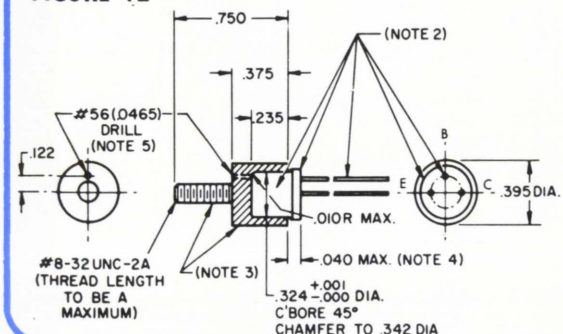
CASE 39


CASE 40


CASE 41


CASE 42


TO-18
(Epoxy Encapsulated)

FIGURE 12


NOTES:

1. All dimensions in inches, unless otherwise specified.
2. Constructional details for this transistor insert (shall be JEDEC TO-5).
3. Stud heat-sink material: aluminum screw machine stock.
4. The specified dimension applies to the maximum permissible protrusion of the transistor (face plane) from the heat-sink inclosure.
5. Orientation of exhaust hole is not restricted relative to positioning of transistor insert within the stud heat-sink.

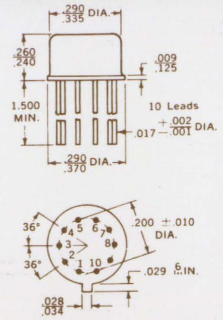
OUTLINE DIMENSIONS

All dimensions are in inches. See respective data sheet for complete outline dimensions and specifications of industrial types.

OUTLINE DIMENSIONS

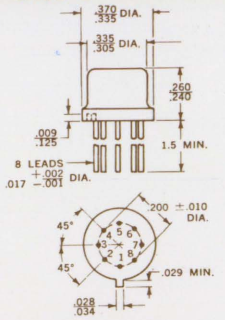
All dimensions are in inches. See respective data sheet for complete outline dimensions and specifications of industrial types.

CASE 1



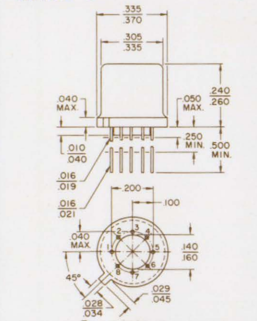
10-Lead TO-5 Package

CASE 2



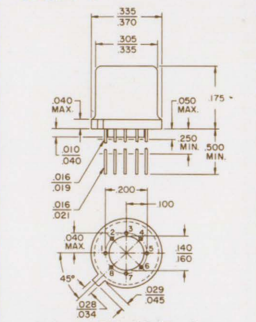
8-Lead TO-5 Package

CASE 3



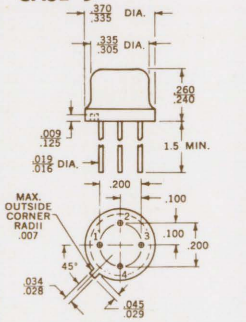
8-Lead TO-76 Package

CASE 4



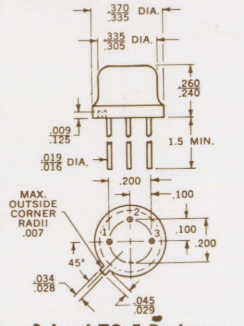
8-Lead TO-99 Package

CASE 5



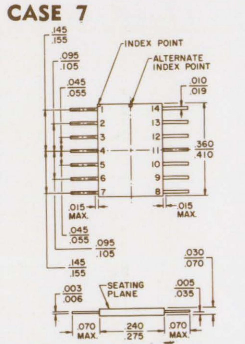
4-Lead TO-5 Package

CASE 6



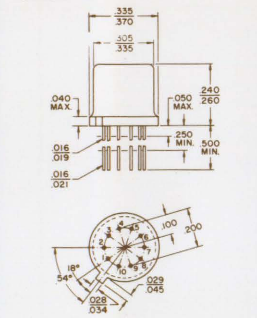
3-Lead TO-5 Package

CASE 7



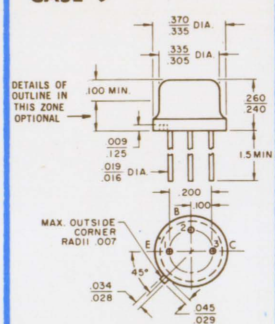
14-Lead TO-87 Flat Pack

CASE 8



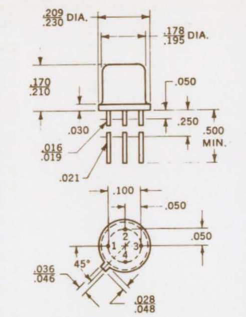
10-Lead TO-74 Package

CASE 9



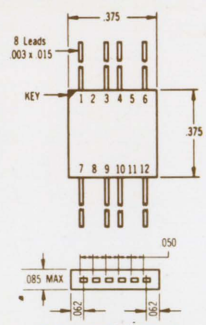
3-Lead TO-18 Package

CASE 10



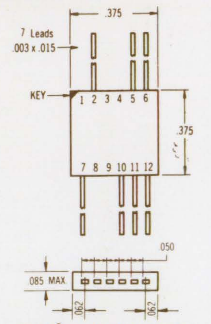
4-Lead TO-72 Package

CASE 11



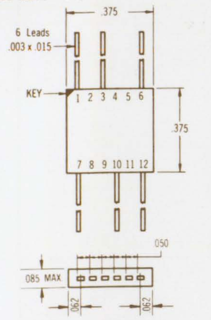
8-Lead Flat Pack

CASE 12



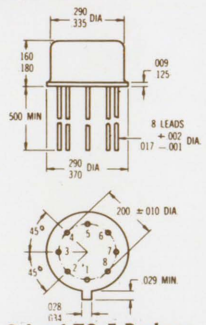
7-Lead Flat Pack

CASE 13



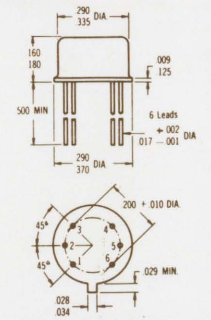
6-Lead Flat Pack

CASE 14



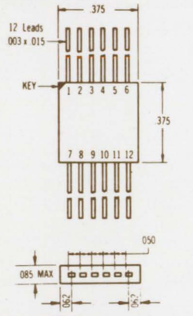
8-Lead TO-5 Package

CASE 15



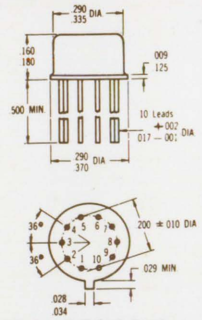
6-Lead TO-5 Package

CASE 16



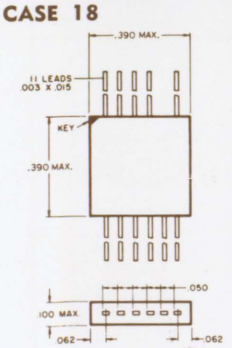
12-Lead Flat Pack

CASE 17



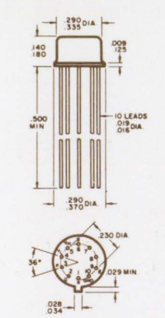
10-Lead TO-5 Package

CASE 18



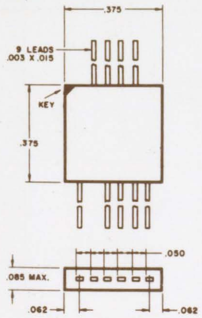
11-Lead Flat Pack

CASE 19



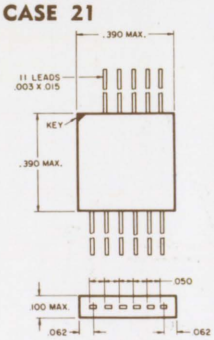
10-Lead TO-5 Package

CASE 20



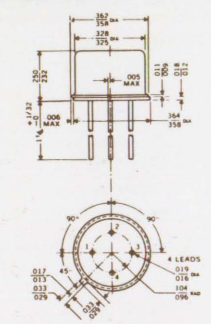
9-Lead Flat Pack

CASE 21



11-Lead Flat Pack

CASE 22



4-Lead TO-5 Package

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ †I_{CEX} (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 78	2N3728	FA	npn,DPE,si	400	1.6 W	200	9.15	30	500	*30-280	.010	–	–	
	2N3729	FA	npn,DPE,si	400	1.6 W	200	9.15	30	500	*30-280	.010	–	–	
	2N3733	RCA	npn,si	400	23W	200	130	–	3A	–	*250	*20	60	Vces=40; overlay type
	40281	RCA	npn,si	*400	11.6W	200	660	18	1a	–	*100	*22	60	† Iceo
	40307	RCA	npn,si	*400	23W	200	131	40	3A	*10 (min)	*0.25	*20	60	Overlay type
	A466	AMP	npn,. L,si	*400	150	175	1.0	*40	25	*60	.001	–	72	Cre=.015 pf
	MM1945	MO	npn,E,si	*400	800	175	5.33	*40	500	*25	0.5	*5	18	
	MPS2894	MO	pnp,EP,si	*400	1000	125	10	12	–	*40-150	.08	*6	92	
	2N834	MO	npn,EP,DD,si	*450	500	175	2	*40	200	5	.01	*2.8	18	SY, TR, GI, FA, NA, SPR, ITT
	2N982	SPR	pnp,MD,ge	*450	60	100	0.8	*20	100	*100	1	*1.9	18	
HF 79	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	
	TI407	TI	npn,PL,si	*450	200	125	2	12	30	*20	0.5	2.2	–	Plast, IEC, GME
	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	.3	*4	18	TI, RCA
	2N962	MO	pnp,EM,ge	*460	300	100	4	*12	–	*40	–	.3	18	SY, TI, RCA
	2N964	MO	pnp,EM,ge	*460	300	100	4	*15	–	*70	.3	*4	18	SY, TI, RCA
	2N964A	MO	pnp,EM,ge	*460	300	100	4	*15	–	*80	.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	
	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
	2N2883	FA	npn,PE,si	*500	1750	200	10	200	300	*30	0.1	*1.0	5	
HF 81	2N2884	FA	npn,PE,si	*500	1750	200	10	20	300	*30	0.1	*1.0	5	
	2N3227	SPR	npn,PE,si	*500	1200	200	6.85	*40	500	*30	0.2	*4	18	
	2N3375	RCA	npn,si	*500	11.6W	200	660	40	1.5A	–	100	*10	60	RCA "Overlay" emitter type, MO, VEC
	2N3553	RCA	npn,si	*500	7W	200	1.14	40	1	–	100	*10	39	RCA "Overlay" emitter type, MO, VEC
	2N3924	MO	npn,A*,si	*500	7000	200	40	18	500	5	100	*12.5	39	*Annular
	2N3925	MO	npn,A*,si	*500	10000	200	57.1	18	1000	5	100	*12.5	102	*Annular
	2N3926	MO	npn,A*,si	*500	11600	200	66.3	18	1500	5	100	*12.5	60	*Annular
	2N3927	MO	npn,A*,si	*500	23200	200	132.5	18	3000	5	250	*25	60	*Annular
HF 82	2N3961	MO	npn,si	*500	10000	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
	40290	RCA	npn,si	*500	7W	200	40	–	0.5A	–	*100	*17	39	Vces=90; overlay type
	40291	RCA	npn,si	*500	11.6W	200	66	–	0.5A	–	*100	*17	60	Vces=90; overlay type
	40305	RCA	npn,si	*500	7W	200	40	40	1000	*10 (min)	*0.1	*10	39	Overlay type
	MPS3639	MO	pnp,EP,si	*500	500	125	5	6	80	*30-120	–	*3.5	92	Ices=.01
	MPS3640	MO	pnp,EP,si	*500	500	125	5	12	80	*30-120	–	*3.5	92	Ices=.01
	40306	RCA	npn,si	*500	11.6W	200	66	40	1.5A	*10 (min)	*0.1	*10	60	Overlay type
	A1243	AMP	pnp,MS,ge	*500	50	75	.9	20	7	*10	8	–	18	
	AF139	SA	pnp,MS,ge	*500	60	90	2.5	15	10	*50	0.7	–	18	uhf-stages
HF 83	AFY39	SA	pnp,MS,ge	500	225	90	5.0	*32	30	85	0.4	–	18 lg	vhf antennas
	MM1943	MO	npn,E,si	*500	600	175	4.0	*40	200	*25	0.1	*4	18	
	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
	2N2368	FA	npn,PE,si	*550	1200	200	6.85	15	500	*40	0.1	*2.5	18	SPR, MO
	2N3013	FA	npn,PE,si	*550	1.2W	200	6.85	15	–	*60	–	*5	52	
	2N3014	FA	npn,PE,si	*550	1.2W	200	6.85	20	–	*60	–	*5	52	
	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	
	40280	RCA	npn,si	*550	7W	200	1.14	18	500	–	*100	*15	39	
HF 84	A472	AMP	npn,si	*550	230	175	1.54	*40	25	*150	.001	–	72	Cre=.023 pf.
	A473	AMP	npn,si	*550	230	175	1.54	*40	25	*150	.001	–	72	Cre=.023 pt.
	2N709/46	SY	npn,si	600	400	200	–	*15	–	*20-120	.005	*3.0	46	TR
	2N709/51	SY	npn,si	600	300	200	–	*15	–	*20-120	.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
	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
	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	

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 85	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
	2N3424	FA	npn,PE,si	*600	1.2W	200	3.44	15	50	*20-200	0.010	1.7	–	AL
	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	.05	*2.0	72	
	2N3995	TI	pnp,ge	*600	300	140	4	*20	100	150-450	3	*4	39	
	AF139	AMP	pnp,MS,ge	*600	50	75	.9	*20	7.0	*10	12	–	18	
	MM1941	MO	npn,E,si	*600	600	175	4.0	*30	200	*25	0.1	*0.5	18	
	MPS918	MO	npn,EP,si	*600	500	125	5	15	–	*20	.01	*1.7	92	
HF 86	MPS3563	MO	npn,EP,si	*600	500	125	5	12	–	*20-200	.05	*1.7	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
	2N3303	FA	npn,PE,si	650	3W	200	17	12	1A	*60	100	*6.0	–	MO
	D16K1	GE	npn,PL,si	650	200	100	2.67	30	25	*110	0.5	*1.4	98	For AGC @ 45 MHz
	D16K2	GE	npn,PL,si	650	200	100	2.67	30	25	*110	0.5	*1.4	98	For AGC @ 45 MHz
	D16K3	GE	npn,PE,si	*650	200	100	2.67	30	25	*110	0.5	*1.4	98	For AGC @ 200 MHz
	2N2369A	FA	npn, PE,si	*675	1.2W	200	6.85	15	200	*65	0.05	*23	18	SPR
	2N2708	RCA	npn,EP,si	*700	200	200	–	35	–	180	0.01	1.5	–	AL
HF 87	2N2962	SPR	pnp,ED,ge	*700	3000	100	40	*40	300	–	1.5	7	37	PG=6db @ 160MHz
	2N2963	SPR	pnp,ED,ge	*700	3000	100	40	*40	300	–	1.5	7	37	PG=5db @ 160MHz
	2N3784	MO	pnp,EM,ge	*700	150	100	2	20	20	*20-200	5	*1	72	
	2N3785	MO	pnp,EM,ge	*700	150	100	2	12	20	*15-200	5	*1	72	
	2N2964	SPR	pnp,ED,ge	*700	3000	100	40	*30	300	–	1.5	*7	37	PG=6db @ 160MHz
	2N2965	SPR	pnp,ED,ge	*700	3000	100	40	*30	300	–	1.5	*7	37	PG=5db @ 160MHz
	2N3304	FA	pnp,PE,si	*700	500	200	2.0	6.0	–	*63	0.010	*1.9	18	
	40404	RCA	npn,EP,si	*700	300	175	2	*40	500	*25-65	.025 (max)	4 (max)		
	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, GME
HF 88	S15657	FA	npn,DPE,si	750	200	125	5	15	–	–	–	*2.5	–	R0110 package
	S15658	FA	npn,DPE,si	750	600	125	6	15	–	*70	.050	–	–	R0110 package
	SI5659	FA	npn,DPE,si	750	1.0 W	200	5.71	20	–	*70	.050	–	5	
	2N709	FA	npn,PE,si	*800	0.5W	200	5	6.0	–	*55	0.005	*2.5	18	SY, AL, TI, RCA, VEC
	2N709A	FA	npn,PE,si	*800	500	200	5	6.0	–	*60	0.005	*2.5	18	SY, TR, VEC
	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	.005	*3.0	51	
	2N917	FA	npn,DP,si	*800	300	200	1.71	15	–	50	0.0005	*1.5	18	AL, TI, TRWS
	2N3866	MO	npn,si	*800	5000	200	28.5	30	400	–	20	*3	39	RCA
	2N3783	MO	pnp,EM,ge	*800	150	100	2	20	20	*20-200	5	*1	72	
HF 89	A1220	AMP	pnpPADT,ge	*820	90	90	–	25	15	*20	.6	*1.4	–	Low Noise type
	2N2966	PH	–	*850	60	100	.5	20	100	*15	1	1	18	UHF amplifier
	2N3600	RCA	npn,PE,si	*850	300	–	–	*30	–	*20	0.01	1.7	–	
	40405	RCA	npn,EP,si	*850	300	175	2	*40	500	*20 (min)	–	3.5 (max)	–	
	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
	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
	2N2729	FA	npn,PE,si	*900	0.8W	200	4.56	15	50	*50	0.0001	*2.4	46	AL
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, GME
	2N3662	GE	npn,PEP,si	*900	200	100	2.67	*18	25	*75	0.5	1.2	98	
	2N3663	GE	npn,PEP,si	*900	200	100	2.67	*30	100	*75	0.5	1.2	98	
	40238	RCA	npn,PL,si	*900	180	175	1.2	*35	50	40-170	0.02 (max)	–	–	
	40239	RCA	npn,PL,si	*900	180	175	1.2	*35	50	27-100	0.02 (max)	–	–	
	40240	RCA	npn,PL,si	*900	180	175	1.2	*35	50	27-275	0.02 (max)	–	–	
	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	
	2N2482	RCA	npn,DM,si	*1000	150	100	–	*20	100	25-200	5	*4.5	18	
HF 91	2N2784	SY	npn,si	1000	300	200	–	15	–	40-120	.005	3.0	†	† TO-18, 46, 51, VEC
	2N2808	RA	npn,si	*1000	200	300	1.15	10	25	*20	.01	*0.7	18	4 Leads
	2N2809	RA	npn,si	*1000	200	300	1.15	15	25	*20	.01	*0.7	18	4 Leads
	2N2810	RA	npn,si	*1000	200	300	1.15	10	25	*20	.01	*0.7	18	4 Leads
	2N2857	RCA	npn,PE,si	*1000	300	200	–	*30	20	*30-150	0.01	1.3	–	
	2N3572	TI	npn, PL, si	*1000	200	200	1.14	13	50	20-300	0.01	0.85	–	4 lead sim to TO 18
	A490	AMP	npn,si	1000	200	200	1.12	*30	20	*70	.010	1.8	72	
	MM2503	MO	pnp,EP,ge	1000	75	100	1.0	15	20	*20	10	*2	72	
	MM2550	MO	pnp,EP,DJ,ge	*1000	300	100	4	10	100	*20	10	*3	18	
	MM2552	MO	pnp,EP,DJ,ge	*1000	600	100	8	10	100	*30	10	*3	5	

(see pages 4-9 for explanation of company abbreviations.)

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Solid State Time Delay Relays for as little as $17.50

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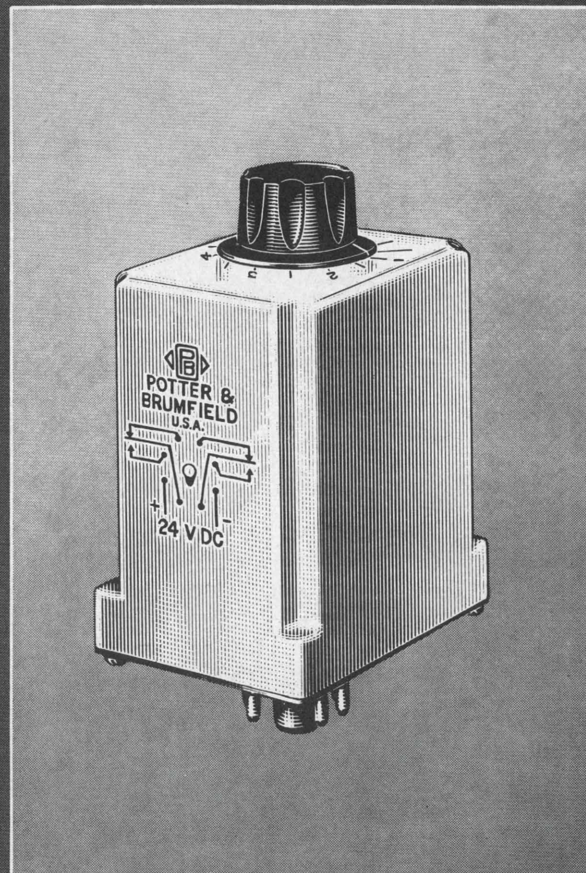

why pay for operating characteristics you don't need?

Here is a practical cost-saving answer to many timing applications which do not require the extreme precision of much more expensive relays. CH Series solid state time delay relays are quality-built to perform dependably in most industrial applications. Where more critical perameters are required, we recommend our CD Series.

SAVE UP TO 60%—You can save up to 60% of your time delay relay costs with our new CH Series. Adjustable or fixed models are available with delays on operate or release as well as "interval on".

ACCURACY ±10%—Accuracy is ±10% over the -10° to 55°C temperature range for adjustable time delays. Fixed delays have an accuracy of ±5% at 25°C ambient temperature. Reset time is 100 milliseconds.

INTERNAL RELAY RATED 10 AMPERES—An internally-mounted DPDT relay is rated at 10 amperes, 115 VAC, resistive. Both AC and DC models are available and all come in a white nylon case with octal plug. CH relays for DC operation have an internal protection against damage by reversal of input polarity. Relays will not operate falsely nor be damaged by a transient input voltage having a magnitude up to twice rated input voltage and a duration of eight milliseconds.

Write for the complete catalog of P&B Time Delay Relays. You can get CH Series relays from your local electronic parts distributor.

SPECIFICATIONS

CH and CD Series Comparison

	CH SERIES	CD SERIES
Dial Setting	Reference scale	Time-calibrated ±5% of full scale
Temperature Range	−10°C to +55°C	−40°C to +55°C
Accuracy Over Temperature and Voltage Range	±10% of nominal	±5% of nominal
Transient Protection	Twice rated input voltage for 8 milliseconds	Tested to 1000V—½ cycle surges (on all 115V AC models)
Inherent False Operation	Contacts may transfer momentarily if timing interval is interrupted	None
Reset Time	100 milliseconds	60 milliseconds
Repeatability	±2%	±1%
Polarity Reversal Protection (on DC)	Yes	Yes

POTTER & BRUMFIELD

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ON READER-SERVICE CARD CIRCLE 17

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (μA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 92	MM2554	MO	pnp,EP,DJ,ge	*1000	600	100	8	10	100	*30	10	*3	5	
	2N2929	MO	pnp,EM,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	.01	*0.7	18	4 Leads
	2N2809A	RA	npn,si	*1200	200	300	1.15	15	25	*20	.01	*0.7	18	4 Leads
	2N2810A	RA	npn,si	*1200	200	300	1.15	10	25	*20	.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
	2N3880	KMC	–	*1200	200	200	1.74	*30	30	*150	.01	*1.8	72	
	40235	RCA	npn,PL,si	*1200	180	175	1.2	*35	50	40-170	0.02 (max)	–	–	
	40236	RCA	npn,PL,si	*1200	180	175	1.2	*35	50	40-275	0.02 (max)	–	–	
	40237	RCA	npn,PL,si	*1200	180	175	1.2	*35	50	27-275	0.02 (max)	0.6 (max)	–	
HF 93	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	†.005	*2.5	18	
	2N2999	TI	pnp,ge	*1400	75	100	1	*15	20	15	5	1.7	72	
	TIXM104	TI	pnp,PL,ge	*1400	40	125	1	*12	20	10-250	6	–	–	
	2N3570	TI	npn , PL, si	*1500	200	200	1. 14	15	50	20-150	0. 01	0. 75	–	4-lead sim to To 18
	TIX3024	TI	pnp,PL,ge	*1500	75	100	1	*15	50	30-300	7	*3	–	
	TIXM101	TI	pnp,PL,ge	*1500	75	100	1	*15	50	30-300	7	*3	72	
	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	–	
HF 94	2N3960	MO	npn,si	*1600	750	200	4.3	12	30	*40-200	†.005	*2.5	18	
	2N4260	MO	pnp,AE,si	*1600	200	200	1.14	15	30	*30-150	†.005	*2.5	72	
	TIXM103	TI	pnp,PL,ge	*1800	40	125	1	*12	20	10-250	6	–	–	
	2N4261	MO	pnp,AE,si	*2000	200	200	1.14	15	30	*30-150	†.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
	AFY34	SA	pnp,EP,MS,ge	3500	–	90	6.3	*40	20	10	–	–	†	† coax
	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	
HF 95	2N656	TI	npn,si	–	4	200	22.8	60	–	*30	10	–	–	TRWS, FA, TR, AMP, CDC, STC, SSP
	2N657	TI	npn,si	–	4	200	2.28	100	–	*30	10	–	–	TRWS, FA, TR, AMP,CDC, STC, SSP RCA
	2N706A	TI	npn,si	–	300	175	2.0	20	50	2	10	*5	18	FA, SY, MP, TR, GI, ITT, MO
	2N710	TI	pnp,ge	–	300	100	4.0	*15	50	6	3	–	18	SY
	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
HF 96	2N739	TI	npn,si	–	500	175	3.33	80	50	40	1	*10	18	TR
	2N740	TI	npn,si	–	500	175	3.33	80	50	80	1	*10	18	TR, AL
	2N743	TI	npn,si	–	300	175	2	12	200	*20	1	*5	18	FA, SY, GI, TR, ITT
	2N744	TI	npn,si	–	300	125	2	12	200	9	1	*5	18	FA, SY, MP, TR, GI, ITT, MO
	2N753	TI	npn,si	–	300	175	2	20	50	*40	0.5	*5	18	FA, SY, MP, TR, GI, ITT, MO
	2N781	SY	pnp,EP,ge	–	300	100	–	*15	200	*25	3	–	18	AL
	2N782	SY	pnp,EP,ge	–	300	100	–	*12	200	*20	3	–	18	
	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	
HF 97	2N851/TI-422	TI	npn,si	–	300	175	2	12	200	9	–	*5	50	
	2N852/TI-423	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
	2N930	TI	npn,si	–	300	175	2	45	30	150	0.01	*8	18	FA, GI, SPR, AL, TR, NUC, MO, UC
	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	*5,000	0.01	*25	18	AL
	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
HF 98	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
	2N1143A	TI	pnp,ge	–	750	100	10	*30	100	15.6	4	–	–	SY
	2N1247	TR	npn,PLE,si	–	30	150	.24	6	5	*15	.005	*20	5	GE
	2N1507	TI	npn,si	–	600	175	4	*60	1000	*100	1	*35	5	TRWS, CDC
	2N1564	TI	si,npn	–	600	175	4	60	50	20	1	*10	5	TRWS, TR
	2N1565	TI	npn,si	–	600	175	4	60	50	40	1	*10	5	TRWS, TR
	2N1566	TI	npn,si	–	600	175	4	60	50	80	1	*10	5	TRWS, TR
	2N1572	TI	npn,si	–	600	175	4	80	50	20	1	*10	5	TR

(see pages 4-9 for explanation of company abbreviations.)

High-Frequency *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (µA)	C_{oe} $*C_{ob}$ (pF)	Package Outline (TO-)	Remarks
HF 99	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
	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
HF 100	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	–	
	2N2191	TI	pnp,ge	–	125	85	2.1	25	30	60	3	*2.5	–	
HF 101	2N2192A	GE	npn,PE,si	–	2.8W	200	16	40	1A	*100-300	0.010	*20	5	CDC, GI, FA, NA, MO, AL
	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	.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
	2N2411	TI	pnp,si	–	300	200	1.72	20	100	*20	0.01	*5	18	
HF 102	2N2412	TI	pnp,si	–	300	200	1.72	20	100	*40	0.01	*5	18	
	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 @ 100MHz
	2N2486	NA	npn,D,si	–	8700	175	50	140	–	–	1.0	*12	5	VHF Power 3W @ 200MHz
	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 @ 130MHz
	2N2650	NA	npn,D,si	–	8700	175	50	140	–	–	1.0	*12	5	VHF Power 4.5W @ 130MHz
	2N2723	SSD	n,PL	–	800	200	4.6	60	40	*2000	.010	–	18	Darlington amp, SPR
HF 103	2N2724	SSD	n,PL	–	800	200	4.6	60	40	*7000	.010	–	18	Darlington amp, SPR
	2N2725	SSD	n,PL	–	800	200	4.6	45	30	*2000	.002	–	18	Darlington amp, SPR
	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
	2N3016	BE	npn,PE,si	–	25000	150	420	50	2500	*60-150	0.1	*50	5	SSP
HF 104	2N3017	BE	npn,PE,si	–	25W	150	420	50	5A	*60-150	0.1	*50	†	†MT27
	2N3018	BE	npn,PE,si	–	25000	150	420	50	10000	*60-150	0.1	*50	–	Isolated Collector
	2N3138	NA	npn,D,si	–	20000	200	125	65	2000	–	500	30	24	VHF Power 7.5W @ 70 MHz
	2N3139	NA	npn,D,si	–	20000	200	125	140	200	–	500	*30	24	VHF Power 14W @ 70 MHz
	2N3140	NA	npn,D,si	–	20000	200	125	65	2000	–	500	*30	24	VHF Power 4W @ 130 MHz
	2N3141	NA	npn,D,si	–	20000	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 5.4 W @ 70 MHz
	2N3143	NA	npn,D,si	–	25,000	200	142	140	2000	–	500	*30	16	VHF Power 8.3 @ 70 MHz
	2N3144	NA	npn,D,si	–	25,000	200	142	65	2000	–	500	*30	16	VHF Power 4.0W @ 130 MHz
	2N3145	NA	npn,D,si	–	25,000	200	142	140	2000	–	500	*30	16	VHF Power 6.0W @ 130 MHz
HF 105	40080	RCA	npn,si	–	500	175	3.33	30	*250	–	10	–	39	
	40081	RCA	npn,si	–	2W	175	13W/C	†60	*250	–	10	–	39	†Vcex
	40082	RCA	npn,si	–	5W	175	330	†60	1.5a	–	10	39	–	†Vcex
	40242	RCA	npn,PL,si	–	180	175	1.2	*35	50	*80	0.02 (max)	0.5	–	
	40243	RCA	npn,PL,si	–	180	175	1.2	*35	50	*80	0.02 (max)	0.5	–	
	40244	RCA	npn,PL,si	–	180	175	1.2	*35	50	*65	0.02 (max)	0.6	–	
	40245	RCA	npn,PL,si	–	180	175	1.2	*35	50	*120	0.02 (max)	0.5	–	
	40246	RCA	npn,PL,si	–	180	175	1.2	*35	50	*55	0.02 (max)	0.6	–	
	40279	RCA	npn,si	–	11.6W	200	0.66	40	1.5A	*10 (min)	*0.1	*10	60	
	A1170	AL	npn,DP,si	–	300	200	–	10	–	*10	0.010	*3.0	18	
HF 106	TIXS09	TI	npn,EP,si	–	200	200	1.14	13	50	20-300	0.01	1.7	–	Ti-line Package
	TIXS10	TI	npn,EP,si	–	200	200	1.14	15	50	20-200	0.01	1.7	–	Ti-Line Package
	TIX3016A	TI	npn, EP, si	–	200	200	1.14	15	50	20-200	0.01	1.7	–	Ti-Line Package

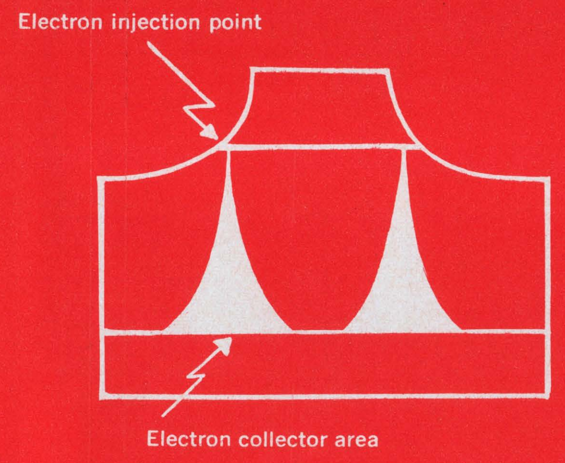
(see pages 4-9 for explanation of company abbreviations.)

RCA HOMETAXIAL-BASE MEANS

HOMOGENEOUS-BASE DESIGN IN AXIAL DIRECTION REDUCES RISKS OF SECOND BREAKDOWN...

Used in RCA Silicon Power Transistor Line for applications up to 50 Kc/s

RCA HOMETAXIAL-BASE TECHNOLOGY



Hometaxial-Base means uniform junctions and homogeneous base construction free of fields in an axial direction. It is in the region of these fields, that second breakdown and electrical collapse occur, caused by excessive concentration of minority carriers. Hometaxial-Base technology provides current "fan-out" to the collector and creates carrier dispersion in the base, thereby reducing risks of second breakdown. Thus, every transistor can be used within its maximum current-voltage-temperature boundaries without derating!

EVERY RCA HOMETAXIAL-BASE TRANSISTOR MEANS RUGGEDNESS!

- Power-Rating Tested (PRT) at maximum power level for 1 second.
- Low saturation voltage for greater switching efficiency.
- Sharp saturation voltage knee for greater circuit efficiency.
- Mechanically rugged—proved after long experience in Mil-approved and demanding aerospace applications.
- Demonstrated superior performance in environmental tests of vibration, shock, and acceleration.
- Improved beta characteristics for less distortion during operation.
- From a family of single diffused types manufactured by RCA since 1957 and backed by more than 50 million hours of operational life tests.

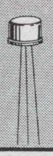
RCA HOMETAXIAL-BASE TRANSISTORS ARE NOW USED IN:

- Series Regulators
- High Fidelity Power Amplifiers
- Inverters/Converters
- Solenoid or Relay-Control Circuits
- Magnetic Deflection Circuits
- Switching Regulators
- Vehicular Voltage Regulators
- Ignition Circuits
- Servo Power Amplifiers
- Public Address Amplifiers
- Ultrasonic Power-Amplifiers

NO ELECTRICAL COLLAPSE

RCA'S HOMETAXIAL-BASE ECONOMY SILICON TRANSISTORS

Offer the ultimate in design simplicity for applications from I mA to 30A

 TO-5 I_C (Max) TO 1A	 TO-66 I_C (Max) TO 4A	 TO-3 I_C (Max) TO 15A	 TO-3 I_C (Max) TO 30A
40347 h_{FE} = 20-80 @ I_C = 450 mA V_{CEV} (Max) = 60V	40250 h_{FE} = 25-100 @ I_C = 1.5A V_{CEV} (Max) = 50V	40251 h_{FE} = 15-60 @ I_C = 8A V_{CEV} (Max) = 50V	2N3771 h_{FE} = 15-60 @ I_C = 15A V_{CEO} (sus) (Min) = 40V
40348 h_{FE} = 30-100 @ I_C = 300 mA V_{CEV} (Max) = 90V	2N3054 h_{FE} = 25-100 @ I_C = 0.5A V_{CEV} (Max) = 90V	2N3055 h_{FE} = 20-70 @ I_C = 4A V_{CEV} (Max) = 100V	2N3772 h_{FE} = 15-60 @ I_C = 10A V_{CEO} (sus) (Min) = 60V
40349 h_{FE} = 25-100 @ I_C = 150 mA V_{CEV} (Max) = 140V	2N3441 h_{FE} = 20-80 @ I_C = 0.5A V_{CEV} (Max) = 160V	2N3442 h_{FE} = 20-70 @ I_C = 3A V_{CEV} (Max) = 160V	2N3773 h_{FE} = 15-60 @ I_C = 8A V_{CEO} (sus) (Min) = 140V

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Power

Types rated at one watt and higher. In order of increasing power dissipation.

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
	2N2038	TR	npn,PL,si	.6	.0055	175	45	.5	*12-36	.015	2,000	5	ETC
	2N2039	TR	npn,PL,si	0.6	.0055	175	75	.5	*12-36	.015	2,000	5	ETC
	2N2040	TR	npn,PL,si	.6	.0055	175	45	.5	*30-90	.015	2,000	5	ETC
P 2	2N2041	TR	npn,PL,si	.6	.0055	175	75	.5	*30-90	.015	2,000	5	ETC
	2N957	FA	npn,DD,si	0.8	0.0065	150	20	–	*60	10	*250000	18	TRWS, AMP
	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	C.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, RCA, NUC
	2N707	FA	npn, DD, si	1	0. 0067	175	*56	–	*12	0.000005	400000	18	TRWS, MO, GI
	2N2106	GE	npn,si	1	.008	200	*60	1	12-36	.2	15000	5	TR
	2N2107	GE	npn,si	1	.008	200	*60	1	30-90	.2	15000	5	TR, [illegible]
	2N2108	GE	npn,si	1	.008	200	*60	1	75-200	.2	15000	5	TR, TI
	2N708	FA	npn,DP,si	1.2	0.0069	200	15	–	*50	0.000004	400000	18	ITT, SY, MO, TR, GI, AMP, NA, RCA, NUC
	2N869	FA	pnp,DP,si	1.2	0.00686	200	18	–	*60	0.000005	*200000	18	MO
P 4	2N914	FA	npn,PE,si	1.2	0.0069	200	15	–	*55	0.000004	*370000	18	ITT, MO, TR, GI, NUC, SPR
	2N915	FA	npn,DP,si	1.2	0.0069	200	50	–	*100	0.000005	*300000	18	NA, MO
	2N916	FA	npn,DP,si	1.2	0.0069	200	25	–	*100	0.000005	*400000	18	TRWS, NA, MO
	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
	2N996	FA	pnp,PE,si	1.2	0.00685	200	12	–	*75	0.0002	*230000	18	TR
	2N2368	FA	npn,PE,si	1.2	0.0685	200	15	0.5	*40	0.001	550000	18	TR, AL, MO, SPR
	2N2369	FA	npn,PE,si	1.2	0.00685	200	15	0.5	*80	0.001	*650000	18	TR, MO, AL, NUC, SPR
	2N978	FA	pnp,DD,si	1.25	0.010	150	20	–	*30	0.001	*60000	18	TR
	SFT367	NUC	pnp,ge	1.25	–	85	16	1	*50	0.01	–	1	
P 5	SFT377	NUC	npn,ge	1.25	–	85	16	0.6	*50	0.01	–	1	
	TI159	TI	pnp,ge	1.4	.0187	100	40	3	*20-60	.65	6	–	
	TI160	TI	pnp,ge	1.4	.0187	100	60	3	*20-60	.65	6	–	
	TI161	TI	pnp,ge	1.4	.0187	100	80	3	*20-60	.65	6	–	
	TI162	TI	pnp,ge	1.4	.0187	100	100	3	*20-60	.65	6	–	
	2N717	FA	npn, DD, si	1.5	0.010	175	*60	–	*40	0.00001	60000	18	TRWS, CDC, TR, GI, AMP NA
	2N718	FA	npn, DD, si	1.5	0.010	175	*60	–	*75	1	80	18	TRWS, CDC, SY, MO, TR, GI, AMP, AL, NA
	2N719	FA	npn, DD, si	1.5	0.010	175	*120	–	*40	0.001	60000	18	TRWS, CDC, TR, GI, AMP
P 6	2N720	FA	npn, DD, si	1.5	0.010	175	*120	–	*80	0.001	80000	18	TRWS, CDC, TR, GI, AMP, AL, NA
	2N721	FA	pnp,DD,si	1.5	0.010	175	35	–	*60	0.001	*60000	18	KSC, TR
	2N722	FA	pnp,DD,si	1.5	0.010	175	35	–	*50	0.001	*90000	18	KSC, MO, TR
	2N4105	AMP	npn,ge	1.6	2.5	90	*25	1.0	*200	.025	*1.0	1	
	2N4106	AMP	pnp,ge	1.6	2.5	90	*25	1.0	*200	.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
	2N719A	FA	npn, DP, si	1.8	0.0103	200	*120	–	*40	0.000005	60000	18	TRWS, CDC, AMP, AL, GI, TR
	2N720A	FA	npn, DP, si	1.8	0.0103	200	*120	–	*80	0.000005	60000	18	TRWS, CDC, GI, AMP, AL, RCA, TR
P 7	2N870	FA	npn, DP, si	1.8	0.0103	200	60	–	*75	0.000004	80000	18	CDC, GI, AMP, AL
	2N871	FA	npn, DP, si	1.8	0.0103	200	60	–	*130	0.000004	100000	18	CDC, GI, AMP, AL, RCA, NA
	2N910	FA	npn,DP,si	1.8	0.0103	200	60	–	140	0.000005	*80000	18	TRWS, CDC, AL
	2N911	FA	npn,DP,si	1.8	0.0103	200	60	–	70	0.000005	*70000	18	TRWS, CDC, AL
	2N912	FA	npn,DP,si	1.8	0.0103	200	60	–	45	0.000005	*60000	18	TRWS, CDC, AL
	2N696	FA	npn, DD, si	2	0.0133	175	*60	–	*40	0.00001	–	5	TRWS, TR, GI, AMP, CDC, NA
	2N697	FA	npn, DD, si	2	0.0133	175	*60	–	*75	0.00001	–	5	TRWS, MO, TR, GI, AMP, CDC,
	2N699	FA	npn, DD, si	2	0.0133	175	*120	–	*80	0.00001	–	5	TRWS, SY, TR, GI, AMP, CDC, RCA, NA

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	fαe $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 8	2N1131	FA	pnp,DD,si	2	0.0133	175	35	0.6	*30	0.00001	*70000	5	KSC, MO
	2N1132	FA	pnp,DD,si	2	0.0133	175	35	0.6	*45	0.00001	*90000	5	KSC, MO
	2N1252	FA	npn,DD,si	2	0.0133	175	*30	–	*35	0.0001	*80000	5	SY, TR, NA
	2N1253	FA	npn,DD,si	2	0.0133	175	*30	–	*45	0.0001	*110000	5	NA
	2N1420	FA	npn, DD, si	2	0.0133	175	*60	–	*700	0.00001	100000	5	TRWS, CPC, MO, TR, GI, NA, AMP
	2N1837	TRWS	npn,PL,si	2	.013	175	*80	0.50	*40-120	.0005	4500	5	CDC
	2N1838	TRWS	npn,PL,si	2	.013	175	*45	0.50	*40-150	.0015	2300	5	CDC
	2N1839	TRWS	npn,PL,si	2	.013	175	*45	0.50	*12-50	.0015	3500	5	CDC
P 9	2N1840	TRWS	npn,PL,si	2	.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
	2N1984	FA	npn, DD, si	2	0.016	150	25	–	80	0.001	30000	5	AMP, ETC, AL
	2N1985	FA	npn, DP, si	2	0.016	150	25	–	60	0.001	30000	5	AMP, ETC, AL
	2N1986	FA	npn, DD, si	2	0.016	150	25	–	150	0.001	50000	5	GI, AMP, ETC, AL
	2N1987	FA	npn, DD, si	2	0.016	150	25	–	50	0.001	50000	5	GI, AMP, ETC, AL
	2N1988	FA	npn, DD, Si	2	0.016	150	45	–	*75	0.001	50000	5	GI, ETC, AL
	2N1989	FA	pnp, DD, si	2	0.016	150	45	–	*40	0.001	50000	5	STC, ETC, AL
	2N1990	FA	npn, DD, si	2	0.016	150	*100	1.0	*30	0.001	–	5	SY, GI, AMP, AL
	2N1991	FA	pnp, DD, si	2	0.016	150	*30	–	*30	0.001	50000	5	KSC, TR, MO
P 10	2N2303	FA	pnp, DD, si	2	0.0133	175	35	–	*90	0.001	70000	5	TR, MO
	BFY 33	SA	npn,PL,si	2.6	0.016	200	*50	0.5	>35	.00002	80000	5	
	BFY 34	SA	npn,PL,si	2.6	0.016	200	*75	0.5	*40-120	.00001	80000	5	
	BFY 46	SA	npn,PL,si	2.6	0.016	200	50	0.5	100-300	.00001	100,000	5	
	BFY 12	SA	npn,EP,PL,si	2.6	0.016	200	40	0.5	33-170	.00002	180,000	5	
	2N1335	TRWS	pnp,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1336	TRWS	npn,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1337	TRWS	npn,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1338	TRWS	npn,PL,si	2.8	.019	175	*80	0.30	*10-150	0.001	–	5	
	2N1339	TRWS	npn,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
P 11	2N1340	TRWS	npn,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1341	TRWS	npn,PL,si	2.8	.019	175	*120	0.30	*10-150	0.001	–	5	
	2N1342	TRWS	npn,PL,si	2.8	.019	175	*150	0.30	*12	0.01	–	5	
	2N1409	TRWS	npn,PL,si	2.8	.0187	175	*30	0.50	*15-45	0.010	5000	5	GI
	2N1410	TRWS	npn,PL,si	2.8	.0187	175	*45	0.50	*30-90	0.010	2500	5	GI
	2N2192A	GE	npn,si	2.8	.016	200	40	1	100-300	0.01	130000	5	CDC, GI, MO, FA, NA, AL
	2N2193A	GE	npn,PE,si	2.8	.016	200	50	1	40-120	1	–	5	CDC, FA, GI, MO, NA, AL
	2N2194A	GE	npn,PE,si	2.8	.016	200	40	1	*20-60	1	–	5	CDC, FA, GI, MO, NA, AL
	2N2195A	GE	npn,PE,si	2.8	.016	200	25	1	20	.01	130000	5	CDC, FA, GI, MO, AL
	2N2243A	GE	npn,PE,si	2.8	.016	200	80	1	*40-120	0.1	–	5	CDC
P 12	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	.025	175	60	.15	*20-80	0.001	10,000	5	TI
	2N1207	TR	npn,PL,si	3	.025	175	125	.15	*20-80	0.001	10,000	5	TI
	2N1505	TRWS	npn,PL,si	3	.175	175	*50	0.5	*7-100	.05	20000	5	NUC
	2N1506	TRWS	npn,PL,si	3	.175	175	*60	0.5	*10-100	.01	20000	5	NUC STC, RCA, NA
	2N1561	MO	pnp,DM,ge	3	0.04	100	25	.25	10	0.01	*500	–	
	2N1562	MO	pnp,DM,ge	3	0.04	100	25	.25	9	0.01	*450	–	
	2N1613	FA	npn, DP, si	3	0.0172	200	*75	–	*80	0.0000003	80000	5	TRWS, CDC, MO, TR, GI, AMP, AL, RCA
P 13	2N1692	MO	pnp,DM,ge	3	0.04	100	25	.25	10	0.01	*500		
	2N1693	MO	pnp,DM,ge	3	0.04	100	0.04	.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,
	2N1893A	TRWS	npn,PL,si	3	.017	200	*140	0.50	*40-120	.0001	3000	5	GI, TR, NA
	2N1973	FA	npn, DP, si	3	0.00456	200	60	–	140	0.000005	80000	5	TRWS, AMP, TR
	2N1974	FA	npn,DP,si	3	0.0172	200	60	–	70	0.000005	70000	5	AL, TRWS, AMP, TR
	2N1975	FA	npn, DP, Si	3	0.0172	200	60	–	45	0.000005	60000	5	TRWS, AMP, TR
	2N2049	FA	npn, DP, si	3	0.0172	200	*75	–	*130	0.000004	86000	5	AL
	2N3732	RCA	pnp,DJ,ge	3	0.1	85	*–100	3	–	0.2	–	3	
	2N1506A	TRWS	npn,PL,si	3.5	.200	200	*80	0.5	*10-100	.0005	20000	5	VEC
P 14	SP10800	FA	npn,DP,si	3.5	.200	200	45	–	*60-600	.010	–	89	Dual npn
	2N497	TI	npn, TD, si	4	0.0228	200	60	1	*12-36	0.01	*20	5	TRWS
	2N498	TI	npn, TD, si	4	0.0228	200	100	1	*12-36	0.01	*20	5	TRWS
	2N656	TI	npn,si	4	0.0228	200	60	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, STC, SSP
	2N657	TI	npn,si	4	0.0228	200	100	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, STC
	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	.04	200	*80	5.0	*40-120	100	20000	5	TI, AMP, SSP
	2N2658	SOL	npn,si	4	.04	200	*100	5.0	*40-120	.0001	20000	5	TI, AMP, SSP

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 15	2N3469	SOL	npn,si	4	.04	200	35	5	*100	.0001	*20,000	5	
	40264	RCA	npn,si	4	0.2	150	300	0.1	*60	0.1	*25	–	
	NPC 514	NUC	npn,si	4	–	–	*300	0.2	*30	0.1	–	–	
	2N497A	GE	npn,si	5		200	60	1	12-36	.010	15,000	5	SSP, TR, TI
	2N498A	GE	npn,si	5	.0286	200	100	1	12-36	.01	15,000	5	TR, SSP, TI
	2N656A	GE	npn,si	5	.0286	200	60	1	30-90	.010	15,000	5	TR, SSP, TI
	2N657A	GE	npn,si	5	.0286	200	100	1	30-90	.01	15,000	5	TR, SSP, TI
	2N699B	FA	npn, DD, si	5	0.0286	200	80	–	*80	0.3	–	5	GI, TRWS
	2N1067	–	npn,si	5	0.33	175	*60	.5	*15-75	.5	10	8	STC
	2N1479	RCA	npn,si	5	.0286	200	40	1.5	*20-60	.01	50	5	STC, TR
P 16	2N1480	RCA	npn,si	5	.0286	200	55	1.5	*20-60	.01	50	5	STC, TR
	2N1481	RCA	npn,si	5	.0286	200	40	1.5	*35-100	.01	50	5	STC, TR
	2N1482	RCA	npn,si	5	.0286	200	55	1.5	*35-100	.01	50	5	STC, TR
	2N1615	TR	npn,PL,si	5	.045	175	100	.2	*25	.002	2,000	5	CDC
	2N1700	RCA	npn	5	.0286	200	40	1	*20-80	.075	40	5	STC, TR, TI
	2N2017	GE	npn,si	5	.0285	200	60	1	*15-200	0.01	–	5	CDC, TR
	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	
	2N2284	BE	pnp,ge	5	0.066	110	100	3	*20	100	–	37	
	2N2270	RCA	npn,si	5	.0286	200	45	1	*50-200	50	1000	5	CDC, GI, TR, NA
P 17	2N2297	FA	npn, PE, si	5	0.0286	200	35	1.0	*50	0.2	90000	5	TR, NA
	2N2350A	GE	npn,PE,si	5	.0285	200	25	1	*20	0.1	–	46	
	2N2351A	GE	npn,PE,si	5	.0285	200	50	1	*40-120	1	–	46	NA
	2N2352A	GE	npn,PE,si	5	.0285	200	40	1	20-60	1	–	46	NA
	2N2353A	GE	npn,PE,si	5	.0285	200	25	1	*20	1	–	46	NA
	2N2364A	GE	npn,PE,si	5	.0285	200	80	1	*40-120	.0001	–	46	
	2N2726	GE	npn,si	5	.0266	200	*200	1	*30-90	.01	–	5	TI
	2N2727	GE	npn,si	5	.0266	200	*200	1	*75-150	.01	–	5	TI
	2N2890	FA	npn,PE,si	5	0.0286	200	80	–	55	0.000002	*50000	5	
	2N2891	FA	npn,PE,si	5	0.0286	200	80	–	*80	0.000002	*50000	5	
P 18	2N3016	BE	–	5	–	–	*100	2.5	*60-150	0.001	–	5	
	2N3056	FA	npn,DPE,si	5	.286	200	*100	1	*120	.010	80,000	46	
	2N3056A	FA	npn,DPE,si	5	.286	200	*140	1	*120	.010	200 MHz	46	
	2N3057	FA	npn,DPE,si	5	.286	200	*100	1	*300	.010	100 MHz	46	
	2N3057A	FA	npn,DPE,si	5	.286	200	*140	1	*300	.010	200 MHz	46	
	2N3114	FA	npn,DP,si	5	0.0286	200	150	–	*60	0.3	*54000	5	MO, TRWS
	2N3374	VEC	npn,PE,si	5	.286	200	80	.5	2.9	.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	–	5	
	2N3660	TR	pnp,si	5	0.028	200	30	2	50	0.00001	30Mc	5	
P 19	2N3661	TR	pnp,si	5	0.028	200	50	2	50	0.00001	30Mc	5	
	2N3665	TR	npn,si	5	0.028	200	80	1	*80	0.00005	60Mc	5	
	2N3665	FA	npn,DPE,si	5	.0286	200	*120	1	*120	150	60,000	5	
	2N3666	FA	npn,DPE,si	5	.0286	200	*120	1	*300	150	60,000	5	
	2N3699	MO	pnp, AE, si	5	0.0286	200	60	3	*35-150	0.001	*60 MHz	5	
	2N3731	RCA	pnp,DJ,ge	5	0.16	85	*–320	10	–	0.2	–	3	
	2N3916	FA	npn,DP,si	5	.040	150	150	10	*150	–	50,000	5	
	40309	RCA	npn, si	5	0.028	200	18	0.7	*70-350	250	*100 MHz	5	
	40311	RCA	npn, si	5	0.028	200	30	0.7	*70-350	250	*100 MHz	5	
	40314	RCA	npn,si	5	0.028	200	40	0.7	*70-350	250	*100 MHz	5	
P 20	40315	RCA	npn, si	5	0.028	200	35	0.7	*70-350	250	*100 MHz	5	
	40317	RCA	npn,si	5	0.028	200	40	0.7	*40-200	250	–	5	
	40319	RCA	pnp,si	5	0.028	200	–40	–0.7	*35-200	250	*100 MHz	5	
	40320	RCA	npn,si	5	0.028	200	40	0.7	*40-200	250	–	5	
	40321	RCA	npn,si	5	0.028	200	–	1	*25-200	0.1	–	5	V_{CER} = 300
	40323	RCA	npn, si	5	0.028	200	18	0.7	*70-350	250	*100 MHz	5	
	40326	RCA	npn,si	5	0.028	200	40	0.7	*40-200	250	–	5	
	40327	RCA	npn, si	5	0.028	200	–	1	*40-250	0.005	–	5	I_{CER} = 300
	40347	RCA	npn,si	5	0.028	200	40	1	*20-80	0.001	–	5	
	40348	RCA	npn,si	5	0.028	200	65	1	*30-100	0.001	–	5	
P 21	40360	RCA	npn, si	5	0.028	200	70	0.7	*40-200	0.001	*100 MHz	5	
	40361	RCA	npn,si	5	0.028	200	70	0.7	*70-350	–	*100 MHz	5	I_{CER} = 0.001 mA
	40362	RCA	pnp,si	5	0.028	200	–70	–0.7	*35-200	–	*100 MHz	5	I_{CER} = 0.001 mA
	40367	RCA	npn, si	5	0.028	200	55	1.5	*35-100	0.004	–	5	
	PT3500	TRWS	–	5	0.03	200	40	0.5	10-80	0.1	–	39	
	40250VI	RCA	npn,si	5.8	0.033	200	40	4	*25-100	1	*1000	66	free air heat radiator
	40375	RCA	npn,si	5.8	0.033	200	50	10(peak)	*50-200	*5	*60 MHz	66	free air heat radiator
	2N3719	MO	pnp,AE,si	6	.034	200	40	3	*25-180	.01	*60000	5	
	2N3720	MO	pnp,AE,si	6	.034	200	60	3	*25-180	.01	*60000	5	
	0C30	AMP	pnp,PADT,ge	6.7	–	75	*16	1.4	*36	.012	–	–	Special AF Power

(see pages 4-9 for explanation of company abbreviations.)

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)		
	2N326	SY	npn,AL,ge	7	–	85	*35	2	*15-60	.5	0.15	3	
	2N1183	RCA	pnp,ge	7.5	0.1	100	20	3	*20-60	.25	10	8	
	2N1183A	RCA	pnp,ge	7.5	0.1	100	30	3	*20-60	.25	10	8	
	2N1183B	RCA	pnp,ge	7.5	0.1	100	40	3	*20-60	.25	10	8	
	2N1184	RCA	pnp,ge	7.5	0.1	100	20	3	*40-120	.25	10	8	
P 22	2N1184A	RCA	pnp,si	7.5	0.1	100	30	3	*40-120	.25	10	8	
	2N1184B	RCA	pnp,ge	7.5	0.1	100	40	3	*40-120	.25	10	8	
	2N4077	AMP	npn,ge	7.5	0.12	90	*32	1.0	*150	.025	*1.0	–	
	2N4078	AMP	pnp, ge	8.0	0.13	90	*32	1.0	*150	.018	*1.0	–	
	2N122	TI	npn,si	8.75	0.07	150	*120	0.14	*3	0.01	–	–	
	2N2631	RCA	npn,si	8.75	.05	200	60	1.5	*50-250	0.0001	1500	39	VEC, TI
	2N2881	STC	pnp	8.75	.05	200	60	2	*20-60	–	–	5	CT
	2N2882	STC	pnp	8.75	.05	200	100	2	*20-60	–	–	5	CT
	2N2911	STC	npn	8.75	.05	200	125	3	*20-60	–	–	5	
	V-600	VEC	npn,PE,si	8.75	.050	200	60	1.5	–	.000005	–	5	
P 23	V-601	VEC	npn,PE,si	8.75	.050	200	60	1.5	–	.001	–	5	
	V-602	VEC	npn,PE,si	8.75	.050	200	40	1.5	–	.001	–	5	
	2N1068		npn,si	10	.067	175	*60	1.5	*15-75	.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	–	–	AMP, 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
	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
P 24	2N1721	TI	npn,si	10	0.134	175	100	1	*40	1	–	–	SSP
	2N2017	BE	–	10	–	–	*100	5	*30	–	–	†	† MT-27, TI
	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
	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	ITT	pnp,AJ,ge	10	–	100	*80	3.0	–	–	7	†	†MS7, KSC
P 25	2N3418	TI	npn, EP, si	10	0.133	175	60	5	*20-60	0. 00003	*40	5	
	2N3419	TI	npn, EP, si	10	0. 133	175	80	5	*20-60	0. 00003	*40	5	
	2N3420	TI	npn, EP, si	10	0.133	175	60	5	*40-120	0. 00003	*40	5	
	2N3421	TI	npn, EP, si	10	0.133	175	80	5	*40-120	0. 00003	*40	5	
	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
	40256	RCA	npn,si	10	0.066	200	350	1	*40-60	*0.05	–	–	
	40255	RCA	npn, si	10	0. 066	200	250	1	*40-160	*20	–	5	
	TIP14	TI	npn,EP,si	10	.133	150	60	1	*30-150	.05	10,000	–	Tab-Pac
	2N301	RCA	pnp,AJ,ge	11	–	85	*40	3	*70	3	–	3	DE, KSC, BE, ITT, LAN
P 26	2N301A	RCA	pnp,AJ,ge	11	–	85	60	3	*70	3	–	3	DE, KSC, BE, ITT
	VX-3375	VEC	npn,PE,si	11.6	–	200	40	1.5	–	*0.1	*600,000	–	
	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	
	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
	40022	RCA	pnp, AJ,ge	12.5	0.66	100	*32	5	*70	1	*300	3	
	40050	RCA	pnp,AD,ge	12.5	0.66	100	*40	5	90	max. 0.5	500	3	
P 27	40051	RCA	pnp,AD,ge	12.5	0.66	100	*50	5	90	max. 0.5	500	3	
	40254	RCA	pnp,AJ, ge	12.5	0.66	100	*32	5	*70	3	*300	3	
	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	.0667	200	*80	1	*30-90	.075	–	–	Special Heat Sink
	2N2197	GE	npn,si	15	66.7	175	*80	1	*200	–	–	–	
	2N2201	GE	npn,si	15	.067	175	100	1	*30-90	.05	15000	–	
	2N2202	GE	npn,si	15	.067	175	100	1	30-90	.05	15000	–	
	2N2203	GE	npn,si	15	.067	175	100	1	30-90	.05	15000	–	
	2N2204	GE	npn,si	15	.067	175	100	1	30-90	.05	15000	–	
P 28	2N2239	GE	npn,si	15	.120	200	*60	1	*30-200	10	–	5	Special Heat Sink
	2N2611	GE	npn,si	15	.067	175	100	1	12-36	.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	*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	

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{\circ}C$	T_j (°C)	V_{CEO} $^*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^\dagger I_{CEX}$ (mA)	f_{ae} $^*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 29	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	
	2N2988	TI	npn, P, si	15	0.15	200	100	1	*25-75	.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	.000025	*30	5	
	2N2991	TI	npn, P, si	15	0.15	200	80	1	*25-75	.000025	*30	††	††MT 13
	2N2992	TI	npn,P,si	15	0.15	200	100	1	*25-75	.000025	*30	††	††MT 13
	2N2993	TI	npn, P, si	15	0.15	200	80	1	*60-120	.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	–	–	
P 30	2N3919	FA	npn,DPE,si	15	.200	150	*120	10	120	–	80,000	3	
	2N3920	FA	npn,DPE,si	15	.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	
	BD109	SA	npn,PE, si	15	0.15	175	40	2	20...120	0.0001	50, 000	–	SOT–9 package
	2N2525	TRWS	npn,PL,si	16	.091	200	*100	1	*>10	–	10000	–	
	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	.2	–	–	MT59 package
	V-610	VEC	npn,PE,si	17.5	.100	200	60	2.5	–	.000005	–	–	
	V-611	VEC	npn,PE,si	17.5	.100	200	60	2.5	–	.001	–	–	
P 31	V-612	VEC	npn,PE,si	17.5	.100	200	40	2.5	–	.001	–	–	
	2N156	KSC	pnp,ge	20	.333	100	*30	3	*25	1.0	4.0	13	
	2N158	KSC	pnp,ge	20	.333	100	*60	3	*21	1.0	4.0	13	
	2N158A	KSC	pnp,ge	20	.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
	2N2553	TI	pnp,ge	20	0.267	100	*60	3	18	0.125	–	–	BE
P 32	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
	2N2563	TI	pnp,ge	20	0.267	100	*100	3.5	25	0.125	–	–	KSC, BE
P 33	2N2697	SOL	npn, si	20	0.2	200	*80	5.0	*40-120	.0001	20000	–	
	2N2698	SOL	npn, si	20	0.2	200	*100	5.0	*40-120	.0001	20000	–	
	2N2875	TR	pnp,PLE,si	20	.14	175	50	2	*15-60	.001	–	–	
	2N3738	MO	npn,si	20	.133	175	225	.250	*40-120	0.1	*15000	66	
	2N3739	MO	npn,si	20	.133	175	300	.250	*40-120	0.1	*15000	66	
	2N3766	MO	npn,si	20	.133	175	60	1	*40-160	0.1	*15000	66	
	2N3767	MO	npn,si	20	.133	175	80	1	*40-160	0.1	*15000	66	
	2N3917	FA	npn,DPE,si	20	5	150	40	10	10	.00001	*2500	3	
	KM7007	KSC	pnp,AJ,ge	20	–	100	30	3.0	–	–	6	†	†MS-7
	KM7008	KSC	pnp,AJ,ge	20	–	100	60	3.0	–	–	6	†	†MS-7
P 34	KM7009	KSC	pnp,AJ,ge	20	–	100	80	3.0	–	–	6	†	†MS-7
	KM7010	KSC	pnp,AJ,ge	20	–	100	100	3.0	–	–	6	†	†MS-7
	2N234A	BE	pnp,ge	25	0.5	90	25	3	–	–	–	3	KSC
	2N235A	BE	pnp,ge	25	0.5	90	*50	3	–	7	–	3	KSC, ITT
	2N235B	BE	pnp,ge	25	0.5	90	*50	3	–	–	–	3	ITT
	2N285A	BE	ge,PNP	25	0.5	95	–	3	–	–	–	3	
	2N285B	BE	pnp,ge	25	0.5	95	–	3	–	–	–	3	
	2N399	BE	–	25	–	–	–	3	*34-40	–	–	3	KSC
	2N401	BE	–	25	–	–	–	3	31-36	–	–	3	KSC
	2N418	BE	–	25	–	–	–	5	*40	–	–	3	KSC, ITT
P 35	2N419	BE	–	25	–	–	–	3	35	–	–	3	KSC
	2N420	BE	–	25	–	–	–	5	*40	–	–	3	ITT
	2N420A	BE	–	25	–	–	–	5	*40	–	–	3	
	2N1218	SY	npn,AL,ge	25	–	100	*45	3	*40-160	3	7	3	
	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

(see pages 4-9 for explanation of company abbreviations.)

TRIPLETT

MODEL 3490-A TRANSISTOR ANALYZER

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$400.00

1 READS LEAKAGE CURRENT DOWN TO
100 nanoamperes on 6ua suspension meter

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Great flexibility allows plotting of transistor characteristic curves along with setting up nearly any type of transistor test. Input bias reversing switch gives added versatility.

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Iceo, Ico (Icbo):	0-6 Ma, 0-600 ua, 0-60 ua, 0-6 ua.
Collector Voltage:	0-120 V, 0-60 V, 0-30 V, 0-12 V, 0-6 V, 0-3 V, 0-1.2 V.
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Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	W/°C	T_j (°C)	V_{CEO} *V_{CBO} (V)	I_c (A)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	f_{ae} *f_T (kHz)	Package Outline (TO-)	Remarks
P 36	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	
	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	RCA	npn,si	25	0.143	200	60	7	*2,000 - 20,000	0.1	–	–	Darlington Type, TI
	2N3231	RCA	npn,si	25	0.143	200	80	7	*2,000 - 20,000	0.1	–	–	Darlington Type, TI
P 37	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	
	2N3836	TI	npn,EP,si	25	.143	200	60	7	*2 K-20 K	0.01	40,000	–	Darlington
	2N3837	TI	npn,EP,si	25	.143	200	80	7	*2 K-20 K	0.01	40,000	–	Darlington
	40368	RCA	npn, si	25	0.143	200	55	3	*35-100	0.009	–	8	
	PT5694	TRWS	–	25	.143	200	40	2.0	10-80	2.0	3.0	–	MT59 package
	TI156	TI	pnp,ge	25	.33	100	30	3	*25-75	.65	6	–	
	TI158	TI	pnp,ge	25	.33	100	60	3	*25-75	.65	6	–	
P 38	TI539	TI	pnp,ge	25	.33	100	60	3.5	*30-75	1	6	–	
	TI540	TI	pnp,ge	25	.33	100	60	3.5	*30-75	1	6	–	
	V-800	VEC	npn,PL,si	25	.142	200	140	–	–	.750	–	–	
	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
P 39	2N1762	ITT	–	28	–	95	65	3	60	1	15	–	KSC
	KM7000	KSC	pnp,AJ,ge	28	–	100	*60	3.0	–	–	10	†	†MS-7
	KM7001	KSC	pnp,AJ,ge	28	–	100	*100	3.0	150	–	9	†	†MS-7
	KM7002	KSC	pnp,AJ,ge	28	–	100	80	3.0	–	–	–	†	†MS-7
	40250	RCA	npn, si	29	0.194	200	40	4	*25-100	1	–	66	
	40310	RCA	npn,si	29	0.16	200	35	4	*20-120	0.01	*750	66	
	40312	RCA	npn,si	29	0.16	200	–	4	*20-120	0.01	*750	66	V_{CER} = 60
	40316	RCA	npn, si	29	0.16	200	40	4	*20-120	0.01	*750	66	
	40324	RCA	npn,si	29	0.16	200	35	4	*20-120	0.01	*750	66	
	2N1978	FA	npn,DP,si	30	0.172	200	*60	–	*30	.01	*50000	–	
P 40	2N2150	TI	npn, TD, si	30	0.4	175	80	2	*20-60	0.01	*20	21	
	2N2151	TI	npn, TD, si	30	0.4	175	80	2	*40-120	0.01	*20	††	††MT 21
	2N2869	RCA	pnp,AJ,ge	30	–	100	*60	10	*90	0.5	–	3	LAN
	2N2870	RCA	pnp,A,ge	30	–	100	50	10	*90	0.5	450	3	LAN
	2N2877	SOL	npn,si	30	0.3	200	*80	5	*20-60	.0001	30000	–	TI, SSP
	2N2878	SOL	npn,si	30	0.3	200	*80	5	*40-120	.0001	50000	–	TI, SSP
	2N2879	SOL	npn,si	30	0.3	200	*100	5	*20-60	.0001	30000	–	TI, SSP
	2N2880	SOL	npn,si	30	0.3	200	*100	5	*40-120	.0001	50000	–	TI, SSP
	2N2892	FA	npn,PE,si	30	–	200	80	–	*55	.0002	*50000	–	AMP
	2N2893	FA	npn,PE,si	30	–	200	80	–	*80	0.0002	*50000	–	AMP
P 41	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.
	2N3745	SOL	npn,si	30	.3	200	*80	5	*20-60	.0001	*30,000	–	hex isolated col.
	2N3746	SOL	npn,si	30	.3	200	*100	5	*20-60	.0001	*30,000	–	hex isolated col.
	2N3747	SOL	npn,si	30	.3	200	*60	5	*40-120	.0001	*40,000	–	hex isolated col.
	2N3748	SOL	npn,si	30	.3	200	*80	5	*40-120	.0001	*40,000	–	hex isolated col.
	2N3749	SOL	npn,si	30	.3	200	*100	5	*40-120	.0001	*40,000	–	hex isolated col.
	2N3750	SOL	npn,si	30	.3	200	*60	5	*100-300	.0001	*50,000	–	hex isolated col.
P 42	2N3751	SOL	npn,si	30	.3	200	*80	5	*100-300	.0001	*50,000	–	hex isolated col.
	2N3752	SOL	npn,si	30	.3	200	*100	5	*100-300	.0001	*50,000	–	hex isolated col.
	2N3850	SSP	npn,TDP	30	0.4	200	*100	5	*150	.0001	*40	59	
	2N3851	SSP	npn,TDP	30	0.4	200	*60	5	*90	.0001	*30	59	
	2N3852	SSP	npn,TDP	30	0.4	200	*60	5	*150	.0001	*40	59	
	2N3853	SSP	npn,TDP	30	0.4	200	*60	5	*90	.0001	*30	59	
	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

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

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)	fαe *f_T (kHz)	Package Outline (TO-)	Remarks
				MAX. RATINGS					CHARACTERISTICS				
P 43	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	
	FT207A	FA	npn,DPE,si	30	2.7	200	80	50	20	.0050	*3.5	59	
	FT207B	FA	npn,DPE,si	30	2.7	200	80	50	20	.0050	*3500	–	
	KM7011	KSC	pnp,AJ,ge	30	–	100	30	5.0	–	–	8	†	†MS-7
	KM7012	KSC	pnp,AJ,ge	30	–	100	60	5.0	–	–	8	†	†MS-7
	KM7013	KSC	pnp,AJ,ge	30	–	100	80	5.0	–	–	8	†	†MS-7
	KM7014	KSC	pnp,AJ,ge	30	–	100	100	5.0	–	–	8	†	†MS-7
	KM7015	KSC	pnp,AJ,ge	30	–	100	60	5.0	–	–	10	†	†MS-7
	KM7016	KSC	pnp,AJ,ge	30	–	100	80	5.0	–	–	10	†	†MS-7
P 44	KM7017	KSC	pnp,AJ,ge	30	–	100	100	5.0	–	–	10	†	†MS-7
	OC26	AMP	pnp,A,ge	30	.9	90	32	3.5	*60	.20	150	3	
	2N538	SOL	pnp,ge	34	0.46	100	*80	3.5	*20-50	2	200	–	KSC
	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
P 45	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
	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
	2N2836	AMP	pnp,AJ,ge	35	.66	90	55	3.5	*30	.1	–	3	KSC
	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	
P 46	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	
	40313	RCA	npn,si	35	0.2	200	–	2	*40-250	*5	–	66	V_{CER}=300
	40318	RCA	npn,si	35	0.2	200	–	2	*40(min.)	*5	–	66	V_{CER}=300
	40322	RCA	npn,si	35	0.2	200	–	2	*40(min.)	*5	–	66	V_{CER}=300
	40328	RCA	npn,si	35	0.2	200	–	2	*20(min.)	*5	–	66	I_{CER}=300
	40364	RCA	npn, si	35	0.2	200	–	7	*35-175	–	*15	66	V_{CER}=60; I_{CER}=0.5
	2N663	DE	pnp,AJ,ge	37.5	2	100	25	4	*25-75	4	15	3	KSC
	2N665	DE	pnp,AJ,ge	37.5	2	100	40	5	*40-80	10	20	3	KSC, MO
	2N3154	ITT	–	37.5	–	100	25	3	60	1	15	–	KSC
P 47	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
	2N1047B		npn,si	40	0.228	200	80	0.750	*12	0.050	–	–	TI
	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
P 48	2N1048A	TI	npn,si	40	0.228	200	120	0.500	*12	0.350	–	–	STC, TR
	2N1048B		pnp,si	40	0.228	200	120	0.750	*12	0.100	–	–	TI
	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		npn,si	40	0.228	200	80	0.750	*30	0.050	–	–	TI
	2N1049C	TI	npn,si	40	0.228	200	80	1	*30	0.010	–	–	
	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
P 49	2N1050C	TI	npn,si	40	0.228	200	120	1	*30	0.010	–	–	
	2N1647	TR	npn,PL,si	40	.267	175	*80	3	*15-45	.1	3,000	–	STC
	2N1648	TR	npn,PL,si	40	.267	175	120	3	*15-45	.1	2,000	–	STC
	2N1649	TR	npn,PL,si	40	.267	175	*80	3	*30-90	.1	3,000	–	STC
	2N1650	TR	npn,PL,si	40	.267	175	120	3	*20	.1	2,000	–	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
	2N2018	TR	npn,PL,si	40	.267	175	*150	2	*15	.1	2,000	–	
	2N2019	TR	npn	40	.267	175	*200	2	*15	.1	2,000	–	
	2N2020	TR	npn,PL,si	40	.267	175	*150	2	*25	.1	3,000	–	

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{\circ}C$	T_j ($^{\circ}C$)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $^{\dagger}I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 50	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	–	–	*	*7/8" Hex, TI
	2N2829	STC	npn	40	.229	200	60	3	*20-60	–	–	*	*7/8" Hex, TI
	2N2902	TI	npn, TD, si	40	0.228	200	120	2	*30-90	0.25	*2	57	
	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
P 51	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
	PT5692	TRWS	–	40	.229	200	40	4.0	10-80	4.0	2.5	–	MT59 package
	2N2266	SOL	pnp,ge	43	0.5	125	*100	5	*25-75	2	200	–	
	2N2267	SOL	pnp,ge	43	0.5	125	*120	5	*25-75	2	200	–	
	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	–	
	2N1120	BE	pnp,ge	45	0.667	95	*80	15	30-120	15	–	41	MO, ITT
	2N456A	TI	pnp,ge	50	0.667	100	*40	7	*40	0.5	–	3	DE, BE, MO, ITT
	2N457A	TI	pnp,ge	50	0.667	100	*60	7	*40	0.5	–	3	DE, KSC, BE, MO, ITT
P 52	2N458A	TI	pnp,ge	50	0.667	100	*80	7	*40	0.5	4	3	DE, BE, MO, ITT
	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
	2N678B	BE	pnp,ge	50	0.66	100	*60	15	*50-100	5	–	3	TI, ITT
	2N678C	BE	pnp,ge	50	0.66	100	*60	15	*50-100	5	–	3	TI, ITT
	2N1014		pnp,ge	50	100	–	*100	–	*20	–	–	–	KSC
	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
P 53	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
	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
	2N1724A	TI	npn,si	50	0.67	175	120	5	*30	0.1	–	–	BE
	2N1725	TI	npn,si	50	0.67	175	80	5	*50	0.1	–	–	BE, MO, TR
	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
P 54	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
	2N236A	BE	pnp,ge	60	0.83	100	–	3	–	–	–	3	KSC
	2N236B	BE	pnp,ge	60	0.83	100	–	3	–	–	–	3	
	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	
P 55	2N1080	TR	npn,PL,si	60	.34	175	*60	3	*20-80	10	10,000	53	
	2N1210	TR	npn,PL,si	60	.40	175	60	5	*15-75	10	3,000	–	BE
	2N1211	TR	npn,PL,si	60	.40	175	*80	5	*15-75	10	3,000	53	BE, TI
	2N1616	TR	npn,PL,si	60	.40	175	60	5	*15-75	10	3,000	–	STC, BE, TI
	2N1618	TR	npn,PL,si	60	.40	175	*100	5	*15-75	10	3,000	–	STC, BE, TI
	2N1620	TR	npn,PL,si	60	.40	175	*100	5	*15-75	10	3,000	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	
P 56	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	
	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	

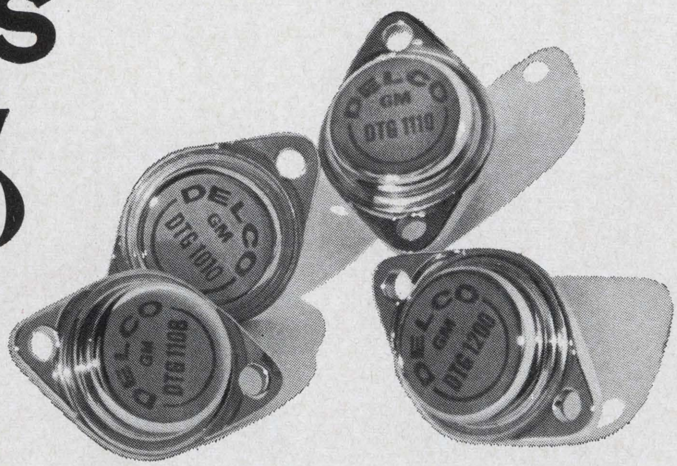
(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^oC$	T_j (^oC)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 57	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	
	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
	2N555	MO	pnp,AJ,ge	65	0.72	90	*30	3	55	20	6	3	DE, KSC, ITT
	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	
	2N1430	BE	pnp,ge	70	0.833	110	100	10	*30-90	–	–	41	
	2N3223	GE	npn,si	70	0.4	175	60	2	160	0.1	–	–	TI
	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
	2N1511	RCA	npn,si	75	.429	200	40	6	*15-45	.025	30	36	STC
	2N1512	RCA	npn,si	75	.429	200	55	6	*15-45	.025	30	36	STC
	2N1513	RCA	npn,si	75	.429	200	40	6	*25-75	.025	30	36	STC
P 60	2N1514	RCA	npn,si	75	.429	200	55	6	*25-75	.025	30	36	STC
	2N1703	RCA	npn,si	75	200	.429	40	5	*15-60	.2	25	36	STC
	2N2912	MO	pnp,EP,ge	75	1	110	6	25	*75	0.2	–	8	75w @ 35° C
	40369	RCA	npn,si	75	0.429	200	55	3	*25-75	0.01	–	3	
	3N45	SOL	pnp,ge	75	1	100	*60	12	*30-120	3	600	15	
	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	
	DTG600	DE	pnp,PADT, ge	75	1.0	110	*90	25	115	–	–	3	
	DTG601	DE	pnp,PADT,ge	75	1.0	110	90	25	115	–	–	3	
P 61	DTG602	DE	pnp,PADT,ge	75	1.0	110	100	25	115	–	–	3	
	2N3264	RCA	npn, si	† 84	0.66	200	90	25	*20-80	10	–	–	†Tc = 75C, TI
	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
	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	
	2N1235	TI	npn,si	85	0.485	200	*100	2	*12	10	–	53	
	2N1260	TI	npn,si	85	0.485	200	*120	2	*12	10	–	53	
	2N2383	STC	npn	85	.5	200	60	3	*20-60	–	–	–	STC
	2N2384	STC	npn	85	.5	200	60	3	*20-60	–	–	*	*$^{11}/_{16}$" Hex
P 62	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	
	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	
	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	
	2N3612	MO	pnp,AJ,ge	85	1	110	35	7	*35-70	0.04	–	3,41	
P 63	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	
	2N3615	MO	pnp,AJ,ge	85	1	110	50	7	*30-60	0.06	–	3,41	
	2N3616	MO	pnp,AJ,ge	85	1	110	60	7	*30-60	0.06	–	3,41	
	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	
	MP2060	MO	pnp,AJ,ge	85	1	110	25	7	*30-200	0.06	–	3	
	MP2061	MO	pnp,AJ,ge	85	1	110	35	7	*30-200	0.06	–	3	
	MP2062	MO	pnp,AJ,ge	85	1	110	50	7	*30-200	0.06	–	3	
	MP2063	MO	pnp,AJ,ge	85	1	110	60	7	*30-200	0.06	–	3	

(see pages 4-9 for explanation of company abbreviations.)

FOUR SPECIALISTS
(and what they can do for you)

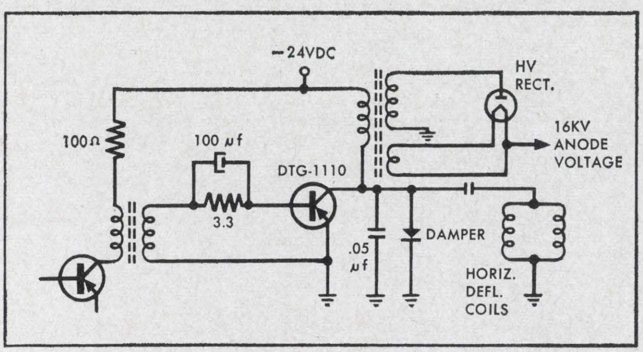


These four high power Nu-Base germanium transistors were created to relieve some special problems where reliable peak power handling is a requirement. Each is in a class by itself with special benefits for ignition, TV horizontal sweep circuits and high power audio output (tentative specifications are provided).

These are rugged, durable transistors with built-in protection against secondary breakdown (thanks to Delco's Hydrokinetic Alloy process). Extreme parameter stability is a result of our Surface Passivation and Ambient Control (SPAC).

THE DTG-1110

This is a 200-volt 15-amp transistor with high power dissipation characteristics, low thermal resistance and a rugged performance record.



TV horizontal deflection incorporating the DTG-1110.

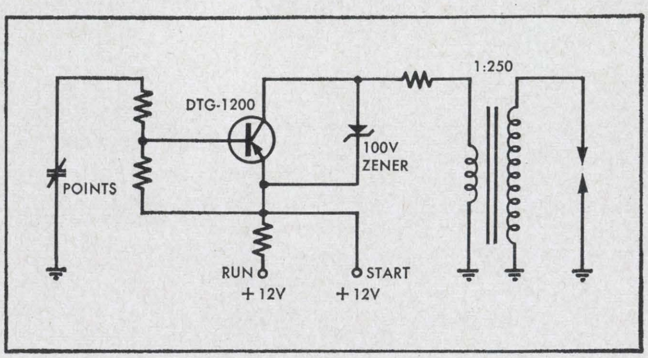
The drive requirements for your circuits are substantially reduced because of the high saturated current gain of this special application transistor.

THE DTG-1010

A 325-volt 15-amp transistor, this device's higher voltage offers many advantages. It's ideal for switching high inductive loads as found in many CRT deflection circuits.

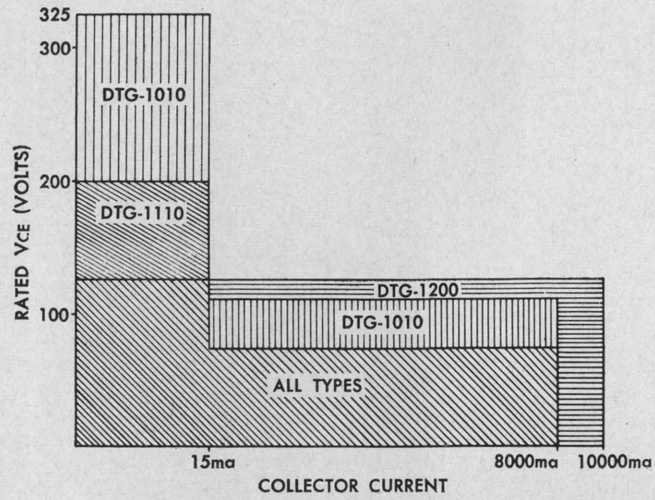
THE DTG-1200

With a (V_{CE} Sus) rating of −120 volts, it offers excellent gain, high speed and high sustaining voltage characteristics.



Automobile ignition circuit with the DTG-1200.

It's the ideal transistor for an ignition circuit. Also can be used in fluorescent light power inverter circuits. Mobile or portable operation is possible and fluorescent tube efficiency is improved due to higher oscillation frequency.



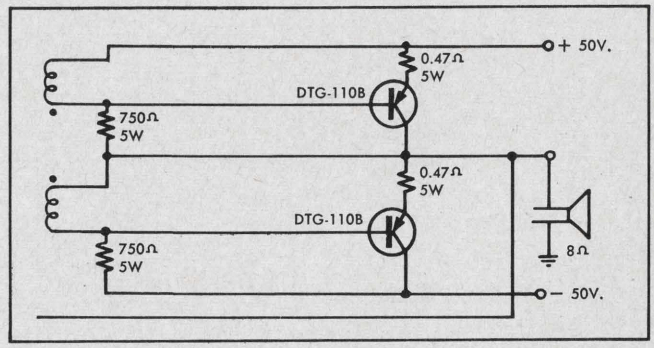
Tested sustaining voltage areas of the DTG-1110, DTG-1010 and DTG-1200.

THE DTG-110B

The DTG-110B is a high power transistor which will substantially reduce component costs and improve the reliability of quality home entertainment audio output circuits. It's designed especially for use in high fidelity amplifiers.

The linear gain and the specific gain band-width product of the DTG-110B offer low distortion and improved amplifier gain-phase characteristics.

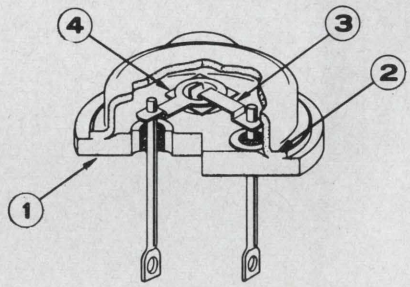
Exceptional efficiency in the driver stages is possible because of the DTG-110B's superb transconductance properties.



This two-stage output circuit produces well in excess of 50 watts RMS audio power with a simple drive requirement.

THE TO-3 PACKAGE

Delco Radio's TO-3 package wraps up this group of transistors.



With its solid copper base (1), maximum thermal resistance is just 0.8° per watt, and freedom from conventional weld contamination is assured with Delco cold weld construction (2). The TO-3 heavy-duty connectors (3) offer high current ruggedness, and the large germanium wafer (4) delivers high continuous and peak power handling ability.

Totally, four Nu-Base specialists in Delco TO-3 packages. For data, prices and delivery, call one of our sales offices or your Delco Radio Semiconductor Distributor.

	DTG-1110	DTG-1010	DTG-1200	DTG-110B
Collector Emitter Voltage (V_{CE} SUS)			—120V	—40V
Collector to Emitter Voltage (V_{CEX})	—200V	—325V		—90V
Collector Emitter Voltage (V_{CEO})				—40V
*Emitter Diode Voltage (V_{EBO})	—1.0V	—1.0V	—1.0V	—2V
Collector Current (I_C)	—15A	—15A	—15A	—25A
Base Current (I_B)	—3A	—3A	—3A	—5A
Maximum Junction Temperature	110°C	110°C	110°C	110°C
Minimum Junction Temperature	—65°C	—65°C	—65°C	—65°C
Lead Temperature 1/16" ± 1/32" from case for 2 seconds	245°C	245°C	245°C	245°C

*This voltage can be exceeded provided the maximum I_B and device dissipation limits are not exceeded.

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Division of General Motors, Kokomo, Indiana

ON READER-SERVICE CARD CIRCLE 20

Power *(continued)*

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 64	2N176	MO	pnp,AJ,ge	90	1.2	100	*40	3	*25-90	–	7	3	DE, KSC, ITT
	2N178	MO	pnp,ge	90	1.43	90	30	3	*15-45	3	5	3	KSC
	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
	2N257	CL	–	90	–	100	35	5	–	2	5	3	KSC, BE
	2N268	ITT	–	90	–	100	60	5	–	2	6	3	KSC, BE
	2N268A	ITT	–	90	–	100	60	5	20	2	–	3	KSC, BE
	2N297A	ITT	–	90	–	100	60	5	20	2	–	3	MO, KSC, BE, DE
	2N350A	MO	pnp,AJ,ge	90	1.2	100	*50	3	20-60	3	5	3	KSC, BE
	2N351A	MO	pnp,AJ,ge	90	1.2	100	*50	4	*25-90	3	5	3	KSC, ITT
P 65	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
	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
	2N637A	BE	–	90	–	–	55	5	*30-60	–	–	3	KSC
	2N637B	BE	–	90	–	–	65	5	*30-60	–	–	3	KSC
	2N638	BE	–	90	–	–	30	5	*20-40	–	–	3	KSC
	2N638A	BE	–	90	–	–	65	5	*30-60	–	–	3	KSC
P 66	2N638B	BE	–	90	–	–	65	5	*20-40	–	–	3	KSC
	2N669	MO	pnp,AJ,ge	90	1.6	100	*40	3	90	3	5	3	DE, KSC
	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
	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
P 67	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
	2N1136A	BE	–	90	–	–	55	5	*50-100	–	–	3	KSC, ITT
	2N1136B	BE	–	90	–	–	65	5	*50-100	–	–	3	KSC, ITT
	2N1137	BE	–	90	–	–	30	5	75-150	–	–	3	KSC, ITT
	2N1137B	BE	–	90	–	–	65	5	*75-150	–	–	3	KSC, ITT
	2N1138	BE	–	90	–	–	30	5	100-200	–	–	3	KSC, ITT
P 68	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
	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
P 69	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
	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
P 70	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
	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

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{\circ}C$	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 71	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
	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
P 72	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
	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
P 73	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
	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
P 74	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
	2N1548	MO	pnp,AJ,ge	90	1.2	100	*120	5	*75	2	4	3	KSC, BE, ITT
	2N1549	MO	pnp,AJ,ge	90	1.2	100	20	15	*10	3	10	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
P 75	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
	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
P 76	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
	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	
	2N2063A	ITT	–	90	–	100	20	5	20	2	5	3	
	2N2064A	ITT	–	90	–	100	20	5	50	2	1	3	
P 77	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
	DTG411	DE	npn,TDP,si	90	0.8	150	300	1.0	*90	–	–	3	
	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	
	2N2286	BE	–	100	–	–	60	25	*20	–	–	3	

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{o}C$	T_j (^{o}C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $\dagger I_{CEX}$ (mA)	$f_{\alpha e}$ $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 78	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	
	151-04	WH	npn,AJ,si	100	1.4	150	*80	6.0	*11	10	25	†	†MT-1
	151-05	WH	npn,AJ,si	100	1.4	150	*100	6.0	*11	10	25	†	†MT-1
	151-06	WH	npn,AJ,si	100	1.4	150	*120	6.0	*11	10	25	†	†MT-1
	151-07	WH	npn,AJ,si	100	1.4	150	*140	6.0	*11	10	25	†	†MT-1
P 79	151-08	WH	npn,AJ,si	100	1.4	150	*160	6.0	*11	10	25	†	†MT-1
	151-09	WH	npn,AJ,si	100	1.4	150	*180	6.0	*11	10	25	†	†MT-1
	151-10	WH	npn,AJ,si	100	1.4	150	*200	6.0	*11	10	25	†	†MT-1
	151-12	WH	npn,AJ,si	100	1.4	150	*145	6.0	*11	10	25	–	
	151-14	WH	npn,AJ,si	100	1.4	150	*165	6.0	*11	10	25	–	
	151-16	WH	npn,AJ,si	100	1.4	150	*185	6.0	*11	10	25	–	
	151-18	WH	npn,AJ,si	100	1.4	150	*205	6.0	*11	10	25	–	
	151-20	WH	npn,AJ,si	100	1.4	150	*225	6.0	*11	10	25	–	
	152-04	WH	npn,AJ,si	100	1.4	150	*80	6.0	*18	10	25	†	†MT-1
	152-05	WH	npn,AJ,si	100	1.4	150	*100	6.0	*18	10	25	†	†MT-1
P 80	152-06	WH	npn,AJ,si	100	1.4	150	*120	6.0	*18	10	25	†	†MT-1
	152-07	WH	npn,AJ,si	100	1.4	150	*140	6.0	*18	10	25	†	†MT-1
	152-08	WH	npn,AJ,si	100	1.4	150	*160	6.0	*18	10	25	†	†MT-1
	152-09	WH	npn,AJ,si	100	1.4	150	*180	6.0	*18	10	25	†	†MT-1
	152-10	WH	npn,^J,si	100	1.4	150	*200	6.0	*18	10	25	†	†MT-1
	152-12	WH	npn,AJ,si	100	1.4	150	*145	6.0	*18	10	25	–	
	152-14	WH	npn,AJ,si	100	1.4	150	*165	6.0	*18	10	25	–	
	152-16	WH	npn,AJ,si	100	1.4	150	*185	6.0	*18	10	25	–	
	152-18	WH	npn,AJ,si	100	1.4	150	*205	6.0	*18	10	25	–	
	152-20	WH	npn,AJ,si	100	1.4	150	*225	6.0	*18	10	25	–	
P 81	40355	RCA	npn,si	100	1000	175	6.6	*150	50	–	.005(max)	2.8	
	DTS-423	DE	npn,si	100	1.33	150	400	3.5	30-90	–	6000	3	
	40363	RCA	npn,si	115	0.657	200	70	15	*20-70	–	*700	3	Icer=0.5 mA
	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	
	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	
	2N3488	MO	npn,AE,si	117	0.66	200	80	7.5	*20-60	0.025	–	61	
P 82	2N3489	MO	npn,AE,si	117	0.66	200	100	7.5	*15-45	0.025	–	61	
	2N3490	MO	npn,AE,si	117	0.66	200	60	7.5	*40-120	0.025	–	61	
	2N3491	MO	npn,AE,si	117	0.66	200	80	7.5	*40-120	0.025	–	61	
	2N3492	MO	npn,AE,si	117	0.66	200	100	7.5	*30-90	0.025	–	61	
	40251	RCA	npn, si	117	0.668	200	40	7	*15-60	5	–	3	
	40325	RCA	npn,si	117	0.668	200	35	15	*12-60	5	–	3	
	156-04	WH	npn,DJ,si	120	0.68	200	40	8	*15	20	60	–	
	156-06	WH	npn,DJ,si	120	0.68	200	60	8	*15	20	60	–	
	156-08	WH	npn,DJ,si	120	0.68	200	80	8	*15	20	60	–	
	156-10	WH	npn,DJ,si	120	0.68	200	100	8	*15	20	60	–	
P 83	2N1899	TRWS	npn,PL,si	125	1.0	150	*140	10	5.0	10	2500	–	
	2N1900	TRWS	npn,PL,si	125	1.0	150	*140	10	*>8	10	5000	–	
	2N1901	TRWS	npn,PL,si	125	1.0	150	*140	10	5	10	2000	–	
	2N1902	TRWS	npn,PL,si	125	1.0	150	*140	10	5	10	5000	–	
	2N1903	TRWS	npn,PL,si	125	1.0	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
	DTS430	DE	npn, TDP,si	125	0.7	150	400	2.5	*45	–	*4000	3	
P 84	DTS431	DE	npn, TDP, si	125	0.7	150	400	2.5	*35	–	*4000	3	
	2N2733	SOL	pnp,ge	141	1.67	110	*80	65	*30-120	5.0	350	–	
	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

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	W/°C	T_j (°C)	V_{CEO} $*V_{CBO}$ (V)	I_c (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	f_{ae} $*f_T$ (kHz)	Package Outline (TO-)	Remarks
P 85	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
	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	–	–	
P 86	2N512B	TI	pnp,ge	150	2	100	*80	25	*20	0.5	–	–	
	2N513	TI	pnp,ge	150	2	100	*40	25	*20	0.5	–	–	
	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
P 87	2N1358	DE	pnp, AJ, ge	150	0.5	100	-80	-15	*40-80	-4	100	36	RCA
	2N1412	DE	pnp, AJ, ge	150	0.5	100	100	15	*25-50	4	10	36	RCA
	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
	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
P 88	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	–	
	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	–	
P 89	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	–	
	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	–	
P 90	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	
	2N3772	RCA	npn, si	150	0.855	200	60	30	*15-60	5	*700	3	
	2N3773	RCA	npn, si	150	.855	200	140	30	*15-60	2	*500	3	
	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	
P 91	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	
	TI3027	TI	pnp,ge	150	2	100	*45	7	*40	1	–	3	
	TI3028	TI	pnp,ge	150	2	100	*60	7	*40	1	–	3	
	TI3029	TI	pnp,ge	150	2	100	*80	7	*40	1	–	3	
	TI3030	TI	pnp,ge	150	2	100	*100	7	*40	1	–	3	
	TI3031	TI	pnp,ge	150	2	100	*120	7	*40	1	–	3	

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{o}C$	T_j (^{o}C)	V_{CEO} *V_{CBO} (V)	I_c (A)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	f_{ae} *f_T (kHz)	Package Outline (TO-)	Remarks
P 92	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	
	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	
P 93	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	
	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	
P 94	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	
	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	
P 95	2N2357	BE	–	170	–	–	30	50	*15	–	–	41	
	2N2358	BE	–	170	–	–	60	50	*15	–	–	41	
	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	
	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	
P 96	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	
	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	
	MP500	MO	pnp,AJ,ge	170	2	110	30	60	*30-60	4	3.6	36	
P 97	MP500A	MO	pnp,AJ,ge	170	2	110	30	60	*30-60	4	3.6	36	
	MP501	MO	pnp,AJ,ge	170	2	110	45	60	*30-60	4	3.6	36	
	MP501A	MO	pnp,AJ,ge	170	2	110	45	60	*30-60	4	3.6	36	
	MP502	MO	pnp,AJ,ge	170	2	110	60	60	*30-60	4	3.6	36	
	MP502A	MO	pnp,AJ,ge	170	2	110	60	60	*30-60	3	3.6	36	
	MP504	MO	pnp,AJ,ge	170	2	110	30	60	*50-100	4	3.6	36	
	MP504A	MO	pnp,AJ,ge	170	2	110	30	60	*50-100	4	3.6	36	
	MP505	MO	pnp,AJ,ge	170	2	110	45	60	*50-100	4	3.6	36	
	MP505A	MO	pnp,AJ,ge	170	2	110	45	60	*50-100	4	3.6	36	
	MP506	MO	pnp,AJ,ge	170	2	110	45	60	*50-100	4	3.6	36	
P 98	MP506A	MO	pnp,AJ,ge	170	2	110	45	60	*50-100	4	3.6	36	
	2N2580	DE	pnp,DD,si	178	.7	150	400	10	10-40	–	50	36	
	2N2581	DE	npn,DD,si	178	.7	150	400	*@10A	*10	–	50	36	
	2N2582	DE	npn,DD,si	178	.7	150	500	*@5A	*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	–	
	2N1157	SOL	pnp,ge	187	2.5	100	*60	40	*38-84	7	200	–	

(see pages 4-9 for explanation of company abbreviations.)

Power *(continued)*

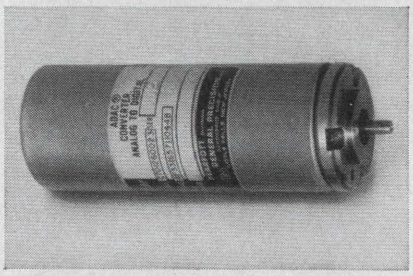
Cross Index Key	Type No.	Mfr.	Type	MAX. RATINGS P_c (W)	$W/^{o}C$	T_j (^{o}C)	V_{CEO} *V_{CBO} (V)	I_c (A)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$f_{\alpha e}$ *f_T (kHz)	Package Outline (TO-)	Remarks
P 99	2N1157A	SOL	pnp,ge	187	2.5	100	*80	40	*38-84	20.	200	–	
	2N2739	WH	npn,AJ,si	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
	2N2751	WH	npn,AJ,si	200	2	175	50	20	*10	15	16	†	† MT 1
P 100	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
	2N2764	WH	npn,AJ,si	200	2	175	100	30	*10	15	14.5	†	† MT 33
P 101	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
	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
P 102	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
	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
	153-04	WH	npn, AJ, si	200	1.33	175	65	7.5	*15	10	33	–	
	153-06	WH	npn, AJ, si	200	1.33	175	85	7.5	*15	10	33	–	
	153-08	WH	npn, AJ, si	200	1.33	175	105	7.5	*15	10	33	–	
P 103	153-10	WH	npn, AJ, si	200	1.33	175	125	7.5	*15	10	33	–	
	153-12	WH	npn, AJ, si	200	1.33	175	145	7.5	*15	10	33	–	
	153-14	WH	npn, AJ, si	200	1.33	175	165	7.5	*15	10	33	–	
	153-16	WH	npn, AJ, si	200	1.33	175	185	7.5	*15	10	33	–	
	153-18	WH	npn, AJ, si	200	1.33	175	205	7.5	*15	10	33	–	
	153-20	WH	npn, AJ, si	200	1.33	175	225	7.5	*15	10	33	–	
	154-04	WH	npn,AJ,si	200	1.33	175	*65	7.5	*25	10	33	–	
	154-06	WH	npn, AJ, si	200	1.33	175	85	7.5	*25	10	33	–	
	154-08	WH	npn, AJ, si	200	1.33	175	105	7.5	*25	10	33	–	
	154-10	WH	npn, AJ, si	200	1.33	175	125	7.5	*25	10	33	–	
P 104	154-12	WH	npn, AJ, si	200	1.33	175	145	7.5	*25	10	33	–	
	154-14	WH	npn, AJ, si	200	1.33	175	165	7.5	*25	10	33	–	
	154-16	WH	npn, AJ, si	200	1.33	175	185	7.5	*25	10	33	–	
	154-18	WH	npn, AJ, si	200	1.33	175	205	7.5	*25	10	33	–	
	154-20	WH	npn, AJ, si	200	1.33	175	225	7.5	*25	10	33	–	
	163-06	WH	pnp, AJ, si	200	2.0	175	75	20	*15	15	22	†	† MT33
	163-08	WH	npn,AJ,si	200	2	175	95	20	*15	15	22	†	† MT 33
	163-10	WH	npn,AJ,si	200	2	175	115	20	*15	15	22	†	† MT 33
	163-12	WH	npn,AJ,si	200	2	175	135	20	*15	15	22	†	† MT 33
	163-14	WH	npn,AJ,si	200	2	175	155	20	*15	15	22	†	† MT 33
P 105	163-18	WH	npn,AJ,si	200	2	175	175	20	*15	15	22	†	† MT 33
	163-20	WH	npn,AJ,si	200	2	175	215	20	*15	15	22	†	† MT 33
	164-04	WH	npn,AJ,si	200	2	175	55	20	*25	15	22	†	† MT 33
	164-06	WH	npn,AJ,si	200	2	175	75	20	*25	15	22	†	† MT 33
	164-08	WH	npn,AJ,si	200	2	175	95	20	*25	15	22	†	† MT 33
	164-10	WH	npn,AJ,si	200	2	175	115	20	*25	15	22	†	† MT 33
	164-12	WH	npn, AJ, si	200	2.0	175	135	20	*25	15	22	†	† MT 33
	164-14	WH	npn, AJ, si	200	2.0	175	155	20	*25	15	22	†	† MT 33
	164-16	WH	npn, AJ, si	200	2.0	175	175	20	*25	15	22	†	† MT 33
	164-18	WH	npn, AJ, si	200	2.0	175	195	20	*25	15	22	†	† MT 33

(see pages 4-9 for explanation of company abbreviations.)

INSPIRATIONAL THOUGHTS FOR THE TECHNICALLY INCLINED

ITTSY BITS

Why the baby talk? We're bubbling with happiness over our latest baby. It's the fifth generation of a native-born family, and although the smallest, it is undoubtedly the best today by virtue of its breeding. This latest offspring is the new Size 11 Shaft Encoder we have named ADAC. Now ADAC, like its ancestors, is characterized by engraved drums which are interconnected by high-speed, anti-backlash, continuous gearing and by special brushes which interrogate and read out the drum position on the run or at rest.



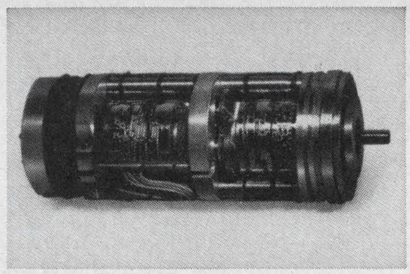
At this point we can almost hear you say, "So what's new about that?" It's an all-around better baby! First of all, the ADAC is a high-speed device designed to run at 200 rpm input shaft speed. It can be interrogated on a bit-by-bit basis in 1 millisecond while on the run. Even more important, it packs a lot of bits into a tiny package – for example, in a can only 1 062″ in diameter and 2.355″ long, you can buy a count of 16,384 bits (2^{14}). We have also included all the advantages of V scan (U scan optional) for unambiguous binary outputs and have incorporated all necessary diode logic as well.

ADAC units are available as binary encoders covering the range of 2^8 through 2^{14}. We also have BCD encoders in decimal counts to 99999 and angular counts to 359.9°. A 2^{10} gray code device is also available.

To give you a better idea of the new encoder's breeding, we think these statistics will prove helpful.

TYPE SIZE 11 UNITS

CHARACTERISTIC	BINARY	BCD
Voltage/Current	28vdc/20ma	28vdc/20ma
Interrogation	Pulsed or continuous	Serial
Readout	On run and static	
Output	Parallel	Parallel digit, serial between digits
Time Sharing	Isolation diodes are standard to permit time sharing	
Counts per revolution	126 or 256	100
Starting Torque	0.20 in. oz.	0.20 in. oz.
Accuracy	± 1 bit for any given input shaft angle	
Life	5,000,000 revolutions at 300 rpm (min)	



SUMMARY OF OTHER FEATURES

■ Solid gold alloy drums and brushes ■ In-line brush geometry ■ Continuous precision gearing ■ Flush conducting and non-conducting drum surface ■ Steel shafts and precision bearings ■ Standard Size 11 mounting ■ Isolation diodes for positive and negative logic included.

The proud parents are anxious to send you a brand new brochure celebrating the event, so let us know who you are and where we can find you.

INERTIA

Sometimes it takes a sharp push to get things going. We say we're working against inertia. At other times we pull and haul to get things "off the dime" overcoming a kind of viscous unwillingness. But inertia and viscosity can be real advantages instead of irritants. There are times, for example, when a tach generator (we make them, too) can be replaced by a viscous or inertial damped servo motor. There's been a lot written on the subject, and we're not going to discuss the obvious advantages of these devices except for the following summary and an invitation to write for more details.

TYPICAL DAMPED SERVOMOTOR CHARACTERISTICS

TYPE—VISCOUS

SIZE	8	8
Part Number	CMO 0180 450	CMO 1302 450
Stall Torque	0.26 in. oz.	0.31
No-Load Speed	5190 rpm	6200
Rotor Moment of Inertia	0.69 gm cm^2	0.48
Theoretical Accel at Stall	28,600 rad/sec^2	48,500
Time Constant	0.0531 sec	0.0119
Fly Wheel Damping	—	196 dyne-cm-sec
Fly Wheel Inertia	—	4.6 gm cm^2
Weight	2.0 oz.	2.6

TYPE—INERTIAL

SIZE	11	15	18
Part Number	CRO 1300 660	T1310-41B	R1320-2B
Stall Torque	0.60	1.45	2.25
No-Load Speed	6000	4500	4500
Rotor Moment of Inertia	1.45	5.48	6.25
Theoretical Accel at Stall	30,700	18,700	26,000
Time Constant	0.022	0.0255	0.0185
Fly Wheel Damping	100	750	750
Fly Wheel Inertia	10	100	100
Weight	6.0	12.0	18

KEARFOTT DIVISION

GENERAL PRECISION INC.

AEROSPACE GROUP
Little Falls, New Jersey

ON READER-SERVICE CARD CIRCLE 22

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 106	164-20	WH	npn, AJ, si	200	2.0	175	215	20	*25	15	22	†	† MT 33
	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
	2N1817	WH	npn, AJ, si	250	2.22	175	100	30	*10	15	14.5	†	† MT 14
P 107	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	2.22	175	50	30	*10	15	16	†	† MT 14
	2N1824	WH	npn, AJsi	250	2.22	175	100	30	*10	15	16	†	† MT 14
	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
P 108	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
	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
P 109	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
	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	–	–	*	*1¹⁄₁₆" Hex
	2N3150	STC	npn	300	2	200	100	70	*10	–	–	*	*1¹⁄₁₆" Hex
P 110	2N3151	STC	–	300	2	200	150	70	*10	–	–	*	*1¹⁄₁₆" Hex
	DTG-1010	DE	pnp, ge	–	0.8	110	*325	15	*12	–	250	3	
	DTG1200	DE	pnp,ge	–	1.25	110	*120	15	0.2	–	250	–	
	DTG-2000	DE	pnp,ge	–	1.25	110	60	25	*25	10	250	3	
	DTG-2100	DE	pnp,ge	–	1.25	110	*80	25	*25	10	250	3	
	DTG-2200	DE	pnp,ge	–	1.25	110	100	25	*25	10	250	3	
	DTG-2300	DE	pnp,ge	–	1.25	110	*120	25	*25	10	250	3	
	DTG-2400	DE	pnp,ge	–	1.25	110	*140	25	*25	10	250	3	
	DTS-413	DE	npn,si	–	0.8	150	400	2.0	20-80	–	5000	3	
	2N4079	AMP	2N4077 & 2N4078 combined to form matched complementary pair										
P 111	2N4107	AMP	2N4105 & 2N4106 combined to form matched complementary pair										
	2N4136	AMP	2N2430 & 2N2431 combined to form matched complementary pair										

(see pages 4-9 for explanation of company abbreviations.)

This 5 MHz counter/timer from Monsanto is only 3½ inches high, and weighs just 16 pounds. Yet it gives you a time base range from 1 μ second to 100 seconds in decade steps, and resolution for frequency measurement of 0.01 Hz.

HOW COME? Integrated circuits. In 90% of the active circuits. That's how Monsanto builds big performance into a small package. Plus speed, accuracy, reliability, low power consumption, low heat generation and easy maintenance. Six of the 13 printed circuit boards are interchangeable.

HOW MUCH? Just $1575. And that low selling price goes with these "high-priced" specs:

• Measures average frequency: 0—5 MHz • Measures average periods: 0.2 μ sec. to 1 sec. • Measures single periods: 1 μ sec. to 10^6 sec. • Measures frequency ratios: 10^{-6} to 10^6 • Measures time intervals: 1 μ sec. to 10^6 sec. • Counts: random or uniformly spaced signals. Want to know more? Just clip the coupon.

Monsanto ®

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Details, please, on the Model 1010 5 MHz Counter/Timer ☐
Model 1000 20 MHz Counter/Timer ☐

Name/Title______________________________

Firm______________________________

Address______________________________

City/State/Zip______________________________

ON READER-SERVICE CARD CIRCLE 23

Low-Level Switching

Generally types rated under one watt. In order of $f_{\alpha e}$ or f_T.

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS 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
	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
	2N328B	TI	pnp,PL,si	0.05	500	200	2.9	35	50	*30	.001	110	0.5	5	SPR
	2N329	RA	pnp,si	0.05	340	160	2.5	30	5	60	0.1	*110	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
LL 2	2N329B	TI	pnp,PL,si	0.05	500	200	2.9	30	50	*60	.001	110	0.6	5	SPR
	2N1034	RA	pnp,si	0.05	250	160	1.85	40	50	15	1	*110	0.5	5	KSC, CT, ETC, SPR
	2N1035	RA	pnp,si	0.05	250	160	1.85	35	50	30	1	*110	0.4	5	KSC, CT, ETC, SPR
	2N1036	RA	pnp,si	0.05	250	160	1.85	30	50	60	1	*110	0.3	5	KSC, CT, ETC, SPR
	2N1037	RA	pnp,si	0.05	250	160	1.85	35	50	25	1	*110	0.5	5	KSC, CT, ETC, SPR
	2N1275	RA	pnp,si	0.05	250	160	1.85	80	50	*15	1	*110	0.3	5	CT, SPR
	2N1640	CT	pnp,SYM	*0.4	250	160	1.9	20	50	*6	.01	*50	–	5	
	2N1641	CT	pnp,SYM	*.8	250	160	1.9	10	50	*10	.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	–	.002	*14	.003	18	CT, Chopper Pairs, SPR
	2N946	SSD	AJ	1	250	175	1.67	80	50	–	.004	*14	.005	18	CT, Chopper Pairs, SPR
	2N944	SSD	AJ	1	250	175	1.67	18	50	–	.003	*14	.004	18	CT, Chopper Pairs, SPR
	2N945	SSD	AJ	1	250	175	1.67	50	50	–	.004	*14	.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	.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	.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	.002	*9	–	18	Chopper
	2N356	GI	npn,AJ,ge	3	100	85	2.0	*20	–	*20-50	5	*14	.20	5	TI
	2N356A	GI	npn,AJ,ge	3	150	100	2.0	*30	–	*20-50	5	*14	.20	5	TI
	2N426	TI	pnp,AJ,ge	3	150	100	2.5	*30	400	*30-60	25	*20	.32	5	
LL 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	.20	5	
	2N1051		npn,DD,si	3	500	150	4	40	100	30-100	.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	.0005	*10	–	46	
	T-404	NUC	pnp,ge	3.5	120	80	–	*25	100	–	5	*20	0.2	1	
	2N404		pnp,AJ,ge	4	150	85	–	24	100	*24	2	–	.1	5	AMP, GI, TI, RCA, NUC
LL 6	2N404A	RCA	pnp,AJ	4	150	85	–	35	100	24	2	–	.1	5	NUC
	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	
	2N1808	TI	npn,AJ,ge	4	150	100	2.5	25	300	*125	5	*20	.15	5	
	2N1169	RCA	npn,AJ,ge	4.5	120	71	–	18	–	*20	10	19	–	5	
	2N1170	RCA	npn,AJ,ge	4.5	120	71	–	20	–	*20	8	19	–	5	AMP
	2N315	GI	pnp,AJ,ge	5	100	85	2	*20	200	*15-30	2	*14	.15	5	TI, IND
	2N315A	GI	pnp,AJ,ge	5	150	100	2	*25	200	*20-50	2	*14	.15	5	TI, IND
	2N315B	GI	pnp,AJ,ge	5	150	100	2	*30	200	*20-50	2	*14	.15	5	
	2N388	TI	pnp,AJ,ge	5	150	100	2	25	500	*60-180	10	*20	–	5	
LL 7	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	.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
	2N2945	CT	pnp,si	*5	400	200	2.3	25	100	*40	.0002	*10	–	46	
	2N3677	CT	pnp,si	5	400	200	–	20	100	–	.001	6	.001	46	
	2N357	GI	npn,AJ,ge	6	100	85	2	*20	–	*20-50	5	*14	.20	5	TI
	2N357A	GI	npn,AJ,ge	6	150	100	2	*30	–	*25-75	5	*14	.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

(see pages 4-9 for explanation of company abbreviations.)

Low-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ (µA)	C_{oe} $*C_{ob}$ (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 8	2N1319	RCA	pnp,AJ,ge	6	120	71	–	*20	400	*30	2.5	*20	0.2	5	TI
	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
	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	.0005	*9	–	46	Chopper
	3N123	SPR	pnp,PE,si	6	100	200	0.58	*30	20	–	0.01	*10	–	72	Dual
	UD-1001	SPR	npn, PE, si	6	200	200	1.1	30	20	–	0.010	*8	–	90	Twin Dual
	UD-1002	SPR	npn, PE,si	6	200	200	1.1	30	20	–	0.010	*8	–	–	Twin Dual, 8 lead flat pack
	UD-1003	SPR	pnp,PE,si	6	200	200	1.1	50	20	–	0.010	*8	–	–	Twin Dual, 8 lead flat pack
LL 9	UD-2000	SPR	pnp,PE,si	6	400	200	–	50	100	*50	0.001	*6	0.1	–	Twin Dual, 6 lead flat pack
	2N3317	SPR	pnp,SP,si	*6.4	150	140	1.3	30	50	–	.001	*9	–	18	Chopper
	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	.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,SR,si	*7.5	150	140	1.3	25	50	65	0.1	*5	0.06	18	*PH orig Reg, CT
LL 10	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	–	.001	*9	–	18	Chopper
	2N414	RCA	pnp, AJ, ge	8	150	85	–	*30	200	80	2	*11	–	5	LAN
	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
LL 11	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	.20	5	TI
	2N358A	GI	npn,AJ,ge	9	150	100	2.0	*30	–	*25-75	5	*14	.20	5	TI
	2N428	TI	npn,AJ,ge	10	150	100	2.5	*30	400	*60	25	*20	.32	5	
	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	.0025	*14	.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
LL 12	2N2944	CT	pnp,si	*10	400	200	2.3	*15	100	*80	.0001	*10	–	46	
	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	.1	*3	1.5	46	
	40346	RCA	npn,si	*10	5W	200	28.5	–	0.5A	*25 (min)	*5	–	0.5	5	V_{CER} = 175
	TW-135	SPR	pnp, PE,si	10	400	200	2.4	30	100	*50	0.001	*9	0.15	18	Complementary to 2N2432
	2N316	GI	pnp,AJ,ge	12	100	85	2.0	*20	200	*20-50	2	*14	.18	5	IND
	2N316A	GI	pnp,AJ,ge	12	150	100	2.0	*25	200	*20-50	2	*14	.18	5	IND
	2N3019	FA	npn,DPE,si	12	800	200	28.6	*140	100	5	–	12	0.2	5	
	2N3020	FA	npn,DPE,si	12	800	200	28.6	*140	100	4	–	12	0.2	5	
LL 13	2N3319	SPR	pnp,SP,si	*12	150	140	1.3	*10	50	–	50	*10	–	18	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	35	0.001	*6	–	5	Chopper, CT
	2N337A	GE	npn,DG,si	*15	500	175	3.33	*45	20	*20-55	.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
	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
LL 14	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	
	2N3677	CT	EP,si	*15	400	200	2.3	*30	100	–	0.001	*10	–	18	Low Rec (SAT) Chopper
	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	.0025	*14	.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

(see pages 4-9 for explanation of company abbreviations.)

Low-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $^*f_T$ (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (mA)	CHARACTERISTICS h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ (µA)	C_{oe} $^*C_{ob}$ (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 15	2N2281		pnp, SP, si	*16	150	140	1.3	*10	50	–	0.003	*7	–	18	Matched 2N2280's, 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	.20	5	TI, IND
	2N317A	GI	pnp,AJ,ge	20	150	100	2.0	*25	400	*20-60	2	*14	.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	
	2N2353	GE	npn, PL, si	20	350	200	–	25	1	*20	–	20	0.35	46	
	2N2678	GE	npn,DG,si	*20	250	175	1.66	*45	25	45-150	.1	*3	1.5	46	
LL 16	UD-1000	SPR	npn,PE,si	20	200	200	1.1	20	20	–	0.010	*10	–	90	Twin Dual
	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	.5	3	1.5	5	TR
	2N524A	MO	pnp,AJ,ge	25-42	225	100	6.67	*45	500	18-41	10	*40	0.130	5	
	2N842	TR	npn,PE,si	30	300	175	2	45	50	*20-55	1	10	1.2	18	
	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 17	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	
	2N1683	RCA	pnp,MS,ge	*50	150	85	–	12	100	*50	3	–	–	5	TI, SPR
	TN-79	SPR	npn, PE, si	50	800	200	4.57	*30	800	*100	0.010	*10	–	5	DC/AC Chopper
	TN-80	SPR	npn,PE,si	50	500	200	2.86	*30	800	*100	0.010	*10	–	18	DC/AC Chopper
	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
	2N1301	RCA	pnp,MS,ge	*60	150	85	–	*13	100	30	3	–	–	5	SPR, TI
LL 18	S18200	FA	npn,DPE,si	60	.4	200	11.4	60	500	300	–	20	.25	50	
	2N398A	MO	pnp,AJ,ge	65	150	100	2	105	200	*65	12	–	.11	5	GI, TI, RCA
	2N3107	FA	npn,DPE,si	70	800	200	4.57	100	1000	60	.01	20	10	5	
	2N3109	FA	npn,DPE,si	70	800	200	4.57	80	1000	60	.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		pnp,MS,ge	80	150	85	–	*13	100	*85	13	–	–	18	SPR
	2N1131A	HU	pnp	*80	750	175	–	*60	–	*30	–	–	–	5	
	2N1132A	HU	pnp	*80	750	175	–	*60	–	*60	–	–	–	5	MO
LL 19	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
	2N3108	FA	npn,DPE,si	96	800	200	4.57	100	1000	40	.01	20	10	5	
	2N3110	FA	npn,DPE,si	96	800	200	4.57	80	1000	40	.01	25	150	5	
	2N1139	TR	npn,PE,si	100	500	175	6.6	15	100	*20-200	5	12	.7	5	
	2N1254	HU	pnp	*100	275	175	–	30	–	30	–	8	–	5	
	2N1255	HU	pnp	*100	275	175	–	30	–	*60	–	8	–	5	
	2N1256	HU	pnp	*100	275	175	–	40	–	*30	–	8	–	5	
	2N1257	HU	pnp	*100	275	175	–	40	–	*60	–	8	–	5	
	2N1258	HU	pnp	*100	275	175	–	30	–	*100	–	8	–	5	
LL 20	2N1259	HU	pnp	*100	275	175	–	50	–	*50	–	8	–	5	
	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	.002	*75	0.5	5	CDC, GI, TR, TRWS
	2N2569	AMP	npn,PE,si	100	300	175	2	*20	100	*50	.01	*10	0.2	18	Chopper – Voffset=145
	2N2570	AMP	npn,PE,si	100	300	175	2	*20	100	*50	.01	*10	0.2	18	Chopper – Voffset=350
	2N3883	MO	pnp,EM,ge	*100	750	100	10	15	300	*30	†	*8	0.5	5	Ices =100
	3N71	SSD	n,PL	*100	100	200	.57	*15	10	*40	.010	*6	50	18	Dual-Emitter Chopper
	3N72	SSD	n,PL	*100	100	200	.57	*15	10	*40	.010	*6	100	18	Dual-Emitter Chopper
	3N73	SSD	n,PL	*100	100	200	.57	*15	10	*40	.010	*6	200	18	Dual-Emitter Chopper
	FT34C	FA	npn,DPE,si	100	800	200	.0286	*150	–	*120	–	–	1	5	
LL 21	FT34D	FA	npn,DPE,si	100	800	200	.0286	120	–	*300	–	–	1	5	
	MCS2135	MO	npn,AE,si	*100	150	125	1.5	60	50	*100-300	.01	*3	0.3	–	
	MCS2136	MO	npn,AE,si	*100	150	125	1.5	60	50	*250-750	.01	*3	0.3	–	
	MCS2137	MO	pnp,AE,si	*100	150	125	1.5	60	50	*100-300	.02	*3	0.2	–	
	MCS2138	MO	pnp,AE,si	*100	150	125	1.5	60	50	*250-750	.02	*3	0.2	–	
	2N1204	MO	pnp, EP, ge	*110	750	100	10	15	500	*15	7	*6.5	0.4	5	
	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
	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	

(see pages 4-9 for explanation of company abbreviations.)

Low-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} (µA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 22	2N2800	MO	pnp,AE,si	*120	3W	200	1.73	35	800	*30-90	†0.1	*25	.4	5	†Icex
	2N2801	MO	pnp,AE,si	*120	3W	200	17.3	35	800	*17-225	†0.1	*25	.4	5	†Icex
	40366	RCA	npn,si	*120	5W	200	28.5	65	1A	*40-120	2 nA	*15	0.5	5	High-Reliability type
	2N1754	*SPR	MADT,ge	*125	50	85	–	*13	100	*75	.6	*1.5	.12	9	GI, *PH orig. Reg.
	S18100	FA	npn,DPE,si	130	.4	200	11.4	*60	500	150	–	10	.25	50	
	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	
	2N1496	MO	npn, EP, ge	*150	750	100	10	25	500	*25	7	*6.5	0.3	31	
	2N2330	MO	npn, AE, si	*150	3w	175	20	20	–	50/–	0.001	*10	0.001	5	SPR
LL 23	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	
	2N1499	PH	pnp,ge	*160	60	100	–	*20	100	*70	.6	*1.5	.12	9	
	2N1708	RCA	npn,PE,si	*200	300	175	–	*25	200	*20	12	*6	0.22	46	FA,SY, GI
	2N2205	RCA	npn,PE,si	*200	300	175	–	*25	200	*20	0.025	*6	0.22	18	SY, RCA
	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	.020	8	0.4	46	
	2N3485A	FA	pnp,PE,si	200	2000	200	11.4	40	600	40-120	.020	8	0.4	46	
	2N3486	FA	pnp,PE,si	200	2000	200	11.4	40	600	100-300	.020	8	0.4	46	
	2N3486A	FA	pnp,PE,si	200	2000	200	11.4	40	600	100-300	.020	8	0.4	46	
LL 24	2N3644	FA	npn,DPE,si	200	700	125	7.0	45	500	200	–	4.5	–	–	
	2N3645	FA	pnp,DPE,si	*200	700	125	7.0	60	500	*200	–	4.5	–	–	
	2N3905	MO	pnp,AE,si	*200	310	135	2.81	40	200	*50-150	†	*4.5	0.25	92	
	2N4125	MO	pnp,AE,si	*200	310	135	2.81	30	200	*50-150	.05	*4.5	0.4	92	
	40218	RCA	npn,MS,si	*200	300	175	2	*25	50	*20-60	0.5 (max)	5 (max)	0.6 (max)	52	
	40222	RCA	npn,PE,si	*200	300	175	2	*25	200	*20 (min)	.025 (max)	6 (max)	.22 (max)	52	
	FK3299	FA	npn,DPE,si	200	175	200	2	30	20	40-120	.15	8	.22	–	Hermet package
	MPS706	MO	npn,EP,si	*200	500	125	5	*25	–	*20	0.5	*6	0.6	92	
	UD-3005	SPR	npn, PE,si	200	350	200	–	60	600	*100-300	0.010	*8	0.4	85	npn Quad
	UD-3006	SPR	npn,PE,si	200	350	200	–	60	600	*100-300	0.010	*8	0.4	85	pnp Quad
LL 25	UD-3007	SPR	npn,PE, si	200	350	200	–	60	600	*100-300	0.010	*8	0.4	85	Complementary Quad
	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	.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, SPR
	2N3250	FA	pnp,DPE,si	250	360	200	6.9	*50	200	150	–	.25	0.25	18	
	2N3641	FA	npn, PE, si	*250	700	125	7.0	30	–	*75	0.05	*6.0	0.35	–	CDC, IEC, GME
	2N3642	FA	npn, PE, si	*250	700	125	7.0	45	–	*75	0.5	*6.0	0.35	–	CDC, IEC, GME
	2N3643	FA	npn, PE, si	*250	700	125	7.0	30	–	*220	0.5	*6.0	0.35	–	CDC, IEC, GME
LL 26	2N3903	MO	npn,AE,si	*250	310	135	2.81	40	200	*50-150	†	*4	0.2	92	
	2N3906	MO	pnp,AE,si	*250	310	135	2.81	40	200	*100-300	†	*4.5	0.25	92	
	2N3946	MO	npn,AE,si	*250	1200	200	6.9	40	200	*50-150	†	*4	0.2	18	
	2N4123	MO	npn,AE,si	*250	310	135	2.81	30	200	*50-150	.05	*4	0.3	92	
	2N4126	MO	pnp,AE,si	*250	310	135	2.81	25	200	*120-360	.05	*4.5	0.4	92	
	FK3300	FA	npn,DPE,si	250	175	200	2	30	20	100-300	.15	8	.22	–	Hermet package
	FK3502	FA	pnp,DPE,si	250	175	200	2	45	500	300	10	8	.25	–	Hermet package
	FK3503	FA	pnp,DPE,si	250	175	200	2	60	500	300	10	8	.25	–	Hermet package
	FV3503	FA	pnp,DPE,si	250	175	200	2	60	500	300	10	8	.25	51	
	MPS2713	MO	npn,AE,si	*250	310	135	2.81	18	200	*30-90	0.5	*2.5	0.3	92	
LL 27	MPS2714	MO	npn,AE,si	*250	310	135	2.81	18	200	*75-225	0.5	*2.5	0.3	92	
	NS1110	NA	npn,PL,si	250	500	200	3	110	100	–	1	*6	–	18	Avalanche Transistor
	NS1111	NA	npn,PL,si	250	500	200	3	60	100	–	.1	*6	–	18	Avalanche Transistor
	NS1500	NA	npn,PL,si	*250	500	200	25	20	100	*50-100	0.5	5	.1	18	
	NS1510	NA	npn,PL,si	*250	500	200	2.5	20	100	*50-100	0.5	3.8	.1	18	
	2N784A	SY	npn,EO,si	300	360	200	–	*40	200	*25-150	.025	3.5	.65	18	
	2N835	MO	npn, EP, si	*300	1W	175	6.67	*25	200	20	0.01	*2.8	30	18	ITT, SPR
	2N838	MO	pnp,EM,ge	*300	150	100	2	*30	100	*30	10	4	0.18	18	
	2N914/46	SY	npn,PL,EP,si	300	400	200	–	*40	–	*30-120	.025	*6	0.7	46	GI
	2N2381	MO	pnp,EM,ge	*300	750	100	10	15	500	*40	1	*3.5	.25	5	
LL 28	2N2382	MO	pnp,EM,ge	*300	750	100	10	20	500	*40	1	*3.5	.25	5	
	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	.025	*4	.25	–	
	2N3251	FA	pnp,DPE,si	300	360	200	6.9	*50	200	300	–	.25	0.25	18	
	2N3605	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	.25	98	
	2N3606	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	.25	98	
	2N3607	GE	npn,PEP,si	300	200	100	2.67	14	200	*65	0.5	*4.8	.25	98	
	2N3904	MO	npn,AE,si	*300	310	135	2.81	40	200	*100-300	†	*4	0.2	92	
	2N3947	MO	npn,AE,si	*300	1200	200	6.9	40	200	*100-300	†	*4	0.2	18	
	2N4124	MO	npn,AE,si	*300	310	135	2.81	25	200	*120-360	.05	*4	0.3	92	

(see pages 4-9 for explanation of company abbreviations.)

Low-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 29	2N4264	MO	npn,AE,si	*300	310	135	2.81	15	200	*40-160	†0.1	*4	0.22	92	
	2N4265	MO	npn,AE,si	*300	310	135	2.81	12	200	*100-400	†0.1	*4	0.22	92	
	40219	RCA	npn,PL,si	*300	360	200	2.06	*40	–	*30-120	.025 (max)	6 (max)	0.4 (max)	52	
	40221	RCA	npn,PE,si	*300	360	200	2.06	*40	–	*30-120	.025 (max)	6 (max)	0.7 (max)	52	
	MM709	MO	npn,AE,si	*300	750	200	4.3	8	100	*15-120	.015	*3	0.35	52	
	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	MC	pnp,ME,ge	*320	300	100	4	7	100	–	3	*4	–	18	
	2N2259	MO	pnp,ME,ge	*320	300	100	4	7	100	–	3	*4	–	18	
	2N834	MO	npn,EM,si	350	1 W	175	6.67	*40	200	25	0.01	*2.8	0.25	18	FA, SY, TR, GI, NA, ITT, SPR
LL 30	2N3009	FA	npn,EP,si	*350	360	200	2.06	15	200	*30-120	0.5	*5	0.18	18	TI
	2N3647	FA	npn,DPE,si	350	400	200	11.43	10	500	25-150	–	4	0.4	46	
	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	
	40220	RCA	npn,PE,si	*350	300	175	2	*40	200	*25 (min)	0.5 (max)	4 (max)	.25 (max)	52	
	MPS834	MO	npn,EP,si	*350	500	125	5	30	200	*25	0.5	*4	0.25	92	
	MPS3646	MO	npn,AE,si	*350	500	125	5.0	15	200	*30-120	†	*5	0.2	92	†ICES =0.5
	2N706	FA	npn,DD,si	*400	1.0	175	6.7	*25	–	*45	0.005	*5	0.3	18	SY, MO, TR, GI, AMP, ITT, SPR, RCA, MO, NUC
LL 31	2N706A	TI	npn,si		300	175	2	20	50	*20	10	*5	0.6	18	FA, SY, TR,,GI, ITT, GE, MO, RA, RCA
	2N706B	MO	npn,EP,si	*400	300	175	2	*25	500	4	.005	*5	.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
	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, RCA, MO, NA, NUC
	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	.4	*3.5	.18	18	SY, RCA, TI, LAN
	2N2537	MO	npn,AE,si	*400	3W	200	17.2	30	–	*50-150	.25	*8	.45	5	SPR, GI, SY, NA
LL 32	2N2538	MO	npn,AE,si	*400	3W	200	17.2	30	–	*100-300	.25	*8	.45	5	SPR, GI, SY, NA
	2N2539	MO	npn,AE,si	*400	8W	200	10.3	30	–	50-150	.25	*8	.45	18	SPR, GI, NA
	2N2540	MO	npn,AE,si	*400	1.8W	200	10.3	30	–	*100-300	.25	*8	.45	18	SPR, GI, NA
	2N3011	TI	npn,EP,si	*400	360	200	2.06	12	200	*30-120	0.4	*4	0.2	18	
	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	†.005				†Icex
	2N3576	TI	pnp,EP,si	*400	360	175	2.4	15	200	*40-120	0.01	*4.5	0.15	18	
	2N3722	FA	npn,PE,si	400	800	200	22.8	60	500	–	–	9.0	.75	5	
	2N3723	FA	npn,PE,si	400	800	200	22.8	80	500	–	–	9.0	.75	5	
	40217	RCA	npn,MS,si	*400	300	175	2	*25	–	*20 (min)	0.5 (max)	5	0.3	52	
LL 33	MPS2894	MO	pnp,EP,si	*400	1000	125	10	12	–	*40-150	.08	*6	0.15	92	
	2N3648	FA	npn,DPE,si	450	400	200	11.43	15	500	30-120	–	4	0.4	46	
	2N4046	FA	npn,PE,si	450	.8	200	20	50	500	*150	–	12	.75	5	
	2N4047	FA	npn,PE,si	450	.8	200	20	50	500	*150	–	10	.95	5	
	2N960	MO	pnp,EM,ge	*460	300	100	4	*15	–	*40	.4	*2.2	0.13	18	RCA
	2N961	MO	pnp,EM,ge	*460	300	100	4	*12	–	*40	.4	*2.2	.13	18	RCA
	2N964	MO	pnp,EM,ge	*460	300	100	4	*15	–	*70	.4	*2.2	.11	18	RCA
	2N965	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	.4	*2.2	.11	18	RCA
	2N966	MO	pnp,EM,ge	*460	300	100	4	*12	–	*70	.4	*2.2	.11	18	RCA
	MPS3639	MO	pnp,EP,si	*500	500	125	5	6	80	*30-120	†	*3.5	0.16	92	†ICES =.01
LL 34	MPS3640	MO	pnp,EP,si	*500	500	125	5	12	80	*30-120	†	*3.5	0.2	92	†ICES =.01
	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
	2N3646	FA	npn, PE, si	550	500	125	5.0	15	–	*60	0.4	*3.3	0.39	–	ICE, GME
	2N4121	FA	pnp,DPE,si	550	200	125	5	40	100	200	–	4.5	.3	–	R0110 package
	2N1992		npn,D,si	*600	350	150	2	15	50	*45	.5	*5	.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, GME
	2N4122	FA	pnp,DPE,si	600	200	125	5	40	100	300	–	4.5	.3	–	R0110 package
LL 35	2N2369	FA	npn,PE,si	*650	1200	200	6.85	15	500	*80	0.1	*2.5	0.2	18	TR, MO, AL
	2N2369A	FA	npn,PE,si	*675	1200	200	6.85	15	200	*65	0.05	*2.3	0.14	18	TR, AL, SPR
	2N2787	GI	npn,si	*700	800	175	5.33	35	–	*20-60	.01	*8	0.4	5	STC, SPR
	2N2788	GI	npn,si	*700	800	175	5.33	35	–	*40-120	.01	*8	0.4	5	STC, SPR
	2N2789	GI	npn,si	*700	800	175	5.33	35	–	*100-300	.01	*8	0.4	5	STC, SPR
	2N2790	GI	npn,si	*700	500	175	3.33	35	–	*20-60	.01	*8	0.4	18	STC, SPR
	2N2791	GI	npn,si	*700	500	175	3.33	35	–	*40-120	.01	*8	0.4	18	STC, SPR
	2N2792	GI	npn,si	*700	500	175	3.33	35	–	*100-300	.01	*8	0.4	18	STC, SPR
	2N709	FA	npn,PE,si	*800	0.5	200	5	6	–	*55	0.005	*2.5	0.21	18	SY, AL, TI, TR, VEC
	2N917	FA	npn,DP,si	*800	0.3	200	1.71	15	–	50	0.0005	*1.5	0.4	18	TI, RCA, AL, TRWS

(see pages 4-9 for explanation of company abbreviations.)

Low–Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (°C)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 36	V-120	VEC	npn,PE,si	*800	–	200	–	*15	–	*110	.00009	*2.1	.12	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
	2N955A	RCA	npn, DD, ge	*1000	150	100	–	*12	150	*50	0.6	*4	0.22	18	
	MM2550	MO	pnp,EP,DJ,ge	*1000	300	100	4	10	100	*20	10	*3	0.2	18	
	MM2552	MO	pnp,EP,DJ,ge	*1000	600	100	8	10	100	*30	10	*3	0.2	5	
	MM2554	MO	pnp,EP,DJ,ge	*1000	600	100	8	10	100	*30	10	*3	0.25	5	
	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	†.005	*2.5	0.35	72	
	2N4261	MO	pnp,AE,si	*2000	200	200	1.14	15	30	*30-150	†.005	*2.5	0.35	72	
LL 37	BSY 62	SA	npn,EP,PL,si	*200000	860	175	7	15	200	20-60	0.5	5	0.6	18	
	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
	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
LL 38	2N711	TI	pnp,ge	–	150	100	2	*12	100	1.5	3	*7.5	0.5	18	SY, MO, AMP, RCA
	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
	2N781	SY	pnp,EP,ge	–	300	100	–	*15	200	*25	3	–	0.2	18	AL
	2N782	SY	pnp,EP,ge	–	300	100	–	*12	200	*20	3	–	0.2	18	
	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	
LL 39	2N851/TI422	TI	npn,si	–	300	175	2	12	200	*20	–	*5	0.35	50	
	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
	2N999	FA	npn,DP,si	–	500	200	10.3	60	500	–	0.0001	*15	1.2	18	
	2N1216	RCA	pnp,MS,ge	–	75	–	–	*25	100	–	–	–	–	5	
	2N1228	HU	pnp	–	400	160	–	15	–	20	.1	–	.2	5	SPR, AMP, CT
	2N1229	HU	pnp	–	400	160	–	15	–	40	.1	–	.2	5	SPR, AMP, CT
	2N1230	HU	pnp,	–	400	160	–	35	–	20	.1	–	.2	5	SPR, AMP, CT
	2N1231	HU	pnp	–	400	160	–	35	–	40	.1	–	.2	5	SPR, AMP, CT
	2N1232	HU	pnp	–	400	160	–	60	–	20	.1	–	.2	5	SPR, AMP, CT
LL 40	2N1233	HU	pnp	–	400	160	–	60	–	40	.1	–	.2	5	SPR, AMP, CT
	2N1234	HU	pnp	–	400	160	–	110	–	20	.1	–	.2	5	SPR, AMP, CT
	2N1302	TI	npn,ge	–	150	85	2.5	*25	300	*20	6	*20	0.2	5	AMP, GE, RCA, NUC
	2N1303	TI	pnp,ge	–	150	85	2.5	*30	300	*20	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1304	TI	npn,ge	–	150	85	2.5	*25	300	*40	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1305	TI	pnp,ge	–	150	85	2.5	*30	300	*40	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1306	TI	npn,ge	–	150	85	2.5	*25	300	*60	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1307	TI	pnp,ge	–	150	85	2.5	*30	300	*60	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1308	TI	npn,ge	–	150	85	2.5	*25	300	*80	6	20	0.2	5	AMP, GI, RCA, NUC
	2N1309	TI	pnp,ge	–	150	85	2.5	*30	300	*80	6	20	0.2	5	AMP, GI, RCA, NUC
LL 41	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	
	2N1507	TI	npn,si	–	600	175	4	*60	1a	*100	1	*35	1.5	5	CDC, AL
	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	.002	*14	.002	5	TRWS, CT, Chopper Pairs, SPR
	2N1918	SSD	AJ	–	250	175	1.67	8	50	*25	.006	*14	.004	5	Chopper Pairs, CT, SPR
	2N1919	SSD	AJ	–	250	175	1.67	18	50	–	.002	*14	.003	5	TRWS, AMP, CT, Chopper Pairs, SPR
	2N1920	SSD	AJ	–	250	175	1.67	18	50	–	.003	*14	.004	5	TRWS, AMP, CT, Chopper Pairs, SPR
LL 42	2N1921	SSD	AJ	–	250	175	1.67	50	50	–	.004	*14	.005	5	TRWS, AMP, CT, Chopper Pairs, SPR
	2N1922	SSD	AJ	–	250	175	1.67	80	50	–	.004	*14	.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

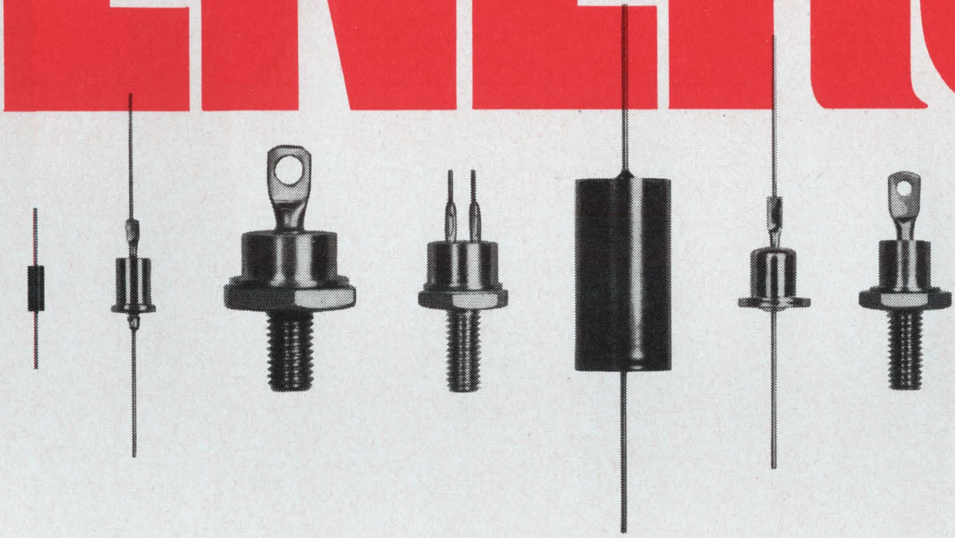
(see pages 4-9 for explanation of company abbreviations.)

Low–Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (MHz)	MAX. RATINGS P_c (mW)	T_j (^oC)	mW/°C	V_{CEO} *V_{CBO} (V)	I_C (mA)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} (μA)	C_{oe} *C_{ob} (pF)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
LL 43	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	–	–	
	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	
LL 44	2N2938	RCA	npn,PE,si	–	300	175	–	*25	500	*60	.003	3.5	0.22	18	
	3217	CT	pnp,si	–	400	200	2.3	*15	100	10	.001	*14	–	46	**SPR**
	3218	CT	pnp,si	–	400	200	2.3	*25	100	5	.001	*14	–	46	SPR
	3219	CT	pnp,si	–	400	200	2.3	*40	100	3	0.001	*14	–	46	SPR
	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	
	2013	BU	–	–	500	150	–	*65	3.0	*30	0.5	7.0	0.5	†	† flat pack
LL 45	PADT60	AMP	pnpn,PADT,ge	–	83	75	1.7	*35	25	–	50	*5	0.6	1	4 Layer Control Device
	SA-537	SPR	pnp,SP,si	–	150	140	1.3	*25	50	10	0.1	*9	0.15	1	
	SA-538	SPR	pnp, SP,si	–	150	140	1.3	*10	50	10	0.1	*9	0.15	1	
	SA-539	SPR	pnp,SP,si	–	150	140	1.3	*25	50	10	0.01	*9	0.15	18	
	SA-540	SPR	pnp,SP,si	–	150	140	1.3	*10	50	10	0.01	*9	0.15	18	
	V-120RH	VEC	npn,PL,si	–	350	200	–	10	–	*110	.0001	*1.7	.13	18	
	V-220	VEC	npn,PE,si	–	–	200	–	*15	–	*70	5	*3.0	.30	18	
	V-221	VEC	npn,PE,si	–	–	200	–	*15	–	*110	5	*3.0	.30	18	
	V-222	VEC	npn,PE,si	–	–	200	–	*15	–	*140	5	*3.0	.30	18	

(see pages 4-9 for explanation of company abbreviations.)

ZENERS



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MIL and industrial devices, including fast-switching types. Choice of ratings and package shapes.

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Rectifier stacks, potted bridges, epoxy resin encapsulations and high voltage assemblies.

IRC®

High-Level Switching

Generally types rated at one watt and above. In order of $f_{\alpha e}$ or f_T.

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $^*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^{\dagger}I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 1	2N1518	DE	pnp,AJ,ge	4	150	100	.5	40	25	*15-60	4	.7	36	ETC
	2N1519	DE	pnp,AJ,ge	4	150	100	.5	60	25	*15-60	4	.7	36	ETC
	2N1520	DE	pnp,AJ,ge	4	150	100	.5	40	35	*17-68	4	.7	36	ETC
	2N1521	DE	pnp,AJ,ge	4	150	100	.5	60	35	*17-68	4	.7	36	ETC
	2N1522	DE	pnp,AJ,ge	4	150	100	.5	40	50	*25-100	4	.7	36	ETC
HL 2	2N1523	DE	pnp,AJ,ge	4	150	100	.5	60	50	*25-100	4	.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	–	–	
	2N2565	KSC	pnp,ge	8	20	100	0.5	*60	3	*20-60	0.65	–	–	
	2N618	MO	pnp,AJ,ge	8.5	90	100	1.25	*80	3	*90	0.8	.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	.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	–	
HL 6	2N2758	WH	npn,AJ,si	14	200	175	2	100	30	*10	15	0.4	–	
	2N2759	WH	npn,AJ,si	14	200	175	2	150	30	*10	15	0.4	–	
	2N2760	WH	npn,AJ,si	14	200	175	2	200	30	*10	15	0.4	–	
	2N2761	WH	npn,AJ,si	14	200	175	2	250	30	*10	15	0.4	–	
	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	–	
	2N2764	WH	npn,AJ,si	14.5	200	175	2	100	30	*10	15	0.63	–	
	2N2765	WH	npn,AJ,si	14.5	200	175	2	150	30	*10	15	0.63	–	
	2N2766	WH	npn,AJ,si	14.5	200	175	2	200	30	*10	15	0.63	–	

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $^*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $^*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $^*h_{FE}$	I_{CO} $^*I_{CEO}$ $^{\dagger}I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
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	–	
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	–	
	2N2772	WH	npn,AJ,si	16	200	175	2	200	30	*10	1.5	0.74	–	
	163-04	WH	npn,AJ,si	22	200	175	2	55	20	*15	15	.30	–	
	163-06	WH	npn,AJ,si	22	200	175	2	75	20	*15	15	.30	–	
	163-08	WH	npn,AJ,si	22	200	175	2	95	20	*15	15	.30	–	
	163-10	WH	npn,AJ,si	22	200	175	2	115	20	*15	15	.30	–	
HL 10	163-12	WH	npn,AJ,si	22	200	175	2	135	20	*15	15	.30	–	
	163-14	WH	npn,AJ,si	22	200	175	2	155	20	*15	15	.30	–	
	163-16	WH	npn,AJ,si	22	200	175	2	175	20	*15	15	.30	–	
	163-18	WH	npn,AJ,si	22	200	175	2	195	20	*15	15	.30	–	
	163-20	WH	npn,AJ,si	22	200	175	2	215	20	*15	15	.30	–	
	164-04	WH	npn,AJ,si	22	200	175	2	55	20	*25	15	.25	–	
	164-06	WH	npn,AJ,si	22	200	175	2	75	20	*25	15	.25	–	
	164-08	WH	npn,AJ,si	22	200	175	2	95	20	*25	15	.25	–	
	164-10	WH	npn,AJ,si	22	200	175	2	115	20	*25	15	.25	–	
	164-12	WH	npn,AJ,si	22	200	175	2	135	20	*25	15	.25	–	
HL 11	164-14	WH	npn,AJ,si	22	200	175	2	155	20	*25	15	.25	–	
	164-16	WH	npn,AJ,si	22	200	175	2	175	20	*25	15	.25	–	
	164-18	WH	npn,AJ,si	22	200	175	2	195	20	*25	15	.25	–	
	164-20	WH	npn,AJ,si	22	200	175	2	215	20	*25	15	.25	–	
	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
HL 12	2N1702	RCA	npn, si	25	75	200	0.429	40	5	*15-60	0.2	–	3	STC
	151-04	WH	npn,AJ,si	25	100	150	1.4	80	6.0	*11	10	0.6	–	
	151-06	WH	npn,AJ,si	25	100	150	1.4	120	6.0	*11	10	0.6	–	
	151-08	WH	npn,AJ,si	25	100	150	1.4	160	6.0	*11	10	0.6	–	
	151-10	WH	npn,AJ,si	25	100	150	1.4	200	6.0	*11	10	0.6	–	
	152-04	WH	npn,AJ,si	25	100	150	1.4	80	6.0	*18	10	0.9	–	
	152-06	WH	npn,AJ,si	25	100	150	1.4		6.0	*18	10	0.9	–	
	152-08	WH	npn,AJ,si	25	100	150	1.4	160	6.0	*18	10	0.9	–	
	152-10	WH	npn,AJ,si	25	100	150	1.4	200	6.0	*18	10	0.9	–	
	2N1016	WH	npn,AJ,si	30	150	150	1.43	30	7.5	*8	10	0.6	–	STC
HL 13	2N1016A	WH	npn,AJ,si	30	150	150	1.43	60	7.5	*10	10	0.6	–	STC
	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	.143	40	2.5	*20-80	.1	–	8	STC
	153-04	WH	npn,AJ,si	33	200	175	1.33	*65	7.5	*15	10	0.6	–	
	153-06	WH	npn,AJ,si	33	200	175	1.33	*85	7.5	*15	10	0.6	–	
HL 14	153-08	WH	npn,AJ,si	33	200	175	1.33	*105	7.5	*15	10	0.6	–	
	153-10	WH	npn,AJ,si	33	200	175	1.33	*125	7.5	*15	10	0.6	–	
	153-12	WH	npn,AJ,si	33	200	175	1.33	*145	7.5	*15	10	0.6	–	
	153-14	WH	npn,AJ,si	33	200	175	1.33	*165	7.5	*15	10	0.6	–	
	153-16	WH	npn,AJ,si	33	200	175	1.33	*185	7.5	*15	10	0.6	–	
	153-18	WH	npn,AJ,si	33	200	175	1.33	*205	7.5	*15	10	0.6	–	
	153-20	WH	npn,AJ,si	33	200	175	1.33	*225	75	*15	10	0.6	–	
	154-04	WH	npn,AJ,si	33	200	175	1.33	*65	7.5	*25	10	0.9	–	
	154-06	WH	npn,AJ,si	33	200	175	1.33	*85	7.5	*25	10	0.9	–	
	154-08	WH	npn,AJ,si	33	200	175	1.33	*105	7.5	*25	10	0.9	–	

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ *f_T (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} *V_{CBO} (V)	I_C (A)	CHARACTERISTICS h_{fe} *h_{FE}	I_{CO} *I_{CEO} †I_{CEX} (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 15	154-10	WH	npn,AJ,si	33	200	175	1.33	*125	7.5	*25	10	0.9	–	
	154-12	WH	npn,AJ,si	33	200	175	1.33	*145	7.5	*25	10	0.9	–	
	154-14	WH	npn,AJ,si	33	200	175	1.33	*165	7.5	*25	10	0.9	–	
	154-16	WH	npn,AJ,si	33	200	175	1.33	*185	7.5	*25	10	0.9	–	
	154-18	WH	npn,AJ,si	33	250	175	1.33	*205	7.5	*25	10	0.9	–	
	154-24	WH	npn,AJ,si	33	200	175	1.33	*225	7.5	*25	10	0.9	–	
	2N1409	RA	npn,si	*40	2.8	150	.22	*30	05	*30	.010	0.5	5	GI
	2N1410	RA	npn,si	*40	2.8	150	.22	*30	0.5	*60	.010	0.5	5	GI
	2N1768		npn, si	40	40	200	.229	40	3	*35-100	.015	–	–	STC
	2N1769		npn, si	40	40	200	.229	55	3	*35-100	.015	–	–	STC
HL 16	2N3850	SSP	npn,TDP	*40	30	200	0.4	*100	5	*150	.0001	0.25	59	
	2N3852	SSP	npn,TDP	*40	30	200	0.4	*60	5	*150	.0001	0.25	59	
	2N2310	RA	npn,si	*50	3	300	.017	60	0.5	*12	10	5	46	
	2N2311	RA	npn,si	*50	3	300	.017	100	0.5	*12	10	5	46	
	2N2312	RA	npn,si	*50	3	300	.017	60	0.5	*30	10	1.5	46	
	2N2313	RA	npn,si	*50	3	300	.017	100	0.5	*30	10	5	46	
	2N2314	RA	npn,si	*50	3	300	.017	35	0.5	*15	10	1.5	46	
	2N2315	RA	npn,si	*50	3	300	.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	
	2N2317	RA	npn,si	*50	3	300	0.17	40	0.5	*40	10	1.5	46	
HL 17	2N3506	MO	npn, EA, si	*60	5	200	0.029	40	3	*40-200	†0.001	1.0	5	† Icex
	2N3507	MO	npn,EA,si	*60	5	200	0.029	50	3	*30-150	†0.001	1.0	5	† Icex
	2N2270	RCA	npn,si	*100	5	200	.0286	45	1	*50-200	5	–	5	TRWS, GI
	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	
	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	
	2N3501	MO	npn,EA,si	*150	5	200	0.0057	150	0.300	*100-300	0.00005	0.4	5	
HL 18	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	
	2N3444	MO	npn,AE,si	*175	5	200	0.029	50	–	*20-60	0.0005	0.6	5	
	2N3467	MO	pnp,EA,si	*175	5	200	0.0057	40	1	*40-120	0.0001	0.5	5	
	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	
	2N1667	AMP	pnp,PADT,ge	200	30	90	–	48	6	140	<100	–	3	
HL 19	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	
	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	–	
	2N3433	WH	npn,AJ,si	*200	150	175	1.33	*250	7.5	*10	10	0.9	–	
HL 20	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
	2N3485A	MO	pnp,AE.si	*200	2	200	0.011	60	0.6	*40-120	0.00001	0.4	46	TI
	2N3486	MO	pnp,AE,si	*200	2	200	0.011	40	0.6	*100-300	0.00002	0.4	46	TI
	2N3486A	MO	pnp,AE,si	*200	2	200	0.011	60	0.6	*100-300	0.00001	0.4	46	TI
	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	
	2N3637	MO	pnp,EA,si	*200	5	200	0.029	175	1	*100-300	0.00010	0.5	5	
HL 21	2N2217	MO	npn,EA,si	250	3	175	.02	30	0.8	20-160	0.00001	0.4	5	GI, SY, SPR, TR, AMP, TRWS, AL
	2N2218	MO	npn,AE,si	*250	3	175	.02	30	0.8	*40-120	0.00001	–	5	GI, SY, SPR, TR, AMP, TRWS, AL
	2N2219	MO	npn, AE, si	250	3	175	.02	30	0.8	100-300	0.00001	0.4	5	GI, SY, SPR, TR, AMP
	2N2219	MO	npn,AE,si	250	3	175	.02	30	0.8	100-300	0.00001	0.4	5	GI, SY, SPR, TR, AMP, AL
	2N2220	MO	npn,AE,si	250	1.8	175	.012	30	0.8	20-60	0.00001	0.4	18	GI, SPR, TR, AMP, AL
	2N2221	MO	npn, AE, si	250	1.8	175	.012	30	0.8	40-120	0.00001	0.4	18	GI, SPR, TR, AMP, AL

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 22	2N2222	MO	npn,AE,si	250	1.8	175	.012	30	0.8	100-300	0.00001	0.4	18	TRWS, GI, SPR, TR, AMP, AL
	2N3250A	MO	pnp,AE,si	*250	1.2	200	0.0069	60	0.2	*50-150	†0.00002	0.25	18	†Icex
	2N3734	MO	npn,AE, si	*250	4	200	.023	30	1.5	*30-120	†.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
	2N3735	MP	npn, AE, si	*250	4	200	.023	50	1.5	*20-80	†.0002	0.2	5	
	2N3736	MO	npn, AE,si	*250	2	200	.011	30	1.5	*30-120	†.0002	0.2	46	
	2N3737	MO	npn,AE,si	*250	2	200	.011	50	1.5	*20-80	†.0002	0.2	46	
	2N914/46	SY	npn,PL,EP,si	*300	400	200	–	*40	–	*30-120	.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
HL 23	2N3251A	MO	pnp, AE, si	*300	1.2	200	0.0069	60	0.2	*100-300	† 0.00002	0.25	18	
	2N3647	MO	pnp, EA, si	*350	2.0	200	0.011	10	0.50	*25-150	† 0.000025	0.4	46	
	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	.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	
	2N3055	RCA	npn,si	*500	115	200	0.657	60	15	*20-70	†5	1.1	3	† Icev, MO
	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	–	
HL 24	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	–	
	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
	2N3014	FA	npn,PE,si	*550	1.2	200	0.00685	20	–	*60	40	–	52	TI
HL 25	2N3424	FA	npn, PE, si	*600	1.2	200	0.29	15	.050	*20-200	0.000010	0.4	–	
	2N3546	MO	pnp,EA,si	*700	1.2	200	0.0069	12	–	*30-120	0.000010	0.15	18	
	2N3054	RCA	npn, si	*1000	25	200	0.143	55	4	*25-100	1.0	1.0	66	
	156-04	WH	npn,DJ,si	*1000	120	200	0.68	40	8	*15	20	1.0	3	
	156-06	WH	npn,DJ,si	*1000	120	200	0.68	60	8	*15	20	1.0	3	
	156-08	WH	npn,DJ,si	*1000	120	200	0.68	80	8	*15	20	1.0	3	
	156-10	WH	npn,DJ,si	*1000	120	200	0.68	100	8	*15	20	1.0	3	
	0C80	AMP	pnp,PADT,ge	2000	.55	75	–	*32	0.3	180	.01	–	1	
	0C22	AMP	pnp,PADT,ge	2500	15	75	.333	32	1	*200	.03	–	3	
	0C23	AMP	pnp,PADT,ge	2500	16	75	.333	40	1	*200	.03	–	3	
HL 26	0C24	AMP	pnp,PADT,ge	2500	15	75	.333	32	1	*200	.03	–	3	
	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	
	2N545	TR	npn,PL,si	4000	5	175	.045	60	.8	*15-80	.015	–	5	SSP, TI
	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
HL 27	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	
	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
	2N3738	MO	npn,si	*15,000	20	175	.133	225	.250	*40-200	0.1	2.5	66	
HL 28	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	
	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, AMP, AL
	2N1984	FA	npn,DD,si	*30000	2	150	0.016	25	–	80	0.001	0.25	5	TRWS, CDC, AMP, AL
	2N1985	FA	npn,DP,si	*30000	2	150	0.016	25	–	60	0.001	0.25	5	TRWS, CDC, AMP, AL
	2N698	FA	npn,DP,si	*40000	3	200	0.0172	60	–	*40	–	–	5	TRWS, TR, GI, AMP, 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

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 29	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	–	
	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
HL 30	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, KSC, 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
	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
	2N720A	FA	npn,DP,si	*60000	1.8	200	0.0103	*120	–	*80	.000005	0.9	18	TRWS, CDC, GI, AMP, AL, NA, TR, RCA
HL 31	2N721	FA	pnp,DD,si	*60000	1.5	175	0.010	35	–	*60	0.001	1.0	18	KSC, TR
	2N909	FA	npn,DD,si	*60000	1.5	175	0.010	*60	–	*250	.00001	0.3	18	TRWS, AMP
	2N912	FA	npn,DP,si	*60000	1.8	200	0.0103	60	–	45	.000005	0.16	18	TRWS, AMP, AL
	2N978	FA	pnp,DD,si	*60000	1.25	150	0.010	20	–	*30	.001	1.3	18	TR
	2N2850	SSP	npn,PE,si	*60000	5	200	0.005	*100	5	*85	–	0.15	5	
	2N2851	SSP	npn,PE,si	*60000	5	200	0.005	*100	5	*85	–	0.2	5	
	2N2853	SSP	npn,PE,si	*60000	5	200	0.005	*60	5	*85	0.001	1.0	5	
	2N2855	SSP	npn,PE,si	*60000	5	200	0.005	60	5	85	0.001	0.2	5	
	2N1972	FA	npn,DD,si	*60000	2	175	0.010	*60	–	*250	.0001	0.4	5	AMP, TR, TRWS
	2N1975	FA	npn, DP, si	*60000	3	200	0.0172	60	–	45	.00005	0.16	5	TRWS, CDC, AMP,
HL 32	2N3117	FA	npn,DP,si	*60000	1.2	200	0.00685	60	–	*300	.00001	0.3	18	UC
	2N3719	MO	pnp, AE, si	*60,000	6	200	.034	40	3	*25-180	.01	0.75	5	
	2N3720	MO	pnp,AE, si	*60,000	6	200	.034	60	3	*25-180	.01	0.75	5	
	2N3879	RCA	npn, si	*60,000	35	200	0.2	75	10(peak)	*20-80	*5	1.2	66	
	2N911	FA	npn,DP,si	*70000	1.8	200	0.0103	60	–	70	.00005	0.13	18	TRWS, AMP, AL
	2N1131	FA	pnp,DD,si	*70000	2	175	0.0133	35	600	*30	0.001	1.0	5	KSC, TR. MO
	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
	2N699	FA	npn,DD,si	*80000	2	175	0.0133	*120	–	*80	.00001	–	5	TRWS, SY, TR, CDC AMP, NA, RCA
HL 33	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
	2N718A	FA	npn,DP,si	*80000	1.8	200	0.0103	*75	–	*80	.0000003	0.6	18	CDC, MO, TR, GI, AMP, AL, NA, RCA, MO, TRWS
	2N720	FA	npn,DD,si	*80000	1.5	175	0.010	*120	–	*80	.001	2.5	18	TRWS, CDC, TR, GI AMP, AL, NA
	2N870	FA	npn,DP,si	*80000	1.8	200	0.0103	60	–	*75	.00004	0.6	18	GI, AMP, AL
	2N910	FA	npn,DP,si	*80000	1.8	200	0.0103	60	–	140	.00005	·0.13	18	TRWS, AMP, AL
	2N1252	FA	npn,DD,si	*80000	2	175	0.0133	*30	–	*35	.0001	0.6	5	SY, AL, NA
HL 34	2N1613	FA	npn,DP,si	*80000	3	200	0.0172	*75	–	*80	.00003	0.6	5	TRWS, CDC, MO. TR. AMP, RCA
	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	
	2N2854	SSP	npn,PE,si	*80000	5	200	0.005	*60	5	*150	0.001	0.2	5	
	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	
	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
HL 35	2N1132	FA	pnp,DD,si	*90000	2	175	0.0133	35	0.6	*45	.00001	1.0	5	KSC, TR, MO
	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
	2N1420	FA	npn,DD,si	*100000	2	175	0.0133	*60	–	*200	.00001	0.7	5	TRWS, CDC, MO, TR GI, NA, AMP
	2N1711	FA	npn,DP,si	*100000	3	200	0.0172	*75	–	*130	.00003	0.5	5	TRWS, CDC, MO, AMP, GI, AL, TR, NA RCA

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

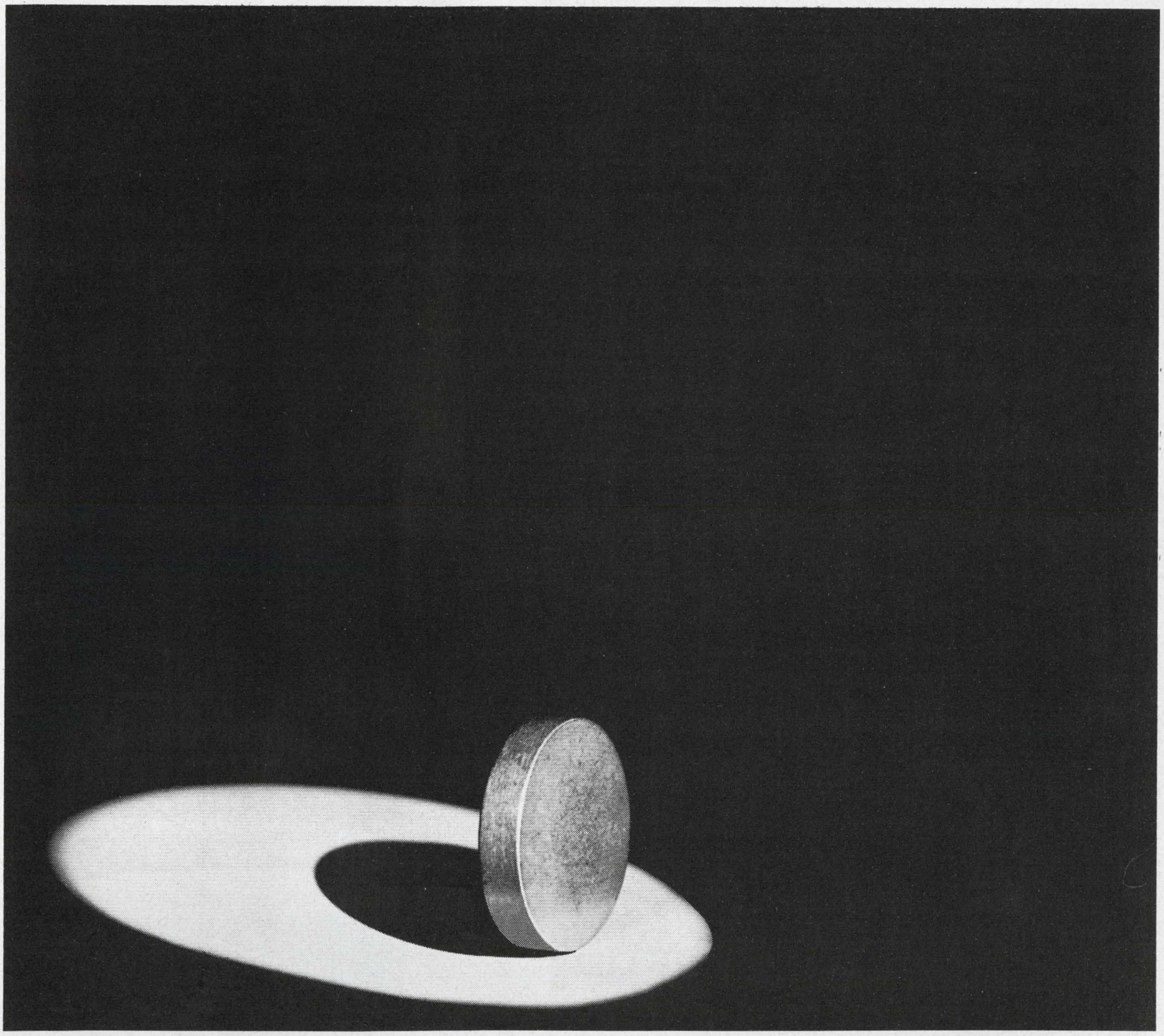
Cross Index Key	Type No.	Mfr.	Type	f_{ae} $*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 36	2N1893A	TRWS	npn,PL,si	*100000	3	200	.017	80	0.50	*40-120	.0001	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	
	2N1253	FA	npn,DD,si	*110000	2	175	0.0133	*30	–	*45	.0001	0.6	5	AL, NA
	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
	2N2194A	GE	npn,PE,si	*130000	2.8	200	.016	40	1	*20-60	1	.25	5	CDC, GI, NA. FA MO, AL
	2N2195A	GE	npn,PE,si	*130000	2.8	200	.016	25	1	*20	10	.25	5	CDC, GI, MO, AL
	2N2243A	GE	npn,PE,si	*130000	2.8	200	0.16	80	1	*40-120	1	.25	5	GI, NA
HL 37	2N2350A	GE	npn,PE,si	*130000	5	200	.0285	25	1	*20	1	25	46	
	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
	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	
	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	
HL 38	BF140	NUC	npn,si	*180 MHz	1	–	–	*135	–	*40	0.001	–	5	
	BF155	NUC	npn,si	180 MHz	1	–	–	*155	–	*40	0.001	–	5	
	2N947	FA	npn,DP,si	*250000	1.2	200	0.0069	*20	0.1	*40	.0001	0.3	18	
	2N3502	FA	pnp, PE, si	*250,000	3.0	200	0.017	60	.600	*70	0.05	0.5	5	TI
	2N3503	FA	pnp, PE, si	*250,000	3.0	200	0.017	60	0.6	*70	0.00000007	0.5	5	TI
	2N3505	FA	pnp, PE, si	*250,000	1.3	200	0.0023	45	0.6	*70	0.00000007	0.5	18	TI
	2N915	FA	npn,DP,si	*300000	1.2	200	0.0069	50	–	*100	.0005	0.8	18	TRWS, AMP, NA, MO, AL
	BSY18	SA	npn,EP, PL, si	*300,000	1.0	200	0.007	12	0.2	*40...120	0.000025	0.25	18	
	BSY63	SA	npn,EP,PL,si	*300,000	1.0	200	0.007	*40	0.2	30...120	0.000025	0.4	18	
HL 39	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
	2N916	FA	npn,DP,si	*400000	1.2	200	0.0069	25	–	*100	.0005	0.4	18	TRWS, AMP, NA, MO
	2N3299	FA	npn, PE, si	*400,000	3.0	200	0.017	*30	–	*75	0,0000002	0.4	5	
	2N3300	FA	npn, PE, si	*400,000	3.0	200	0.017	*30	–	*220	0.0000002	0.4	5	
	2N3301	FA	npn, PE, si	*400,000	1.8	200	0.010	*30	–	*75	0.0002	0.4	18	
	2N3302	FA	npn, PE, si	*400,000	1.8	200	0.010	*30	–	*220	0,0002	0.4	18	
	BSY34	SA	npn, EP,PL,si	*400,000	2.6	200	0.016	40	0.6	42	0.00001	0.3	5	
	BSY58	SA	npn,EP,PL, si	*400,000	2.6	200	0.016	25	0.6	*42	0.00012	0.3	5	
HL 40	2N2368	FA	npn,PE,si	*550000	1.2	200	0.0685	15	0.5	*40	.0001	0.2	18	TR, AL, SPR
	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	–	
	2N2369	FA	npn, PE, si	*650000	1.2	200	0.00685	15	0.5	*80	.0001	0.2	18	AL, NUC, SPR
	2N3303	FA	npn,PE,si	*650000	3.0	200	0.017	12	1.0	*60	0.1	0.18	–	MO
	2N917	FA	npn,DP,si	*800000	0.3	200	0.00171	15	–	50	.00005	0.4	18	AL, TI, RCA, TRWS
	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
	2N420A	BE	pnp,ge	–	25	100	0.5	–	5	*40	–	–	3	ITT
HL 41	2N424A	STC	npn	–	85	200	.483	80	3	*12-60	–	–	53	STC, TR, BE
	2N637	BE	pnp,ge	–	25	100	0.5	*25	5	*30-60	0.5	.8-1.5	3	KSC
	2N637A	BE	pnp,ge	–	25	100	0.5	*60	5	30-60	2-5	.5	3	KSC
	2N637B	BE	pnp,ge	–	25	100	0.5	*60	5	*30-60	2-5	.5	3	KSC
	2N638	BE	–	–	–	–	–	–	–	–	–	–	–	KSC
	2N638A	BE	–	–	–	–	–	–	–	–	–	–	–	KSC
	2N638B	BE	–	–	–	–	–	–	–	–	–	–	–	KSC
	2N656	TI	npn,si	–	4	200	0.0228	60	–	*30	0.010	–	–	TRWS, FA, TR, AMP,
	2N657	TI	npn,si	–	4	200	0.0228	100	–	*30	0.010	–	–	TRWS, FA, TR, AMP, CDC, STC, SSP
HL 42	2N730	TI	npn,si	–	0.5	175	3.33	*60	1	*20	1	1.5	18	TR
	2N731	TI	npn,si	–	0.5	175	3.33	*60	1	*40	1	1.5	18	TR
	2N1011	BE	pnp,ge	–	35	95	0.5	*80	5	*35-75	5	1.5	3	MO, ITT
	2N1038	TI	pnp,ge	–	20	100	0.267	*40	3	*20	0.125	0.25	–	SY
	2N1039	TI	pnp,ge	–	20	100	0.267	*60	3	*20	0.125	0.25	–	SY
	2N1040	TI	pnp,ge	–	20	100	0.267	*80	3	*20	0.125	0.25	–	SY
	2N1041	TI	pnp,ge	–	20	100	0.267	*100	3	*20	0.125	0.25	–	SY
	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	

(see pages 4-9 for explanation of company abbreviations.)

High-Level *(continued)*

Cross Index Key	Type No.	Mfr.	Type	$f_{\alpha e}$ $*f_T$ (kHz)	MAX. RATINGS P_c (W)	T_j (°C)	W/°C	V_{CEO} $*V_{CBO}$ (V)	I_C (A)	CHARACTERISTICS h_{fe} $*h_{FE}$	I_{CO} $*I_{CEO}$ $†I_{CEX}$ (mA)	$V_{ce(sat)}$ (V)	Package Outline (TO-)	Remarks
HL 43	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
	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	–	–	–	
HL 44	2N1243	HU	pnp	–	1	160	–	60	–	40	–	–	–	
	2N1244	HU	pnp	–	1	160	–	110	–	20	–	–	–	
	2N1990	FA	npn,DD,si	–	2	150	0.016	*100	1	*30	0.001	0.4	5	TRWS, CDC, GI, AMP, AL, NUC
	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	
HL 45	2N2291	BE	pnp,ge	–	60	110	0.833	30	10	50-200	5	–	3	
	2N2292	BE	pnp,ge	–	60	110	0.833	50	10	50-200	5	–	3	
	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	
HL 46	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	
	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	
	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
	DTG1110	DE	pnp,PADT,ge	–	80	110	1.0	*200	15	–	–	0.5	3	

(see pages 4-9 for explanation of company abbreviations.)



CRYSTAL SUPPORTS: FRONT AND CENTER

When you stop to realize that the crystal support is a required part of any semi-conductor, you'll realize that it's more than coincidence that the leading semi-conductor manufacturers specify Stackpole crystal supports rather than manufacturing their own.

You see, they know that a compatible coefficient of thermal expansion just isn't enough. They also need Stackpole's unique combination of good electrical conductivity, excellent thermal conductivity, and a surface finish which assures wetability. And they depend on the flat surfaces which Stackpole features to give them maximum contact and conductivity between the base and crystal.

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"OUR 60th YEAR"

ON READER-SERVICE CARD CIRCLE 25

How, why and where to use FETs can be determined by referring to their parameters. Here's a detailed look at the meaning of these characteristics and how to apply them.

What's so special about field-effects? How alike are the junction-FET and the metal-oxide semiconductor (MOS)? Where are they to be preferred over bipolar transistors? Which of their parameters indicate their suitability for specific applications?

In response to these questions, we have prepared a detailed examination which shows how to choose between different units in the FET family. It also offers guide lines for making the most effective use of field-effect devices in circuit design. It takes a long look at FET specifications, shows how and why they are measured and where each one is of prime importance. And finally, it explains the meaning of each parameter.

This parameter-oriented analysis of field-effects clarifies:

- What's unique about them and how they work;
- How to interpret and use the parameter specifications;
- Which parameters govern their small-signal behavior; and
- The difference in characteristics and applications of junction-FETs and MOSs.

The basic properties of FETs

The field-effect transistor (FET) has a number of important attributes that set it apart from other active semiconductor devices: extremely high input resistance, nearly constant current-output characteristics, an almost completely unilateral gain function, a controllable temperature coefficient, and voltage-controlled resistance when operated at low drain-source voltages.

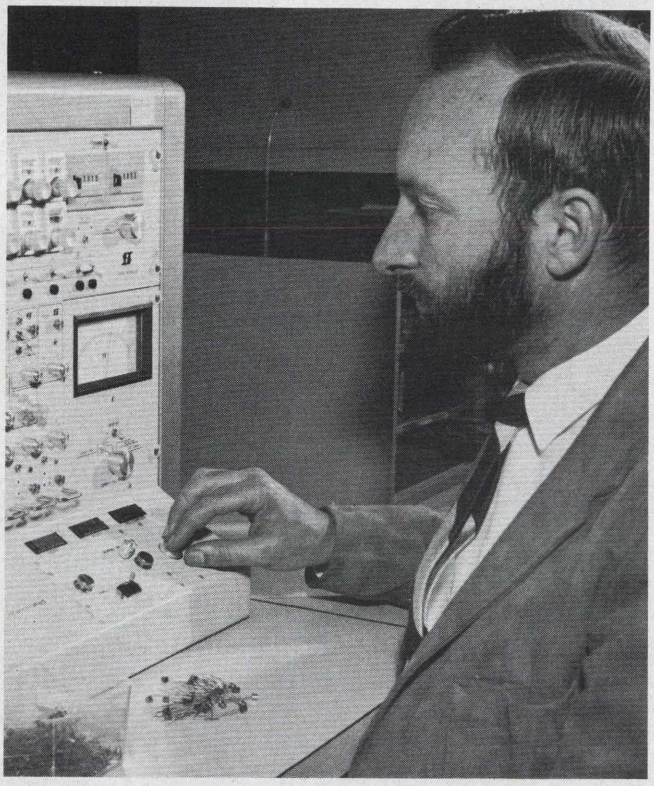
Many users think of the highly popular FET as a near-universal replacement for the vacuum tube. And indeed, its qualities are such that it does possess the dc characteristics of the pentode vacuum tube (Fig. 1a). Present limitations, however, generally restrict FET use to circuits operating below 500 MHz and at power levels less than a few hundred milliwatts.

The FET is simplicity itself, consisting only of a conducting channel flanked by a pair of control electrodes (Fig. 1b). Source and drain connections are made to either end of the channel, and a gate connection is made to the control electrodes. The primary gate electrode may be a pn junction (junction-FET) or an insulated metal electrode (MOS-FET). The secondary gate electrode is a pn junction in any case. A voltage applied between gate and source (or gate and drain) modulates the cross-sectional area of the channel, thus controlling channel resistance.[1,2]

James S. Sherwin, Senior Applications Engineer, Siliconix Inc., Sunnyvale, Calif.

Very high power gain is a FET feature

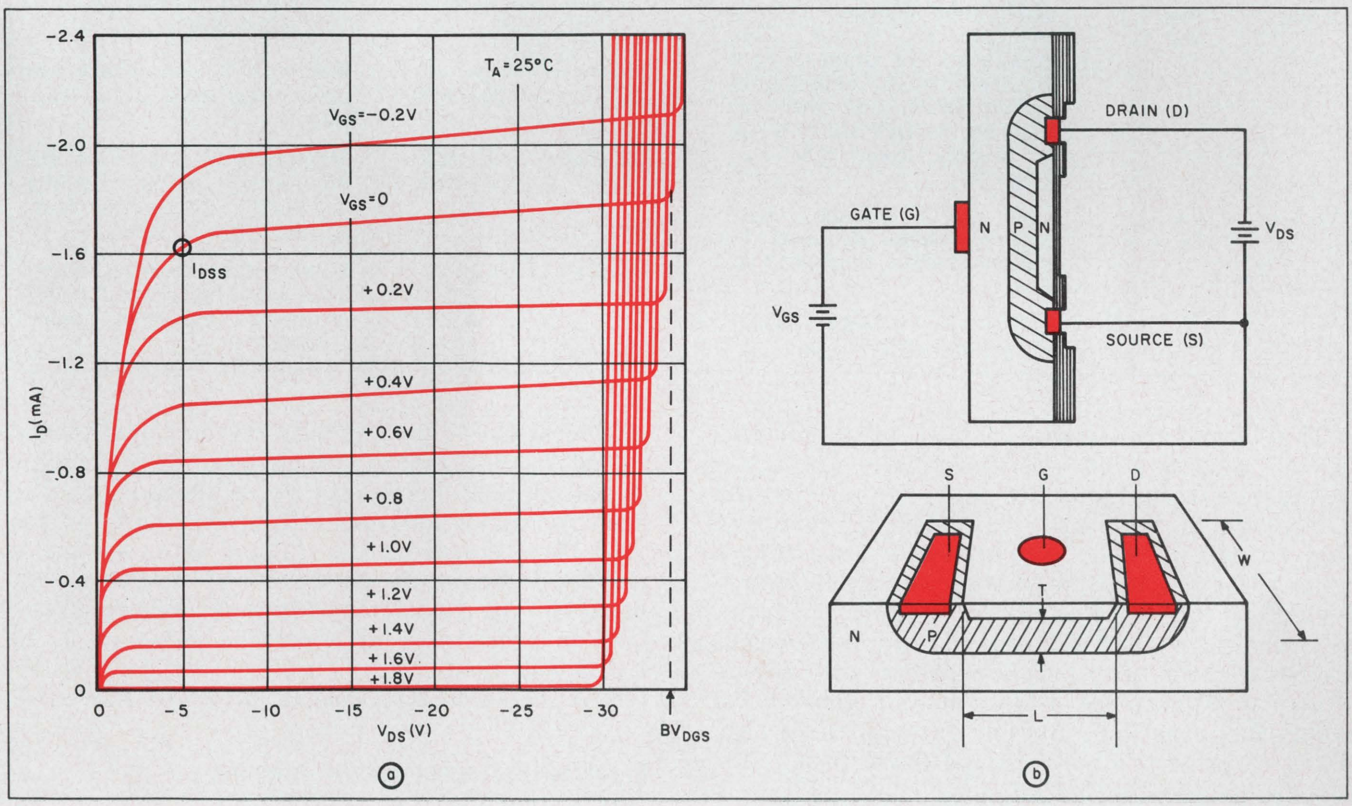
The input resistance is that of a reverse-biased silicon pn junction (SiO_2 insulated-metal electrode in MOS devices), and is measured in gigaohms ($>10^{12}$ ohms for MOS) at dc. The FET is a voltage- or field-controlled device exhibiting very high power gain at low frequencies. Because neither load nor signal current crosses the gate-channel junction, there is almost perfect input-output isolation and unilateral gain.



The closer you pare the differing FET properties, the more apparent becomes their suitability for various applications. Author Sherwin measures FET parameters on a MONITOR automatic FET/transistor test set.

Parameter	Test conditions (must be specified)	Mean of specification
BV_{GSS}	I_G $V_{DS}=0$	Breakdown voltage from gate to channel. Drain and source are shorted, and a reverse bias is placed across the gate-channel junction. This is shown as the breakdown point where $V_{GS} \approx BV_{GSS}$. (Fig. 3)
BV_{GDS}	I_G $V_{DS}=0$	Identical to BV_{GSS}.
BV_{GDO}	I_D $I_S=0$	Breakdown voltage from gate to drain with source open. Under these conditions $V_{GS} \approx V_{GS(OFF)}$ due to self-biasing required to prevent current flow from drain to source.
BV_{SGO}	I_S $I_D=0$	Breakdown voltage from gate to source with drain open. $V_{GD} \approx V_{GD(OFF)}$.
BV_{DSS} BV_{DGS}	I_D $V_{GS}=0$	Breakdown from drain to source with $V_{GS}=0$. This is normally specified for Type-C MOS devices. It represents breakdown from drain to substrate.
BV_{DSX}	I_D V_{GS}	Breakdown from drain to source with $V_{GS} \neq 0$. Normally specified only for Type-B MOS devices when $V_{GS} > V_{GS(OFF)}$. It represents breakdown from drain to substrate.

Parameter	Test conditions (must be specified)	Meaning of specification
I_{GSS}	V_{GS} $V_{DS}=0$	Gate-channel leakage with $V_{DS} = 0$. This represents total gate leakage current at a point below breakdown voltage (Fig. 3) Specified at ½ to 1 times the minimum specified BV_{GSS}. When specified at min BV_{GSS}, I_{GSS} may replace the BV_{GSS} specification in that I_{GSS} is $<I_G$ in the BV_{GSS} specification.
I_{DGO}	V_{DG} $I_S = 0$	Drain-to-gate leakage current with source open. As $V_{GS} \approx V_{GS(OFF)}$ for reasons indicated under BV_{DGO}, $I_{GS} \neq 0$. Then $-I_{DGO} = I_{GD}$ [at specified V_{DG}] + I_{GS} [at $V_{GS} \approx V_{GS(OFF)}$]. See Fig. 4 for a comparison of I_{GSS}, I_{DGO}, I_{SGO}, and $I_{D(OFF)}$. I_{DGO} is representative of I_G under worst probable operating conditions when $V_{GS} = V_{GS(OFF)}$ and V_{DG}=maximum allowable.
I_{SGO}	V_{SG} $I_D = 0$	Source-to-gate leakage current with drain open. Note that $-I_{SGO} = I_{GS}$ at [V_{DG}] + I_{GD} at [$V_{GD} \approx V_{GD(OFF)}$].
I_G	V_{DS} or V_{DG} V_{GS}	Gate leakage current under certain operating conditions. I_G is usually somewhat lower than I_{DGO} since I_{DGO} is the limiting case of I_G.



1. **FET output characteristics resemble** those of the pentode (a). Construction (b) shows how voltage applied between the gate and source terminals modulates channel resistance.

TABLE 1 FET Specification Parameters

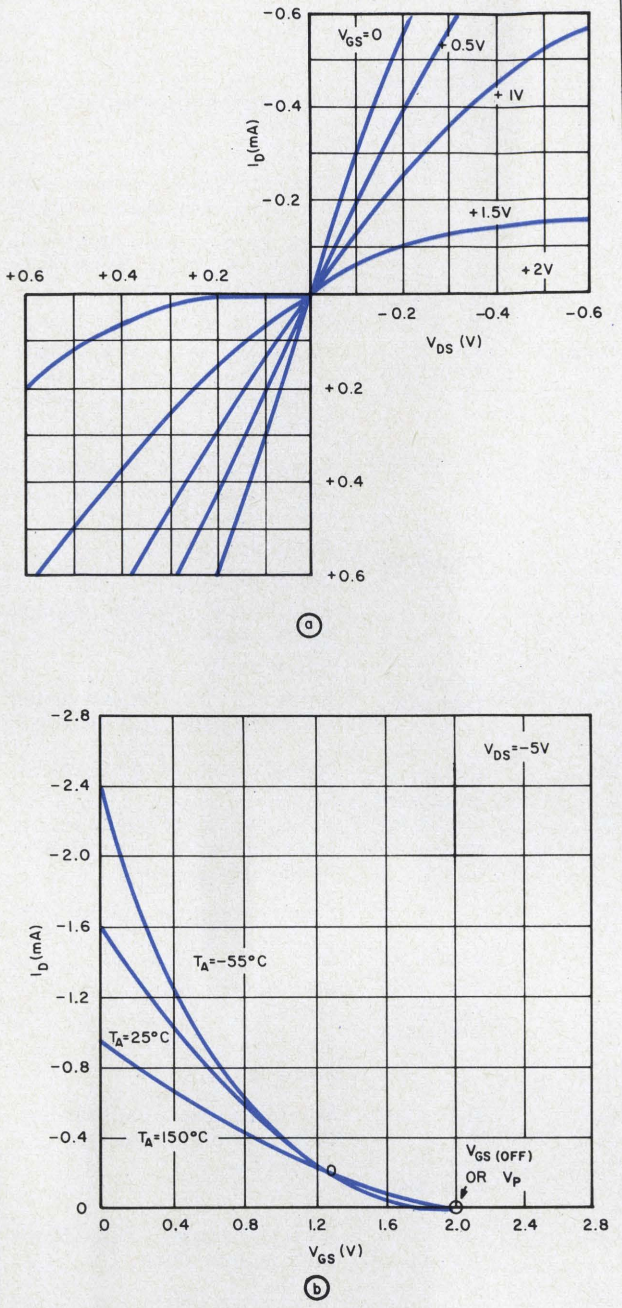
Parameter	Test conditions (must be specified)	Meaning of specification
I_{DSS}	V_{DS} $V_{GS} = 0$	Drain saturation current, the value of I_D measured above the knee of the V_{DS}-I_D characteristic curve, where $V_{DS} > V_P$ (Fig. 1). I_{DSS} is actually defined as I_D at the V_{DS} required for channel pinch-off when the two gate-channel-junction depletion regions meet near the drain.[6] V_{GS} must be zero. At this point I_D is self-limiting, and any increase in V_{DS} causes only slight increase in I_D.[7] In Type-C MOS devices, I_{DSS} is essentially the drain-substrate leakage plus any residual drain-source channel current.
$I_{D(ON)}$	V_{DS} V_{GS}	Drain current under specified bias conditions. Specified for Type-B and Type-C MOS devices as a max intended operating drain current when V_{GS} is biased for max channel conduction.
I_D	V_{DS} or V_{DG} V_{GS}	Drain-source current under certain specified operating conditions.
I_{DX}	V_{DS} or V_{DG} V_{GS}	Same as I_D but a particular set of operating conditions is implied.
I_{DZ}	V_{DS} or V_{DG} V_{GS}	Same as I_{DX} but often used to denote drain current for zero temperature-coefficient operation.
$I_{D(OFF)}$	V_{DS} V_{GS}	Drain-gate leakage current with $V_{GS} > V_{GS(OFF)}$. This represents the drain current observed in an analog-gate circuit which has been biased to the OFF state. $I_{D(OFF)}$ is slightly lower than I_{DGO} (Fig. 7a).
$V_{GS(OFF)}$	V_{DS} I_D	Gate cut-off voltage. Gate-source voltage required to cut-off channel current (Fig. 5b).
V_P		Pinch-off voltage, interchangeable with $V_{GS(OFF)}$.
V_{P1}, $V_{G1S(OFF)}$	V_{DS} I_D $V_{G2S} = 0$	Gate 1 cut-off voltage for tetrodes.
V_{P2}, $V_{G2S(OFF)}$	V_{DS} I_D $V_{G1S} = 0$	Gate 2 cut-off voltage for tetrodes.
$V_{GS(th)}$	V_{DS} I_D	Gate-threshold voltage. Gate-source voltage required to initiate channel conduction in Type-C MOS devices (Fig. 5b).
$V_{GS(r-t)}$	V_{DS} I_G $V_{G2S} = 0$	Gate-to-gate reach-through voltage. Found in tetrodes only. This is the point at which gate current flows from gate to gate. Measured with $V_{G2S} = 0$, hence the subscript GS(r-t) rather than G1G2(r-t).
V_{GS}	V_{DS} I_D	Gate-source voltage at any given operating point.
V_{GSX}	V_{DS} or V_{DG} I_D	Same as V_{GS} but a particular set of operating conditions is implied.
V_{GSZ}	V_{DS} or V_{DG} I_D	Same as V_{GSX} but often used to denote V_{GS} for zero temperature coefficient operation.
$\|V_{GS1}-V_{GS2}\|$	V_{DG} I_S or I_D	Magnitude of gate-to-gate differential offset voltage in differential (matched) pairs.
$\triangle\|V_{SG1}-V_{GS2}\|$	V_{DG} I_S or I_D	Change in $\|V_{GS1}-V_{GS2}\|$ over given temperature range.
$\frac{\triangle\|V_{GS1}-V_{GS2}\|}{\triangle T}$	T_{A1} & T_{A2}	Incremental change in $\|V_{GS1}-V_{GS2}\|$ expressed in $\mu V/°C$.
$\frac{I_{DSS1}}{I_{DSS2}}$	V_{DS} $V_{GS} = 0$	Match in I_{DSS} of differential pairs, expressed as a fraction.
$\|I_{G1}-I_{G2}\|$	V_{DS} & V_{GS} V_{DG} or & I_D T_A	Magnitude of match in I_G for differential pairs. Usually specified at an elevated temperature near 100°C.
$r_{DS(ON)}$	I_D V_{DS} &/or V_{GS}	Static drain-source resistance when biased to full ON condition (maximum operating I_D).

The output resistance is that of a current-limited device when operating with drain-gate voltages of more than a few volts, as shown by the flat section of the output-characteristic curves in Fig. 1a. Magnitude of output conductance ranges from 1 to 100 μmhos, depending on device geometry. When operating at very low values of drain-source voltage, the FET behaves as a voltage-controlled resistor. The output-characteristic curves drawn in Fig. 2a for a low value of applied V_{DS} retain the same slope crossing through the origin. Thus, r_{ds} exhibits a bidirectional characteristic for low V_{DS} values of either polarity.[8]

The temperature dependence of drain current is the combined effect of a negative temperature coefficient due to the majority carrier mobility and a positive temperature coefficient due to the change in gate-channel depletion-layer potential. (As the depletion region narrows with increasing temperature, thus increasing the channel cross-section, a positive temperature coefficient of drain current results). The two temperature-dependent effects tend to cancel and, at a specific value of I_D or V_{GS}, a zero temperature coefficient exists. The effect is shown on the transfer curves of Fig. 2b.[4,5]

Breaking the specification dilemma

Despite wide use of field-effect units, a number of their parameter specifications are still not



2. **A voltage-controlled-resistance property** exists in FETs; it is bidirectional and is limited to the low-level region of V_{DS} (a). A zero temperature coefficient, exhibited by most FETs, can be seen on the transfer curve (point 0 on b).

clearly understood. FET data sheet specifications may also seem confusing to some who have worked only with bipolar transistors. Since a proper grasp of the parameters is essential, those likely to be encountered will be explained. Table 1 contains both the definitions and the necessary test conditions.

Some of the parameters are self-explanatory; others become clearer if a schematic or characteristic curve is provided (see Figs. 3-6. Note that leakage effects are included.[6,7]). The small-signal characteristics of FETs and MOSs involve admittance, transconductance, capacitance and resistance terms (Table 2). FET operation here is typified by biasing so that the largest ac signal to be amplified is small in comparison to the dc bias current and voltage. Equally interesting are the response times and equivalent-noise parameters, the most important of which are presented in Table 3.

The distinction between FET and MOS

The MOS or insulated-gate FET differs from the junction-FET in that the primary gate of the MOS is a metal electrode electrically isolated from the channel by an oxide.[8] This gives it its name, metal-oxide-semiconductor (MOS) or insulated-gate field-effect transistor (IGFET). The generalized structure of the MOS is shown in Fig. 7.

A p-type substrate is used for an n-channel MOS. Into the substrate are diffused two separate N+ regions: these become the source and drain connections. Next, an oxide layer is grown over the entire surface. Holes are then etched through the oxide layer over the N+ regions. Finally, a metal pattern is deposited on the surface allowing metal contact through to the source and drain connections. The metal region over the oxide spanning the two N+ regions is the gate electrode. There is no conducting channel from source to drain.

This process produces a normally-OFF or enhancement-mode MOS, which will not conduct until a positive control signal is applied to the gate. Fig. 8 shows the effect of a positive gate potential applied with respect to the channel. Owing to the electrostatic field created, a redistribution of the minority carriers in the p-type substrate occurs.

This results in the formation of an n-type resistive channel between source and drain. As the gate potential is increased, the channel carrier concentration and induced-channel depth increase to form a lower resistance channel. Thus, the electric field at the gate creates and controls the resistance of a conducting channel between source and drain. This device is now being described on data sheets as a Type-C Field-Effect Transistor, an enhancement-type device, according to EIA JEDEC type registration procedures. It may be conveniently described as a normally-OFF device.

A second type of MOS is the normally-ON or depletion-mode MOS (Fig. 9). This is similar to the device in Fig. 7 except that a conducting channel exists from source to drain in the absence of a gate voltage. A negative gate voltage depletes the channel of carriers, and a positive gate voltage enhances the channel or increases the number of carriers. This device may therefore operate in either the depletion or enhancement mode. Data sheets refer to this device as a Type-B, a depletion unit intended for both enhancement-mode and depletion-mode operation.

The junction field-effect transistor (JFET or just plain FET) is referred to as Type-A, a depletion-type device only for depletion-mode operation. Operation of the three devices is made appar-

Table 2. Small Signal Characteristics of FETS

Parameter	Test Conditions (must be specified)	Meaning of specification
$r_{ds(on)}$	V_{GS} $V_{DS} = 0$ or I_S frequency	Drain-to-source resistance when biased to full ON condition (max operating I_D).
$\|y_{fs}\|$		Magnitude of common-source forward transfer admittance. Sometimes the magnitude signs are omitted. Measured at $V_{GS} = 0$, unless otherwise specified.
$\|g_{fs}\|$		Magnitude of common-source forward transfer conductance. Sometimes the magnitude signs are omitted. This is perhaps a more informative term than y_{fs}. At 1kHz, $y_{fs} \approx g_{fs}$. However, at high frequencies y_{fs} includes the effect of gate-drain capacity, hence may be misleadingly high. The term g_{fs} should be used for all high-frequency measurements.
g_{fsx}	V_{DS} & V_{GS} or V_{DG} & I_D frequency	Same as g_{fs} but a particular set of operating conditions is implied.
$\frac{g_{fs1}}{g_{fs2}}$		Match in g_{fs} for differential pairs. Expressed as a fraction.
$\frac{g_{fsx1}}{g_{fsx2}}$		Match in g_{fsx} for differential pairs.
g_{fsz}		Same as g_{fsx} but often used to denote g_{fs} when biased for zero temperature coefficient operation.
g_m		Mutual conductance. Sometimes used in lieu of g_{fs}.
g_{mo}		Same as g_m, but specifically at $V_{GS}=0$.
y_{iss}		Common-source input admittance with output shorted. Important for high-frequency operation.
g_{iss}	V_{DS} V_{GS} $v_{ds}=0$ frequency	Common-source input conductance with output shorted. This must be specified for high-frequency applications as $g_{iss} \propto 1/\omega^2$.
$Re\|y_{iss}\|$		Real part of y_{iss}. Identically equal to g_{iss}. Sometimes used instead of g_{iss}.

Parameter	Test Conditions (must be specified)	Meaning of specification
g_{is}		Same as g_{iss}.
g_{oss}		Common-source output conductance with input shorted.
$RE\|y_{oss}\|$		Real part of y_{oss}. Identically equal to g_{oss}. Sometimes used instead of g_{oss}.
g_{os}	V_{DS} & V_{GS} V_{DG} & I_D $v_{gs}=0$ frequency	Same as g_{oss}.
$Im\|y_{oss}\|$		Imaginary part of y_{oss}. Output susceptance b_{oss}. Identically equal to $1/\omega C_{oss}$. Sometimes used in lieu of C_{oss}.
C_{iss}	V_{DS} V_{GS} $v_{ds}=0$ frequency	Common-source input capacitance, output shorted. $C_{iss} = C_{dg} + C_{gs}$. (Fig. 6).
C_{is}		Same as C_{iss} if $v_{ds}=0$.
C_{gss}		Same as C_{iss}.
C_{rss}	V_{DS} V_{GS} $v_{gs}=0$ frequency	Reverse transfer capacitance, input shorted.
C_{rs}		Same as C_{rss}.
C_{dg}		Same as C_{rss}, actual value of drain-gate capacitance.
C_{gs}	Values in equivalent circuit not measurable directly.	Actual value of gate-capacitance.
C_{ds}		Actual value of drain-source capacitance, essentially header capacitance.
C_{oss}	V_{DS} V_{GS} $v_{gs}=0$ frequency	Common-source output capacitance, input shorted. $C_{oss} = C_{rss} + C_{ds}$. However, C_{ds} is essentially header capacitance.
C_{os}		Same as C_{oss} if $v_{gs}=0$.
C_{dgs}		Same as C_{oss}.
C_{sgs}	V_{DS} V_{GS} $v_{dg}=0$ frequency	Source-to-gate capacitance, gate and drain shorted. $C_{sgs} = C_{gs} + C_{ds}$.
C_{dgo}	V_{DG} V_{GS} or $I_S=0$ $i_s=0$ frequency	Drain-to-gate capacitance with source open. $C_{dgo} = C_{rss} + \frac{C_{gs}C_{ds}}{C_{gs}+C_{ds}} > C_{rss}$, cut $< C_{dgs}$.
C_{sgo}	V_{GS} V_{DS} or $I_D=0$ $i_d=0$ frequency	Source-to-gate capacitance with drain open. $C_{sgo} = C_{gs} + \frac{C_{dg}C_{ds}}{C_{dg}+C_{ds}} > C_{gs}$, but $< C_{sgs}$.

ent by the Type-A, -B, and -C gate-to-drain transfer characteristics (see Fig. 5b).

Gate control separates MOS from FET

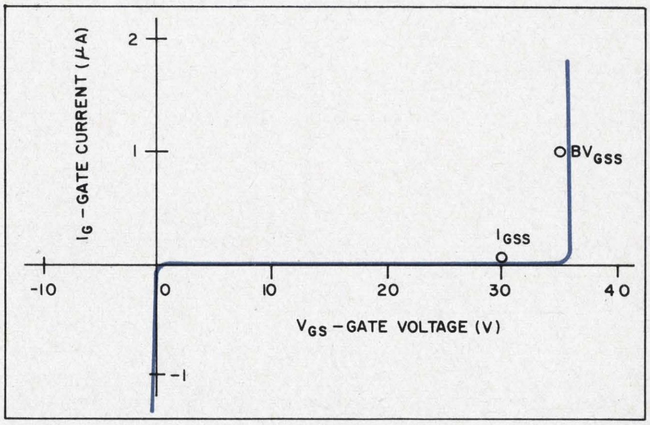
Construction differences between the MOS and FET result in some fairly significant differences in electrical characteristics, including bidirectional gate control, gate current, breakdown paths, dc stability and noise. Bidirectional gate control, already described, is graphed in Fig. 5b.

While FET gate input resistance decreases sharply when forward-biased more than a few tenths of a volt, the MOS gate may be biased to either polarity. As a result, MOS drain current is limited by dissipation and breakdown characteristics rather than by input-resistance considerations. The ON resistance of the depletion-type MOS may then be considerably decreased below that of the zero-bias state. Characterization of the MOS will include $r_{ds(on)}$ in an enhanced state at a given V_{GS}, where $I_{D(ON)}$ is also specified.

The Type-C enhancement-mode MOS is unique in the FET family because it is normally in an OFF state. I_{DSS} is a very low value, similar to $I_{D(OFF)}$ of Types A and B. A new term for Type-C devices only, gate-source threshold voltage $V_{GS(th)}$, describes the gate voltage at which drain current

Table 3. FET Performance Parameters

Parameter	Test conditions (must be specified)	Mean of specification
$t_{delay(on)}$	V_{DD} $I_{D(ON)}$ $V_{GS(ON)}$	Delay time before turn on when pulsed from OFF to ON condition.
t_{fall}	$V_{GS(OFF)}$ Test circuit Pulse rate	Fall time when pulsed from OFF to ON condition.
$t_{delay(off)}$	Input pulse characteristics	Delay time before turn off when pulsed from ON to OFF condition.
t_{rise}	Oscilloscope characteristics	Rise time when pulsed from ON to OFF condition.
t_{on}		$t_{fall}+t_{delay(on)}$.
t_{off}		$t_{rise}+t_{delay(off)}$.
$\bar{e}_n$	V_{DS} V_{GS} or I_D frequency bandwidth	Common-source equivalent short-circuit input noise voltage. Measured at the output with the input shorted, and referred to the input. Expressed as rms volts per root cycle, $\mu V/\sqrt{Hz}$. A function of frequency, so frequency value must be stated.
$\bar{i}_n$	V_{DS} V_{GS} or I_D frequency bandwidth	Common-source equivalent open-circuit input noise current. Expressed as $pA/\sqrt{Hz}$, a function of frequency.
NF	V_{DS} V_{GS} or I_D $R_{generator}$ frequency bandwidth	Noise figure. This represents a ratio between input signal to noise and output signal to noise. NF is a function both of frequency and of generator resistance R_s. Both must be stated or the specification is meaningless. When properly qualified, NF includes the effects of both $\bar{e}_n$ and $\bar{i}_n$.



3. **FET input gate characteristic** shows the breakdown point where $V_{GS} \approx BV_{GSS}$ (see Table 1).

Table 4. FET and MOS applications

Application	Preferred device MOS	FET
Analog switch	X	X
Digital switch	X	
General-purpose amplifier		X
Low-noise amplifier		X
High-frequency amplifier	X	X
Differential amplifier		X
Low-drift single-ended amplifier		X

begins to increase. Except for a translation along the V_{GS} axis, $V_{GS(th)}$ is not unlike $V_{GS(OFF)}$ in Types A and B. In fact, the difference between Type-B and Type-C devices is a simple translation of the transfer curve along the V_{GS} axis (see Fig. 5a).

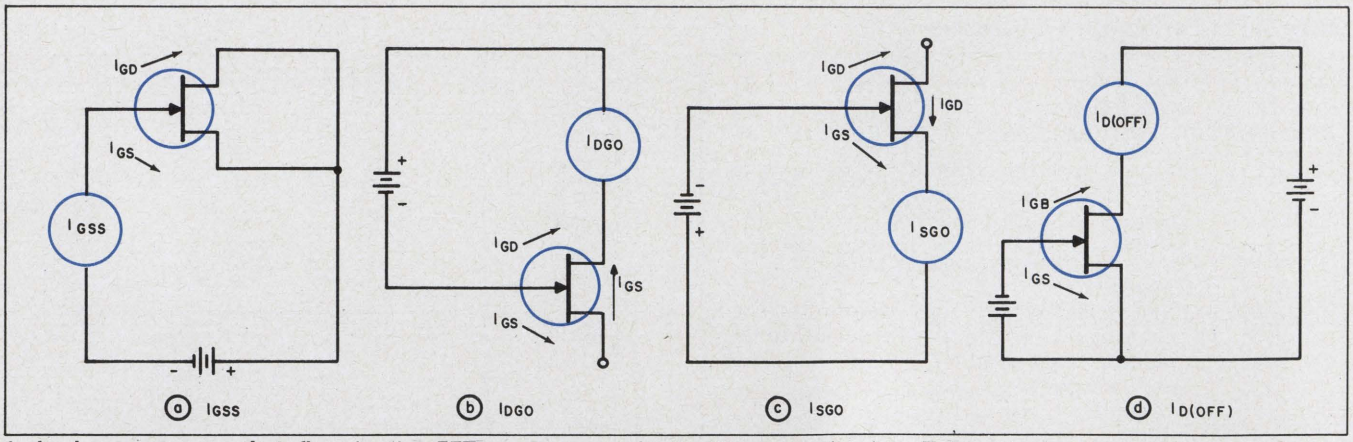
Gate current of the MOS is predictably much less than that of the FET because of the insulating properties of the oxide layer. MOS and FET gate currents may be compared in much the same manner as the leakage of a ceramic dielectric capacitor may be compared to the reverse current of a signal diode. Whereas FET gate current exhibits a significant temperature and voltage dependence, the dc input resistance of the MOS gate is generally greater than 10^{12} ohms under all operating conditions.

A better understanding of breakdown

The voltage breakdown characteristics of the MOS differ markedly from those of the FET. The FET exhibits an avalanche breakdown across the most highly stressed point (drain-gate) of the gate-channel diode junction. In tetrode devices (junction FETs with two gates), there is also a reach-through breakdown from gate to gate when the channel becomes depleted of majority carriers at gate bias levels approaching the cut-off voltage. Different values of reach-through voltage are observed on gates 1 and 2, which are of unequal resistivity. It is important to note that in tetrodes, where one gate (usually the substrate gate) has been internally connected to the source, it is impossible to measure I_{GSS} or BV_{GSS} at voltage levels above the gate-1 reach-through value.

The MOS breakdown mechanisms are of a different nature. Take, for example, the enhancement of device. Breakdown from gate-to-source or gate-to-drain depends upon the thickness and quality of the insulating oxide. When the dielectric strength of the oxide is exceeded, breakdown occurs, puncturing the insulating layer. The breakdown is destructive in nature because a virtual short circuit occurs at the puncture point. This type of breakdown is quite common in dry climates when adequate handling precautions are not observed. For instance, a static electric potential of several thousand volts may easily build up on the gate from contact with nylon smocks. The gate then becomes permanently damaged. To avoid this, some manufacturers supply units with built-in Zener protection or with shorting clips across the gate-to-source junction.

There is also a breakdown from source to drain



4. **Leakage currents that flow** in the FET are measured with these circuits (see Table 1).

on the Type-C and Type-B units when either is biased to cut-off. In each case there is no channel connecting the source and drain which are isolated by the substrate. If the substrate is floating, two diodes appear back-to-back between source and drain. Drain-to-source breakdown (BV_{DSS}) occurs in either polarity across one or the other of these diodes.

If a Type-B device is under consideration, BV_{DSS} is usually replaced by BV_{DSX} where the subscript X indicates some specific bias condition—$V_{GS} > V_{GS(OFF)}$ in this case. When the substrate is internally connected to the source, the breakdown takes place across the drain-substrate junction. A drain-source voltage greater than a few tenths of a volt of opposite polarity will cause forward conduction of the drain-substrate junction. This condition prevents use of the device in high-level, analog-switching circuits.

FET more stable than MOS

The dc stability of the MOS is inferior to that of the FET.[9] Whereas, with the FET, the equivalent drift of V_{GS} is a predictable and repeatable function of temperature, that of the MOS is dependent upon temperature and/or V_{GS} history (recent past excursions). When a gate-channel voltage is applied to the MOS, there is a charge migration in the insulating oxide. When the bias is removed, the time required for restoration of equilibrium is a function of the bias applied, the length of time the bias had been applied, and the temperature both during biasing and after removal of bias.

As these relationships are complex, it is impossible to predict residual gate field conditions accurately. The effect of the disturbance in charge equilibrium is that a residual gate bias exists; this controls the channel as if a small but unknown gate voltage were present. The effect on drain current is that of an indeterminate translation of the gate-drain transfer-characteristic curve horizontally along the V_{GS} axis. High-voltage bias alone has some effect, but high-temperature storage by itself has no effect except to speed the return to equilibrium. The variation in drain current from normal may be less than one per cent after a period of low-voltage biasing at room temperature. It may rise to 30% after several hours of 10-volt biasing at 100°C.

A specific bias point exists on FETs where the drain current exhibits a zero temperature coefficient. Such a point also exists for the MOS, except that a true zero temperature coefficient is rarely, if ever, observed. In MOSs, a zero t.c. exists only for a much smaller range of temperature variation. Bias stability has been observed to be no better than $\Delta|V_{GS}|\ 0 - \approx 10$ mV for a variation of 75°C. This compares with $\Delta|V_{GS}| < 0.5$ mV over $\Delta T = 100°C$ for the FET.

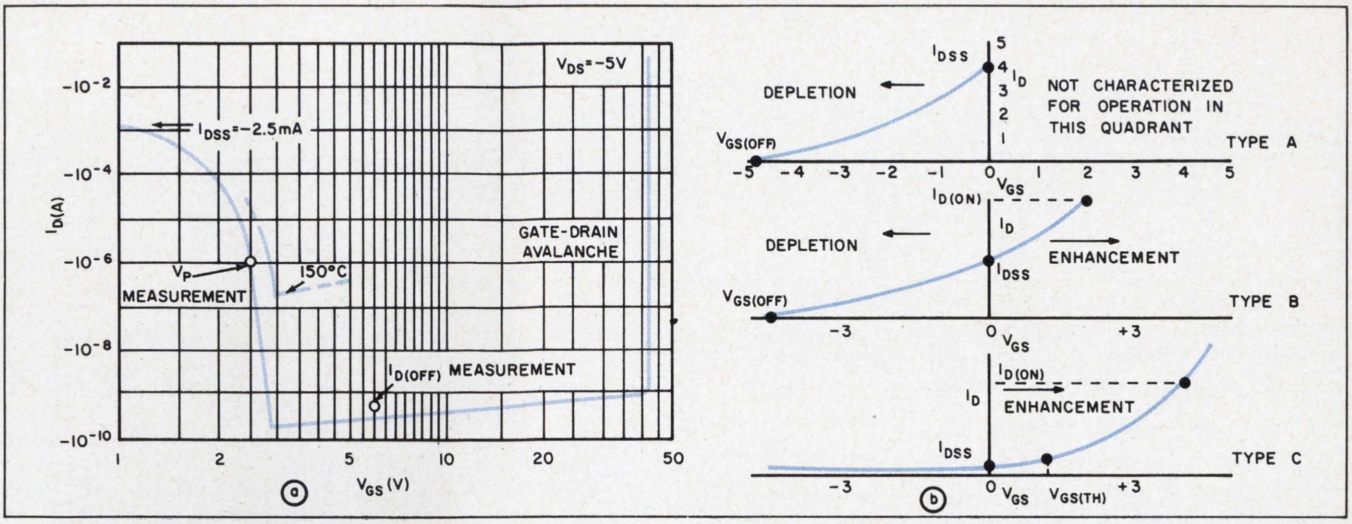
The noise performance of the MOS is also inferior to that of the FET, except perhaps at VHF and above.[10] A high level of excess noise is present at low frequencies, and is believed to be due to the relatively unprotected nature of the MOS channel surface.

MOS forte is switching applications

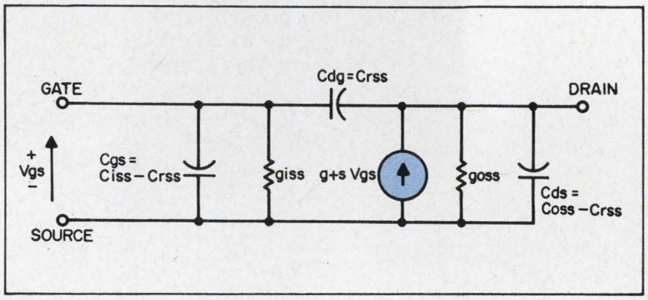
From the preceding discussion of electrical characteristics, it is apparent that the MOS is well suited for some, but not all, circuit applications. Table 4 serves as a guide to suitable FET and MOS applications. A listing in the table does not necessarily mean that the unlisted device is not suitable for the application, but that the listed device is preferred.

Several manufacturers have developed multiple MOS arrays in digital integrated circuits. They have been acclaimed as a means of reducing size, cost and power consumption of digital computers. The MOS is very well suited to switching applications because, as the control voltage varies to turn the device ON, a voltage clamp is not required to prevent gate current flow.

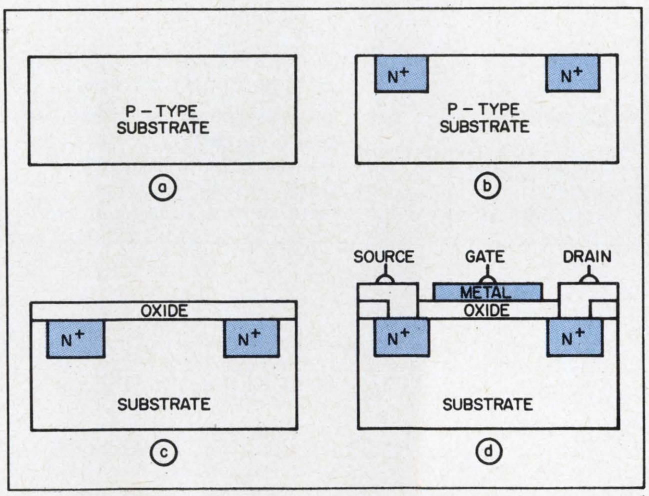
Considerable use of the MOS as an analog multiplexer gate may occur within the next few years. The capabilities of $I_{D(OFF)}$ less than 1 nA, $r_{ds(on)}$ less than 100 Ω, and the normally-OFF advantage are all-important in this application. It is necessary in these analog gating circuits for the MOS substrate to be isolated from source and drain so that the V_{DS} may be of either polarity. Consider the analog gate circuit of Fig. 10a which uses a connected-substrate MOS. Note that if a



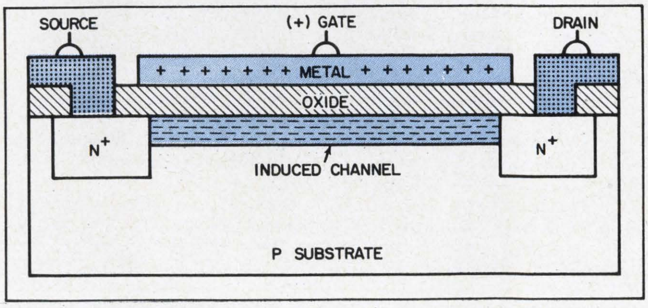
5. **Transfer characteristic** (a) shows how key parameters V_P and $I_{D(OFF)}$ are measured (see Table 1). This is for a Type-A FET unit (depletion mode). All three FET types (depletion, depletion-enhancement (Type-B) and enhancement (Type-C) have unique transfer properties (b). Each governs device suitability for different applications.



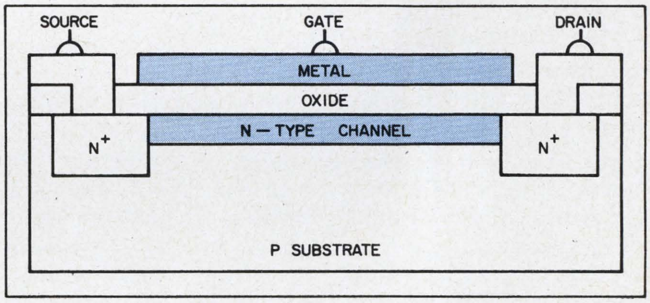
6. **The equivalent circuit of the FET** is used in small-signal applications (see Table 2).



7. **Starting with a p-type substrate (a),** three additional steps are used in MOS construction.



8. **An enhancement channel is formed** in the MOS when a positive gate potential is applied.



9. **Depletion-type MOS** is a normally-ON device. With zero gate potential, conducting channel from source to drain.

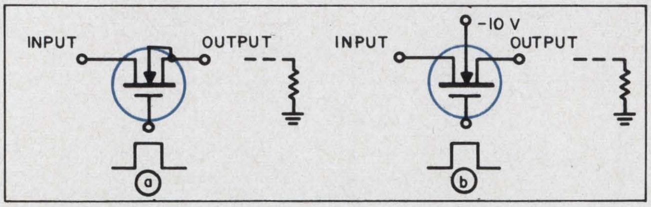
negative input signal were present, the drain-substrate junction would become forward-biased, allowing signals to appear at the output even in the absence of a gate drive. In the circuit of Fig. 10b, an MOS with isolated-substrate is used. Here the substrate is biased more negative than the largest signal to be handled, thus preventing drain-substrate conduction.

Another point of consideration in analog gate circuit design is the relationship between threshold voltage and signal voltage. With the gate at ground potential, a negative signal on the source is equivalent to a positive V_{GS}. Then, if the MOS in Fig. 10b is in its normally-OFF state, the $V_{GS(th)}$ must exceed the maximum peak-signal level.

Low ON resistance a high point

In digital switching applications, the MOS is the most promising device available. The desirable characteristics for this are low ON resistance, low capacitance, high switching speed, high input resistance, high threshold voltage, and a normally-OFF state. The Type-C MOS may be designed to meet all of these characteristics within reasonable limits. Low ON resistance increases switching speed and produces low $V_{DS(ON)}$ values.

The latter term is equivalent except in magnitude to $V_{CE(sat)}$ of bipolar transistors. Low



10. **The MOS is well suited for analog-switching.** A connected-substrate unit is an analog gate (a) for basic multiplexing. The isolated-substrate version blocks output signals (b) when the input goes negative.

capacitance provides for increased switching speed. High input resistance yields a high fan-out capability. High threshold voltage produces good noise immunity. The normally-OFF state allows for simple direct-coupled operation with a single power supply. Combinations of normally-ON and normally-OFF MOS devices within a digital system are another intriguing possibility.

The MOS is not specifically suitable as a general-purpose amplifier because of the drain current instability with bias and temperature. In applications where ambient temperature is moderate and some drift in operating point is tolerable, the normally-ON MOS may be useful. Audio-frequency applications would be limited to medium and/or high-level signals, owing to the large amount of excess noise exhibited by present MOS devices at low frequencies. Because of its relatively inferior noise performance, the MOS is ill-suited as a low-frequency, low-noise amplifier.

MOS is O.K. for RF amplification

The MOS is also limited for use in dc amplifier circuits because of the instability problem already noted. The only possibility at present for this application would be when the MOS is biased near the zero temperature coefficient point. This use is limited only to dc amplifiers with moderate short-term drift performance requirements and a wide latitude on long-term drift performance. The instability restricts the MOS to laboratory uses allowing $>$ 10-m V drift in V_{GS} and military applications allowing $>$100-mV drift.

The MOS does, however, show promise for use as an RF amplifier, particularly where the square-law transfer characteristic produces very low levels of cross-modulation. The low input conductance of the MOS makes it suitable for efficient operation to several hundred megahertz. And, although low-frequency noise is excessive, high-frequency noise may be of a sufficiently low magnitude to permit uhf operation with noise figures below 5 dB.

FET applications are not exclusively limited to amplifiers. FETs are ideally suited to switching applications where the load resistance is high compared to channel resistance. The most important characteristics for each application are listed in Table 5. When referring to the FET tables (pp. 104 to 112), consult these key parameters. They are indices of the suitability of a device for a particular application.*

Table 5. FET applications

Application		Characteristic Definition
Analog switch	$r_{ds(on)}$	Series ON resistance
	$I_{D(OFF)}$	OFF leakage current
	C_{dgs}/C_{sgs} or C_{dgo}/C_{sgo}	Gate-channel capacitance
Digital switch	$r_{ds(on)}$	ON resistance
	$V_{GS(th)}$ or $V_{GS(OFF)}$	Control voltage threshold
	$t_{(on)}+t_{(off)}$	Sum of rise, fall, and switch ing delay times
General-purpose amplifier	I_{DSS}	Drain current at zero gate bias
	g_{fs}	Transconductance at zero gate bias
	$V_{GS(OFF)}$	Gate cut-off voltage
Low-noise amplifier	$\bar{e}_n$	Equivalent short-circuit input noise voltage
	$\bar{i}_n$	Equivalent open-circuit input noise current
	NF	Noise figure for a given source resistance
	g_{fs}	Transconductance
High-frequency amplifier	g_{fs}	Transconductance
	C_{rss}	Reverse transfer capacitance, drain-to-gate
	g_{iss}	Input conductance at intended operating frequency
	C_{iss}	Input capacitance
Differential amplifier	$\frac{\Delta \lvert V_{GS1}-V_{GS2} \rvert}{\Delta T}$	Differential input voltage drift with temperature
	$\lvert V_{GS1}-V_{GS2} \rvert$	Initial input offset voltage at 25°C
	$\lvert I_{G1}-I_{G2} \rvert$	Input current match at maximum operating temperature
	g_{fsx}	Transconductance under operating conditions
	g_{fs1}/g_{fs2}	Transconductance match under operating conditions
Low-drift	I_{DZ}	Zero temperature coefficient drain current
single-ended amplifier	g_{fsz}	Transconductance at I_{DZ}
	I_G	Gate current at I_{DZ}
	V_{GSZ}	Gate-source voltage at I_{DZ}

*A more detailed treatment of FET and MOS applications will be provided in a three-part follow-up design article appearing in the next 3 issues of ELECTRONIC DESIGN.

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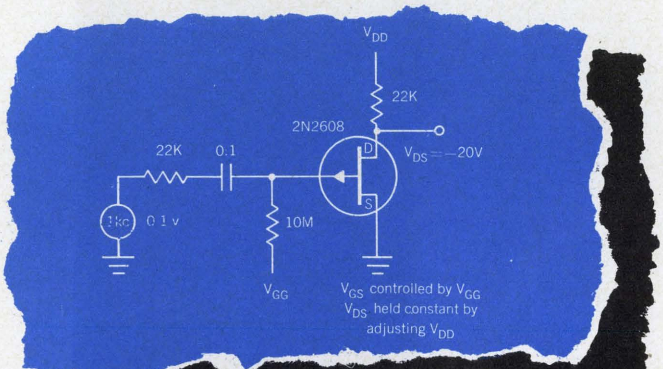

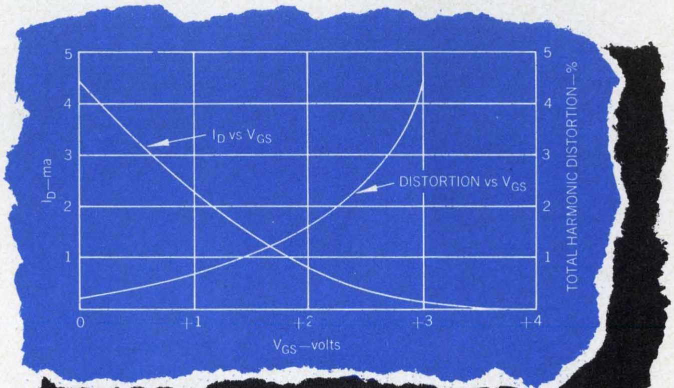

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ON READER-SERVICE CARD CIRCLE 27

Field-Effect

Type 1(a). Analog-switching: Listed by descending order of $r_{ds(on)}$.

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	GME	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	1.0	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
	2N3329	TI	p,DP,F,3	1000	–	–	–	5	1000-2000	10	1-3	72	UC
	2N3460	AL	n,DPE,F,3	1000	–	6	50	2	1000-4500	–	0.2-1	18	DIC, SI, UC
	D1185	DIC	n,DPE,F,3	1000	–	6	40	2	1000-4500	–	0.2-1	18	
	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	
	2N3378	SI	p,DP,F,3	750	–.0004	3	30	5	1500-2300	3	–(3–6)	72	
FET 3	2N3379	SI	p,DP,F,3	750	–.0004	2	30	5	1500-2300	3	–(3–6)	–	Flat pack
	2N3437	DIC	n,DPE,F,3	700	–	6	50	4	1500-6000	–	0.8-4	18	
	2N3459	DIC	n,DPE,F,3	700	–	6	50	4	1500-6000	–	0.8-4	18	
	C6690	CT	n,EP,F,3	700	1.0	5	30	10	–	1.0	–	18	
	C6691	CT	n,EP,F,3	700	1.0	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	
	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	
	2N3436	DIC	n,DPE,F,3	450	–	6	50	8	2500-10,000	–	3-15	18	
	2N3458	DIC	n,DPE,F,3	450	–	6	50	8	2500-10,000	0.25	3-15	18	
	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	
	M100	SI	n,M,3	350(typ)	.001	–	20	–5	1000-2200	–	1.5-4.5	18	
	2N3382	SI	p,DP,F,3	300	–.002	6	30	5	4500-12,500	15	–(3–30)	72	
FET 5	2N3383	SI	p,DP,F,3	300	–.002	5	30	5	4500-12,500	15	–(3–30)	–	Flat pack
	2N3608	GME	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	GME	p,M,4	300	–	3.5	*–20	*–8	600 (min)	1000	0.0001	18	
	M101	SI	n,M,3	300(typ)	1	†7.5	20	–8	1500-3300	–	4-12	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
	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	
	HA2010	HU	p,M,4	200	1000	1	*–35	*5	1000-2000	0	–	72	
FET 6	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	
	2N3993	TI	p,DP,F,3	150	1.2	–	25	4-9.5	6000-12,000	1.2	10 (min)	72	
	TIS05	TI	p,DP,F,3	150	2	5	25	10	6000-12,000	2	10-45	72	
	2N3387	SI	p,DP,F,3	150	–.0025	5	30	9.5	7500-15,000	15	–(15–50)	–	Flat pack
	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	
	2N3972	SI	p,DPE,F,3	100	0.25	†25	40	–3	–	*0.25	5-30	18	
FET 7	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	3.0	15	10	7	10-30000	3	–	18	
	UC251	UC	n,F,3	75	.001	6	30	6	–	1	7.5-75	18	
	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	
	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	
	CM601	CT	n,EP,F,3	50	.003	15	15	10	10-30000	3	–	18	

(see pages 4-9 for explanation of company abbreviations.)

Key to FET listings

Definitions of parameters used appear in the article devoted to FET and MOS characteristics (pp. 94 to 102). In the column headed "Channel, construction, class and number of elements": channel refers to p or n type; classes F and M signify junction-FET and MOS-FET, respectively; construction is indicated by an abbreviated form of the manufacturing process (see page 20 for key to symbols); and number of elements designates the number of accessible leads on the package, e.g., 3 for FETs, 4 for tetrode FETs or MOSs, etc.

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 8	CM602	CT	n,EP,F,3	50	3.0	15	30	10	10-30000	10	–	18	
	TIXS36	TI	n,EP,F,4	50	–	–	30	10	10,000-20,000	10	10,000-	18	
	U182	SI	n,DPE,F,3	40	.00025	†25	40	–10	–	*0.25	50-150	18	
	CM603	CT	n,EP,F,3	35	3.0	15	15	10	20-60000	3	–	18	
	2N4091	AL	n,DP,F,3	30	.00002	5.0	40	10	–	0.2	30 (min)	18	
	UC250	UC	n,F,3	30	.001	6	30	10	–	0.1	50-150	18	
	TIXS41	TI	n,EP,F,3	25	0.5	–	30	10	–	0.2	50 (min)	18	
	2N2386	TI	p,DP,F,3	–	0.01	–	–	8	1000 (min)	10	–	5	
	2N2500	Ti	p,DP,F,3	–	–	–	–	15	1000-2200	10	1-6	5	
	2N3332	TI	p,DP,F,3	–	–	–	–	6	1000-2200	10	1-6	72	
FET 9	2N3796	MO	n,DP,M,4	–	–	0.8	*25	–4	900-1800	–0.001	0.5-3	18	
	2N3797	MO	n,DP,M,4	–	–	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	
	2N3822	TI	n,EP,F,3	–	–	–	50	6	3000-6500	0.1	2-10	72	
	2N3823	TI	n,EP,F,3	–	–	–	30	8	3500-6500	0.5	1-7.5	72	
	2N3909	TI	p,PL,F,3	–	–	–	20	0.3-7.9	1000-5000	10	0.3-15	72	
	2N4220	MO	n,DP,F,3	–	–	2	–30	–4	1000-4000	–0.1	0.5-3	72	
	2N4221	MO	n,DP,F,3	–	–	2	–30	–6	2000-5000	–0.1	2-6	72	
FET 10	2N4222	MO	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	
	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	

(see pages 4-9 for explanation of company abbreviations.)

Field-Effect *(continued)*

Type 1(b). Digital-switching: Listed by descending order of $V_{GS(TH)}$.

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 †BV_{DSX} [Min.] (volts)	C_{rss} [Max.] (pF)	C_{iss} [Max.] (pF)	$t_{on}+t_{off}$ [Max.] (μs)	TO-	Alternate Sources and Remarks
FET 11	2N2497	TI	p,DP,F,3	15 (max)	1000	1-3	10	–	–	32	–	5	
	2N2498	TI	p,DP,F,3	15 (max)	800	2-6	10	–	–	32	–	5	
	2N2499	TI	p,DP,F,3	15 (max)	600	5-15	10	–	–	32	–	5	
	2N2500	TI	p,DP,F,3	15 (max)	–	1-6	10	–	–	32	–	5	
	2N3970	UC	n,F,3	10 (max)	30	50-150	0.25	40	6	25	50	18	
FET 12	TIS05	TI	p,DP,F,3	10 (max)	150	10-45	2	25	–	12	–	72	
	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	
	2N2386	TI	p,DP,F,3	8 (max)	–	–	10	–	–	50	–	5	
	2N3331	TI	p,DP,F,3	8 (max)	600	5-15	10	–	–	20	–	72	
	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	
	2N3824	TI	n,EP,F,3	8 (max)	250	–	0.1	50	3	6	–	72	
FET 13	TIS14	TI	n,EP,F,3	6.5 (max)	–	0.5-15	1	30	4	8	–	72	
	2N3330	TI	p,DP,F,3	6 (max)	800	2-6	10	–	–	20	–	72	
	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	
	2N3329	TI	p,DP,F,3	5 (max)	1000	1-3	10	–	–	20	–	72	
	2N3971	UC	n,F,3	5 (max)	60	25-75	0.25	40	6	25	90	18	
	M101	SI	n,M,4	*–8(max)	300 typ	4-12	–	†20	–	7.5	–	18	
	M100	SI	n,M,4	*–5(max)	350(typ)	1.5-4.5	–	†20	–	7.5	–	18	
	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	
FET 14	2N3608	GME	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	
	TIXS36	TI	n,EP,F,4	3-10	50	40-200	10	30	5	12	–	72	
	DE1004	GME	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	
	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)	–	–	

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 †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	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	
	FI-100	FA	p,EP,M,4	2.5-6.0	1000	–	0.0025	30	1.0	3.5	–	72	
	2N3971	SI	n,DPE,F,3	–2-5(Vp)	60	25-75	*0.25	40	6	25	90	18	
	2N3994	TI	p,DP,F,3	1-5.5	300	2 (min)	1.2	25	5	16	–	72	
	MM2103	MO	p,DP,M,4	–(1.5–5)	600	0-0.005	0.010	*–25	2.5	6.5	0.15	72	
	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	
	MM2102	MO	n,DP,M,3	1-4	200	0-0.010	0.010	*25	1.5	4.5	0.15	72	
	2N3972	SI	n,DPE,F,3	*–(0.5–3)	100	5-30	*0.25	40	6	25	180	18	
FET 16	2N3909	TI	p,PL,F,3	0.3-7.9	–	0.3-15	10	20	16	32	–	72	
	2N3824	MO	n,DP,F,3	–	250	–	–0.1	–50	3	6	–	72	
	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	
	2N4221	MO	n,DP,F,3	–	–	2-6	–0.1	–30	2	6	–	72	
	2N4222	MO	n,DP,F,3	–	–	5-15	–0.1	–30	2	6	–	72	
	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	
FET 17	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	

(see pages 4-9 for explanation of company abbreviations.)

Type 2(a). Low-drift, single-ended dc amplifiers: Listed by ascending order of I_{DX}.

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=–kHz / R_{gen}=–kΩ)	TO-	Alternate Sources and Remarks
FET 18	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	
	2N2841	SI	p,DP,F,3	.014 (typ)	50 (typ)	–	30	1.2 (max)	–	6	3(1 / 10000)	18	
	2N2607	SI	p,DP,F,3	.03 (typ)	120 (typ)	*3	30	0.4-3.5	–	10	–	18	
FET 19	2N2842	SI	p,DP,F,3	.04 (typ)	150 (typ)	–	30	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	
	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	
	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	
	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	
FET 20	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	
	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	
	TIS14	TI	n,EP,F,3	0.5-15	1000-7500	1	30	6.5 (max)	–	8	–	72	
	2N2497	TI	p,DP,F,3	1-3	1000-2000	10	–	15 (max)	–	32	–	5	
	2N3329	TI	p,DP,F,3	1-3	1000-2000	10	–	5 (max)	–	20	3(1/1000)	72	
	MFE2095	MO	n,DP,F,3	1.0-3.0	400-800	–0.1	–50	–5.5	10	6	–	72	
	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	
FET 21	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	
	2N3330	TI	p,DP,F,3	2-6	1500-3000	10	–	6 (max)	–	20	3–1–1000	72	
	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	
	2N3822	TI	n,EP,F,3	2-10	3000-6500	0.1	50	6 (max)	–	6	5(0.01/1000)	72	MO
	2N3819	TI	n,EP,F,3	2-20	2000-6500	2	25	8 (max)	–	8	–	92	
FET 22	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	
	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	
	2N3331	TI	p,DP,F,3	5-15	2000-4000	10	–	8 (max)	–	20	4(1/1000)	72	
	2N4222	MO	n,DP,F,3	5-15	2500-6500	–0.1	–30	–8	40	6	–	72	
	3N98	RCA	n,DP,M,4	7.7 (max)	1000-3000	0.05	*32	6 (max)	200	7	7(1/1000)	72	
	TIXS35	TI	n,EP,F,4	10-50	10,000-20,000	10	30	1-5	–	12	–	72	
	3N99	RCA	n,DP,M,4	10.5	1000-4000	0.05	*32	6 (max)	200	7	7(1/1000)	72	
	TIXS36	TI	n,EP,F,4	40-200	10,000-20,000	10	30	3-10	–	12	–	72	
FET 23	2N2386	TI	p,DP,F,3	–	1000 (min)	10	–	8 (max)	–	50	–	5	
	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	

Late-Arrivals. . .

The following silicon p-channel enhancement mode MOS-FETs, manufactured by General Instrument, are general-purpose ac amplifying units with characteristics similar to cross-index group FET 41:

MEM 511	MEM 520
MEM 517	MEM 550
MEM 517A	MEM 551
MEM 517B	

Use the literature offering and reader-service card (p. 5) to obtain detailed information on the parameters of these devices.

Field-Effect *(continued)*

Type 2(b). Differential dc amplifiers: Listed by descending order of $\frac{\Delta|V_{GS}|}{\Delta|T|}$

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	$\frac{\Delta\lvert V_{GS}\rvert}{\Delta\lvert T\rvert}$ [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 24	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 25	2N3609	GME	p,M,4	110	0.1	*30	–	0.002	35	–	–	5	
	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	
	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 26	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 27	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	3.0 (typ)	0.25	1.0-10	–	1500 (min)	18	
	HA2030	HU	p,M,4	–	0.005	35	–	–	0.000001	0	1000-2000	72	

Type 3(a). General-purpose ac amplifiers: Listed by ascending order of I_{DSS}.

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 28	UC852	UC	p,F,3	0.025 (min)	60	6 (max)	2	25	6	–	–	18	
	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	60-170	–0.7-2	–0.01	40	3	1.5	3	72	
	2N3112	SI	p,DP,F,3	–(.035-.175)	50-115	1-4	0.05	20	3.5	–	–	72	
FET 29	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
	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	
	D1103	DIC	n,DPE,F,3	0.05-0.25	200-1000	–2.5 (max)	–10	25	–	–	–	18	
FET 30	D1179	DIC	n,DPE,F,3	0.05-0.25	200-1000	–2.5 (max)	–5.0	50	–	–	–	18	
	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	
	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	80-220	–1.0-3.5	–0.01	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	
FET 31	C681	CT	n,F,3	0.08-0.4	200-500	0.5-2.5	1.0	30	5	2	–	18	
	UC751	UC	n,F,3	0.1 (min)	350	6 (max)	2	30	10	–	–	18	
	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

(see pages 4-9 for explanation of company abbreviations.)

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 32	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	
	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	
FET 33	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	2.0	–	–	72	
	UC23	UC	n,F,3	0.12-0.6	200 (min)	1.0-2.5	0.01	30	1.3	–	–	–	
	U1286	AL	n,DP	0.2 (min)	1000-10,000	8.0 (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	100-250	–2.5-6.0	–0.01	40	3	1.5	10	72	
	2N2843	SI	p,DPE,F,3	–(0.2-1.0)	540 (min)	1.7 (max)	10	30	17	–	–	18	UC
FET 34	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
	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
FET 35	D1102	DIC	n,DPE,F,3	0.2-1.0	300-1000	–5 (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	–	–	–	
	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	
FET 36	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
	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	4.0	1.2	–	72	
FET 37	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	2.0	–	–	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	
	2N2844	SI	p,DP,F,3	–(0.44-2.2)	1400 (min)	1.7 (max)	30	30	30	–	–	18	UC
	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	
	2N3089	DIC	n,DPE,F,3	0.5-2.0	300-900	–5 (max)	–1.0	40	14	–	50	18	
	2N3089A	DIC	n,DPE,F,3	0.5-2.0	300-900	–5 (max)	–1.0	40	14	–	50	18	
FET 38	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	

(see pages 4-9 for explanation of company abbreviations.)

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 39	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	
	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	
	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	
	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	
	2N3376	SI			800-2300	1-5	3	30	5	3	–	72	
FET 40	2N3377	SI			800-2300	1-5	3	30	4	2	–		
	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	
	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
	2N3365	AL	n,DP,F,3	0.8-4.0	400-2000	12 (max)	5.0	†40	–	–	–	18	DIC, UC
	2N3066	AL	n,DP,F,3	0.8-4.0	400-1000	10 (max)	1.0	†50	10	1.5	–	18	DIC, UC, SI
FET 41	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
	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	
FET 42	DNX1	DIC	n,DPE,F,3	0.8-6	400-1500	–8 (max)	–1.0	50	–	–	–	18	
	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	UC	n,F,3	1-2.5	1500-4500	4 (max)	0.1	50	6	3	–	72	UC
FET 43	2N2497	TI	p,DP,F,3	1-3	1000-2000	15 (max)	10	–	32	–	–	5	SI, UC
	2N3329	SI	p,DP,F,3	–(1-3)	1000-2000	*5 (max)	0.01	–20	20	–	–	72	TI, UC
	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	
	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
	U1283	AL	n,DP	1.0-10	1500 (min)	2.5 (max)	0.5	†50	18	–	–	18	
	UC240	UC	n,F,3	1.0-10	1200 (min)	5.0 (max)	0.1	50	18	–	–	18	
FET 44	2N3695	UC	p,F,3	1.25-3.75	1000-1750	2-5	0.1	30	5	1.2	–	72	
	3N125	MO	n,DP,F,4	1.5-4.5	800-2400	*–4.0	–0.25	–50	14	2	10	72	
	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	
	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
	2N4221	MO	n,DP,F,3	2-6	2000-5000	*–6	–0.1	–30	6	2	20	72	
	UC410	UC	p,F,3	2-6	2250 (min)	4 (max)	0.1	30	8	–	–	72	
	2N3069	AL	n,F,3	2-10	1000-2500	10 (max)	1.0	†50	15	1.5	–	18	DIC, UC, SI
FET 45	2N3822	TI	n,EP,F,3	2-10	3000-6500	*6 (max)	0.1	50	6	3	–	72	MO
	2N2609	SI	p,DP,F,3	–(2-10)	2500 (min)	1-4	30	30	30	–	–	18	AL, UC
	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	
	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	

(see pages 4-9 for explanation of company abbreviations.)

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 46	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	8 (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	
	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
	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	–	–	
	3N126	MO	n,DP,F,4	3-9	1200-3600	*–6.5	–0.25	–50	14	2	20	72	
	2N3436	AL	n,DP,F,3	3.0-15	2500-10,000	10 (max)	0.5	†50	18	–	–	18	UC, SI
FET 47	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	
	2N3458	AL	n,DP	3.0-15	2500-10,000	8 (max)	0.25	†50	18	–	–	18	UC,SI
	2N3797	MO	n,DP,M,3	4-6	1500-3000	*–4	–0.001	–25	8	0.8	60	18	
	UC210	UC	n,F,3	4-12	4500 (min)	4.0 (max)	0.1	50	7.0	–	–	72	
	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
	2N4222	MO	n,DP,F,3	5-15	2500-6000	*–8	–0.1	–30	6	2	40	72	
FET 48	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	
	U1281	AL	n,DP	8 (max)	250 (min)	10 (max)	0.1	†50	–	–	–	18	
	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	
	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	
	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 49	U1287	AL	n,DP,F,3	100 (typ)	20,000	15 (max)	2.0	30	–	–	–	†	†MT25 package
	U148	SI	p,DP,F,3	*	540 (min)	6 (max)	60	20	–	–	–	18	*I_{DSS} (min.) = 0.2
	U149	SI	p,DP,F,3	*	1400 (min)	6 (max)	200	20	–	–	–	18	*I_{DSS} (min.) = 0.44
	2N3608	GME	p,M,4	–	800 (min)	*.4 (typ)	0.002	*–30	8.0	2.5	–	5	
	DE1004	GME	p,M,4	–	600 (min)	*3	1000	*20	10	3	–	18	
	HA2001	HU	p,M,4	–	1000-2000	–	0	*35	8.0	1	–	72	
	TIXS11	TI	p,PL,M,3	–	800 (min)	3-6	0.003	30	8	3	–	72	

Type 3(b). Low-noise ac amplifiers: Listed by descending order of NF.

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	e_n nV/$\sqrt{Hz}$ at (f = –kHz) or *NF [Max.] (dB)	i_n [Max.] pA/$\sqrt{Hz}$ f = –kHz at R_{gen} = –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 50	U168	SI	p,DP,F,3	25/(1)	0.019	800 (min)	–(0.6-6.0)	20	30	65	5 (max)	18	
	2N3578	SI	p,DP,F,3	18/(1)	0.017	1200-3500	0.9-4.5	20	15	65	1.5-4	18	
	2N3458	SI	n,DPE,F,3	*6	.02/1000	2500-10,000	3-15	–	0.25	18	7.8 (max)	18	
	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	
FET 51	2N3821	TI	n,EP,F,3	*5	0.01/1000	1500-4500	0.5-2.5	50	0.1	6	*4 (max)	72	
	2N3822	TI	n,EP,F,3	*5	0.01/1000	3000-6500	2-10	50	0.1	6	*6 (max)	72	
	2N4220	MO	n,DP,F,3	*5	200000/–	1000-4000	0.5-3	–30	–0.1	6	–4 (typ)	72	
	2N4221	MO	n,DP,F,3	*5	200000/–	2000-5000	2-6	–30	–0.1	6	–6 (typ)	72	
	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	
	2N3331	TI	p,DP,F,3	*4	1/1000	2000-4000	5-15	–	10	20	*8 (max)	72	
	2N3455	SI	n,DPE,F,3	*4	.02/1000	400-1200	0.8-4.0	50	–0.04	5	–9.8 (max)	72	
	2N3456	SI	n,DPE,F,3	*4	.02/1000	300-900	0.2-1.0	50	–0.04	5	–4.8 (max)	72	
	2N3457	SI	n,DPE,F,3	*4	.02/1000	150-600	0.05-0.25	50	–0.04	5	–2.3 (max)	72	
FET 52	2N3460	SI	n,DPE,F,3	*4	.02/1000	800-4500	0.2-1.0	50	0.25	18	1.8 (max)	18	
	2N3459	SI	n,DPE,F,3	*4	.02/1000	1500-6000	0.8-4.0	50	0.25	18	3.4 (max)	18	
	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	
	2N3329	TI	p,DP,F,3	*3	1/1000	1000-2000	1-3	–	10	20	*5 (max)	72	
	2N3330	TI	p,DP,F,3	*3	1/1000	1500-3000	2-6	–	10	20	*6 (max)	72	
	P-102	SI	p,DP,F,3	*3	1/1000	1600 (typ)	0.90-4.5	30	10	17	1-4	18	
	2N3452	SI	n,DPE,F,3	*2.0	.1/1000	200-1200	0.8-4.0	50	–0.1	6	–9.8 (max)	72	
	2N3453	SI	n,DPE,F,3	*2.0	.1/1000	150-900	0.2-1.0	50	–0.1	6	–4.8 (max)	72	
	2N3454	SI	n,DPE,F,3	*2.0	.1/1000	100-600	0.05-0.25	50	–0.1	6	–2.3 (max)	72	

(see pages 4-9 for explanation of company abbreviations.)

Field-Effect *(continued)*

Cross Index Key	Type No.	Mfr.	Channel, Construction, Class And No. of Elements	e_n $nV/\sqrt{Hz}$ at (f = –kHz) or *NF [Max.] (dB)	i_n [Max.] $pA/\sqrt{Hz}$ at f = –kHz / R_{gen} = –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 53	2N3823	TI	n,EP,F,3	*2.5	100000/1	3500-6500	1-7.5	30	0.5	6	*8 (max)	72	
	2N3823	SI	n,DPE,F,3	*2.5	.1/1000	3200 (min)	4-20	30	–0.5	6	–8 (max)	72	
	2N3332	TI	p,DP,F,3	*1	1/1000	1000-2200	1-6	–	10	20	*6 (max)	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	
	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	
FET 54	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	
	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	
FET 55	2N2386	TI	p;DP,F,3	–	–	1000 (min)	–	–	10	50	8 (max)	5	
	2N2497	TI	p,DP,F,3	–	–	1000-2000	1-3	–	10	32	15 (max)	5	
	2N2498	TI	p,DP,F,3	–	–	1500-3000	2-6	–	10	32	15 (max)	5	
	2N2499	TI	p,DP,F,3	–	–	2000-4000	5-15	–	10	32	15 (max)	5	
	2N2500	TI	p,DP,F,3	–	–	1000-2200	1-6	–	10	32	15 (max)	5	
	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	
	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	
FET 56	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	
	TIXS36	TI	n,EP,F,4	–	–	10,000-20,000	40-200	30	10	12	*3-10	72	

Type 3(c). High-frequency (f ≧ 1MHz) ac amplifiers: Listed by ascending order of g_{fs}.

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 = –kHz / R_{gen} = –kΩ	TO-	Alternate Sources and Remarks
FET 57	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	GME	p,M,4	600 (min)	3	10	–	*–20	0.0001	–	–	18	
	2N3608	GME	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 58	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	
	TIS14	TI	n,EP,F,3	1000-7500	4	8	–	30	0.5-15	*6.5 (max)	–	72	
	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	
FET 59	2N4038	TRWS	n,DP,M,3	1500-3000	0.2	2.5	–	*20	0-0.1	0-2	3(100MHz/1 MΩ)	72	
	2N4039	TRWS	n,DP,M,3	1500-3000	0.2	2.5	–	*20	0-0.1	–(2-6)	3(100MHz/1MΩ)	72	
	2N3821	TI	n,EP,F,3	1500-4500	3	6	–	50	0.5-2.5	*4 (max)	5(0.01 KHz/1MΩ)	72	
	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	
	2N3822	TI	n,EP,F,3	3000-6500	3	6	–	50	2-10	*6	5(0.01 KHz/1MΩ)	72	
	2N4223	MO	n,DP,F,3	3000-7000	2	6	800	30	3-18	*–(1-7)	5(200MHz/1 KΩ)	72	
	2N3823	TI	n,EP,F,3	3500-6500	2	6	–	30	1-7.5	*8 (max)	2.5(100MHz/1 KΩ)	72	SI, UC
	TIS34	TI	n,EP,F,3	3500-6500	2	6	–	30	4-20	1-8	–	72	
FET 60	K1003	KMC	n,M,4	4000 (min)	1.0	3.5	800	15	12-20	6 (max)	4.5 (200 MHz)	18	
	FT57	FA	n,EP,M,4	6000 (min)	0.8	2.7	60(typ)	25	9-26	10 (max)	4 at 0.1GHz/2.5KΩ		
	TIXS35	TI	n,EP,F,4	10,000-20,000	5	12	–	30	10-50	*1-5	–	72	
	TIXS36	TI	n,EP,F,4	10,000-20,000	5	12	–	30	40-200	*3-10	–	72	

(see pages 4-9 for explanation of company abbreviations.)

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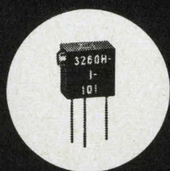

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Use the unijunction transistor that does the job best. Listed by major parameters, these three charts facilitate selection.

Choice of the right unijunction transistor (UJT) for any application will save a lot of design and test time. To facilitate selection, ELECTRONIC DESIGN has separated the UJTs into three categories, each intended for a specific set of applications. The parameter definitions and test set-ups that follow provide a good understanding of how the UJT works, and show the relationship between application and UJT parameter specifications.

Within the limits of its relatively low frequency capabilities (a few hundred kilohertz at most), the UJT is ideal for such applications as relaxation oscillators, timing circuits, voltage and current level-sensing, frequency dividing, precision triggering of the SCR, SCS, and Triac, control of frequency for inverters and oscillators, and sawtooth and pulse generation.

The UJT data listings are organized according to key design parameters. These are:

- Type 1—for pulse applications such as SCR triggering; in order of increasing V_{OB1} (base-one peak-pulse voltage).
- Type 2—for high-frequency, short timing period, and voltage-sensing applications; in order of increasing I_V (valley current).
- Type 3—for low-frequency, long timing period, and current-sensing applications; in order of decreasing values of I_P (peak-point current).

To select a UJT, many other factors should also be considered. These include circuit acceptance of parameter spreads, supply voltage requirements, frequency, ambient temperature range, power dissipation, current limitations, package type and size, and device cost.

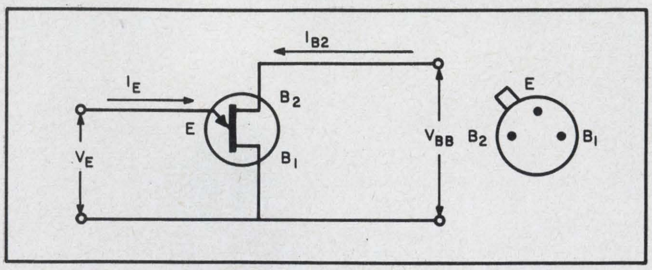
Basic concepts explained

The UJT, a three-terminal semiconductor device, is distinctive by having a negative resistance characteristic which is highly stable with voltage, temperature and time. Fig. 1 shows the schematic symbol for the UJT as well as the relationship of the leads when the device is housed in a standard transistor can. By examining the simplified equivalent circuit shown in Fig. 2, the operation of this device can be easily visualized. Though different geometries exist , the UJT consists basically of a pellet of n-type silicon with ohmic contacts, base-one (B_1) and base-two (B_2), at opposite ends of the pellet. At some point between these two, a single rectifying contact, the emitter (E), is attached. The interbase resistance, R_{BBO}, is the sum of R_{B1} and R_{B2} and is between 5 and 10 kilohms.

In the equivalent circuit, the diode (D) represents the UJT's emitter diode. In normal circuit operation, a positive bias voltage (V_{BB}) is applied at base-two. With no emitter current flowing, the silicon pellet acts as a simple voltage divider; a certain fraction, η, of V_{BB} appears at the emitter. If the emitter voltage, V_E, is less than η V_{BB}, the emitter becomes reverse-biased and only a small emitter leakage current flows. If V_E is greater than η V_{BB}, the emitter is forward-biased and emitter current flows. This causes a decrease in the resistance between the emitter and base-one. As the emitter current increases, the emitter voltage decreases and a negative-resistance characteristic is obtained.

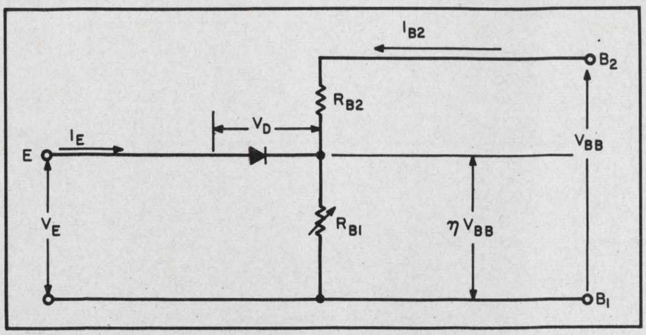
This characteristic is shown in Fig. 3 for a typical UJT. On this curve, the two major points of interest are the peak point and the valley point. To the left of the peak point is the cut-off region where the emitter is reverse-biased and only a small leakage current flows. To the right of the valley point is the saturation region where the dynamic resistance is positive. The negative resistance region lies between these two points.

A better understanding can come from examining the relaxation oscillator circuit, shown in Fig. 4a, which is basic to most UJT applications. At the beginning of each cycle the emitter is reverse-biased and hence non-conducting. As the capacitor (C_T) is charged through the resistor (R_T), the emitter voltage rises toward the supply voltage,

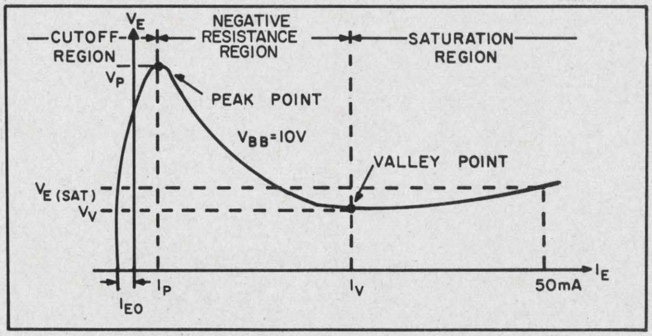


1. **Unijunction transistor** is represented by this symbol, where the emitter, base-one and base-two are identified by E, B_1, and B_2. The circular outline shows the pin relationships for a transistor type package.

Dwight V. Jones, Applications Engineer, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.



2. **Simplified equivalent circuit** of a unijunction transistor aids device analysis. When V_E is larger than $\eta\ V_{BB} + V_D$, the diode conducts, R_{B1} reduces in value, and a large emitter current flows.



3. **Emitter characteristic curve** shows the three operating regions. When the emitter diode goes into conduction, the device shifts its operating point through the negative resistance region to the saturation region.

V_1. When the emitter voltage reaches the peak-point voltage, V_P, the emitter becomes forward-biased and the dynamic resistance between the emitter and base-one drops to a low value. Capacitor C_T then discharges through the emitter. When the emitter voltage reaches $V_{E(MIN)}$, as shown in Fig. 4b, the emitter ceases to conduct and the cycle is repeated. The minimum emitter voltage, $V_{E(MIN)}$, is approximately equal to 0.5 $V_{E(SAT)}$. If R_1 is zero, it is relatively independent of bias voltage, temperature and capacitance. For small values of R_1 and R_2, the frequency of oscillation is:

$$f \approx \frac{1}{R_T C_T ln\ (1/1-\eta)}. \quad (1)$$

The UJT relaxation oscillator is noteworthy for its ability to operate over a wide range of circuit parameters and ambient temperature. Several important conditions must be satisfied if this circuit is to operate satisfactorily. These are:

▪ The load line. formed by resistor R_T, must intersect the emitter characteristic curve to the right of the peak point. This condition ensures that R_T can supply sufficient current to the emitter to trigger the UJT. This condition may be written:

$$\frac{V_1 - V_P}{R_T} > I_P. \quad (2)$$

Generally I_P is specified at an interbase voltage of 25 volts and is inversely proportional to V_{BB}. This equation sets the maximum limit on R_T. R_T must be chosen to satisfy this inequality under the worst conditions for each of the other parameters. The worst conditions would include the maximum value of V_P, the minimum value of V_1, and the maximum value of I_P at the minimum temperature of operation.

▪ The load line formed by R_T must also intersect the emitter characteristic to the left of the valley point. This may be written:

$$\frac{V_1 - V_V}{R_T} < I_V. \quad (3)$$

Since V_V is circuit-dependent, its value should be measured in the actual circuit. If this condition is not satisfied, the load line will intersect the emitter-characteristic curve in the saturation region and the UJT may not turn off after it triggers on the first cycle. Note that the value of valley current includes the effects of the base-one and base-two external series resistors. If these are large, the value of I_V will be reduced as indicated in Fig. 5.

▪ Finally the operation of the UJT relaxation oscillator greatly depends on the allowable range of capacitance C_T. As the size of C_T decreases from 0.01 to 0.001 μF, the amplitude of the emitter waveform will decrease. This decrease is actually a function of the frequency capability of the UJT being used. For most UJTs the emitter peak current should not exceed two amperes for values of C_T less than 10 μF and peak-point voltages less than 30 volts. For higher values of C_T or V_P, resistance should be used in series with the capacitor to protect the emitter circuit. This additional series resistance should be on the order of at least one ohm per microfarad of C_T.

In general the limitations imposed by the first two conditions are not severe. A maximum value of I_P might be 2 μA and a minimum value of I_V might be 8 mA. The allowable range of R_T then would be 1000 to 1 or approximately 3 kΩ to 3 MΩ.

Defining the parameters

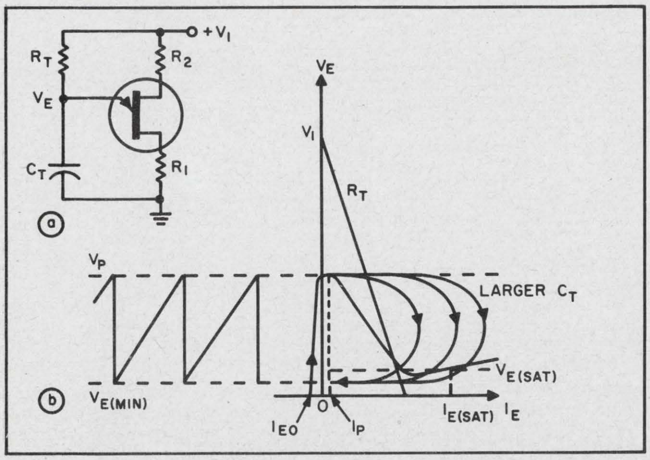
To properly select the device that will function best in any particular circuit, it is important to understand the meaning attached to each of the parameters and the methods by which these values can be checked in the laboratory. The following definitions and test circuits will greatly help in achieving a working design.

The intrinsic stand-off radio (η), one of the most important parameters, is defined by the equation:

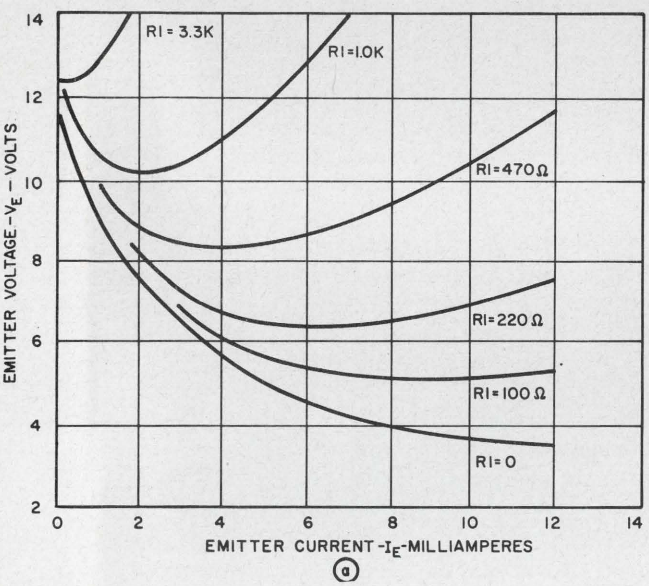
$$V_P = \eta\ V_{BB} + V_D,$$

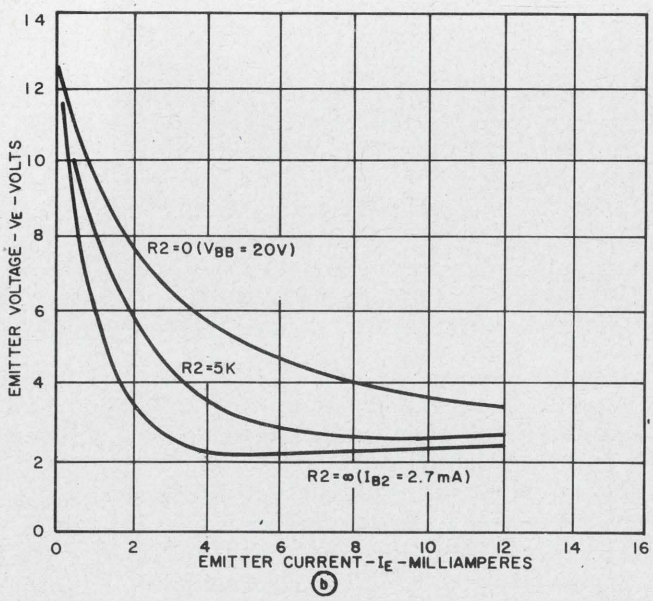
where V_P is the peak-point emitter voltage, V_{BB} is the interbase voltage, and V_D is the emitter diode's forward-voltage drop.

For a given UJT type, there is a range of values for the intrinsic stand-off ratio from device to device. Since the basic UJT circuit has a frequency characteristic which is dependent on R_T, C_T and η, a wide range of η will greatly affect the operating frequency of this basic oscillator. Though R_T can be adjusted to compensate for this

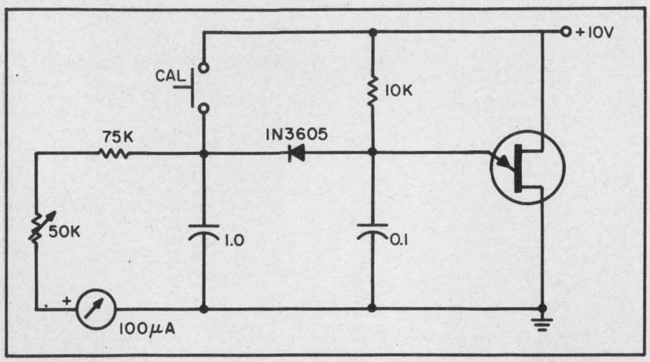


4. **The basic unijunction circuit,** a relaxation oscillator (a), provides a sawtooth output. The characteristic curve (b) shows the effect of increasing the value of the charging capacitor, C_T.





5. **Emitter characteristic curves,** for a typical unijunction transistor, as a function of the base-one series resistance (a) and the base-two series resitance (b).



6. **Test circuit for measuring the intrinsic stand-off ratio** (η) uses a simple peak detector to measure the peak emitter voltage. Direct reading meter is set to read full scale by R_3 when the CAL button is pressed.

variation, in narrow-range and critical circuits, the use of a unijunction having a narrow range of η will greatly simplify the design, assure better temperature stability, and lower component cost. In addition, if the desired circuit is to operate with a low supply voltage, a UJT with a high value of η will permit a lower resistance value for the base-two temperature-compensating resistor (R_2). This results in a higher interbase voltage (V_{BB}) which increases the control range of the emitter timing resistor.

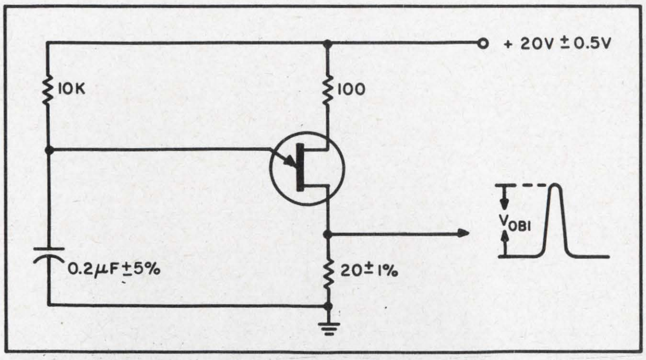
The circuit shown in Fig. 6 may be used to measure η. In this circuit R_1, C_1 and the UJT form a relaxation oscillator. The remainder of the circuit serves as a peak-voltage detector. The diode automatically subtracts the emitter-diode voltage, V_D. To use the circuit, the "CAL" button is pushed and R_3 is adjusted until the meter reads full scale. The "CAL" button is then released and the value of η is read directly from the meter. To protect the unijunction, the power supply should have a current limit control.

The base-one peak-pulse voltage (V_{OB1}) is an important measurement when pulse generation is desirable or required. Essentially a circuit measurement, the use of a standard test circuit allows for easy comparison of various devices. The output of the circuit shown in Fig. 7 can be monitored with a scope to determine all of the pulse characteristics.

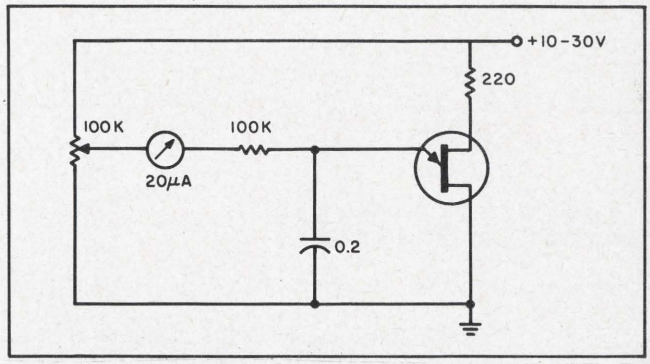
The valley current (I_V) is the emitter current at the valley point. This current will increase as the interbase voltage increases, and decrease with the resistance in series with base-one or base-two. Where fast response or high-frequency operation is desirable, this becomes an important parameter. Being circuit-dependent, this measurement should be made on the actual circuit.

The peak-point current (I_P) represents the minimum current which is required to trigger the UJT. It corresponds to the emitter current at the peak-point and is inversely proportional to the interbase voltage. In applications that require a high input impedance or a long timing period, this parameter becomes important while I_V does not.

The circuit shown in Fig. 8 is used to measure I_P. While observing the meter, the potentiometer setting is slowly increased until the UJT fires, as



7. **Base-one peak-pulse voltage** may be measured by putting a scope across R_{B1}. This simple circuit may be used to compare the pulse capabilities of different UJTs. For SCR triggering, a large pulse is desirable.



8. **Peak-point emitter current** is measured with this circuit. R_1 is increased until a jump in reading is observed on the meter. The current reading just before the jump is the peak-point emitter current.

evidenced by a sudden jump and oscillation of the meter needle. The current reading just prior to the jump is the peak-point current.

The emitter reverse current (I_{EO}), similar to I_{CO} in a conventional transistor, can be measured by applying a voltage between base-two and the emitter, with base-one open-circuited. Unijunction transistors that have a guaranteed low I_P value generally also have a low leakage current. The stability of a UJT is improved as the ratio of the average capacitance-charging current to I_{EO} is increased.

The interbase resistance (R_{BBO}) is the resistance measured between base-one and base-two, with the emitter open-circuited. By using devices that have a higher R_{BBO} rating, power dissipation can be decreased. This is important when higher values of interbase voltages are being used and the interbase power dissipation becomes an appreciable part of the total power dissipation. Since the interbase resistance has a positive temperature coefficient of 0.8%/°C, this characteristic can be used either for temperature compensation or in the design of temperature sensitive circuits. The value of the interbase resistance can be measured with any conventional ohm meter or resistance bridge, if the applied voltage is kept at five volts or less.

The emitter saturation voltage ($V_{E(SAT)}$) indicates the forward drop from emitter to base-one when the device is in the saturation region. Generally, it's measured at an emitter current of 50 mA and an interbase voltage of 10 volts. A low value of emitter saturation voltage will permit the generation of higher amplitude sawtooth voltages and also allow the use of lower supply voltages. In general, the higher the V_{OB1} rating a unijunction transistor has, the lower the saturation voltage will be.

The emitter reverse voltage (V_{EB2}) is the maximum voltage rating for the emitter junction. This rating should never be exceeded and thus restricts the choice of device to one that is compatible with the supply voltage being used.

Data list simplifies selection

Type 1—The UJT is an excellent trigger source for firing silicon-controlled-rectifiers (SCR), silicon-controlled-switches (SCS), and triode-ac-switches (Triac). The trigger pulse generated may represent frequency control, time delay, amplitude level change, or phase control. The base-one peak pulse voltage, V_{OB1}, is the key parameter for these applications. The most desirable UJT types are those with the highest value of guaranteed minimum V_{OB1}. Unijunction transistors that feature high values of V_{OB1} are especially useful for triggering the higher-current SCRs. They are also preferred in circuits where the trigger supply voltage is low or where the size of the oscillator capacitance is limited. Many of the specification sheets will have trigger-circuit design curves which assure SCR triggering over a temperature range.

The minimum I_V specification should also be considered. High values of this parameter enable the circuit designer to use a low resistance for R_T without running into a "latch-on" problem. The lower value of R_T also increases the average charging current to the capacitance C_T; this minimizes the effect of the temperature-sensitive leakage currents in the charging circuit.

Type 2—In designing circuits for high-frequency-control, short-timing-period and voltage-sensing applications, the minimum value of I_V, the valley current, is the key parameter.

Higher I_V ratings allow the use of lower values of R_T. The result is a faster response time for any given capacitor size. Also, where large pulse outputs are required, the capacitor value may be increased. Finally, since I_V decreases with supply voltage, the higher I_V ratings are an advantage for low-supply-voltage applications.

Type 3—In low-frequency-control, long-timing-period, and current-sensing applications, the maximum value of I_P, the peak-point current, is the key design parameter. A low I_P permits longer time constants (R_T C_T) in the emitter circuitry. This enables the designer to use smaller charging capacitors for a given timing period. These, in turn, will have lower leakage figures. Also, as the supply voltage decreases, the lower I_P rating helps to maintain a lower trigger-current requirement. This is an advantage in timing and level-sensing. ■ ■

Unijunction

Type 1. Pulse Generation (e.g., SCR Triggering): In order of increasing values of V_{OB1}

	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
	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
UJT 1	2N1671A	TI	pn,si	3.0	8.0	30	0.47–0.62	4.7	25.0	2.0	5.0	
	2N1671B	GE	n,si	3.0	8.0	30	0.47–0.62	4.7	6.0	0.2	5.0	
	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
	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: In order of increasing values of I_V

	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
	2N3980	TI	pn,AE,si	1.0	0.68–0.82	4.0	0.01	2.0	3.0	30	6.0	MO
	SJ993	TI	pn,si	4.0	0.56–0.75	4.7	0.01	5.0	4.0	30	3.0	TO-18 (Planar)
	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
UJT 2	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	–	TO-5

Type 3. Low-Frequency Control, Long Timing-Periods and Current-Sensing: In order of decreasing values of I_P

	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
	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	3.0	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
UJT 3	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
	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)

(see pages 4-9 for explanation of company abbreviations.)

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Here's the organic stripper that eliminates the mess of mixing and, in many cases, the need for heating. New Photostrip 66 TransistAR®. You just pour it out and put it to work at room temperature. Or heat it up where the application requires.

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ON READER-SERVICE CARD CIRCLE 29

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MKH

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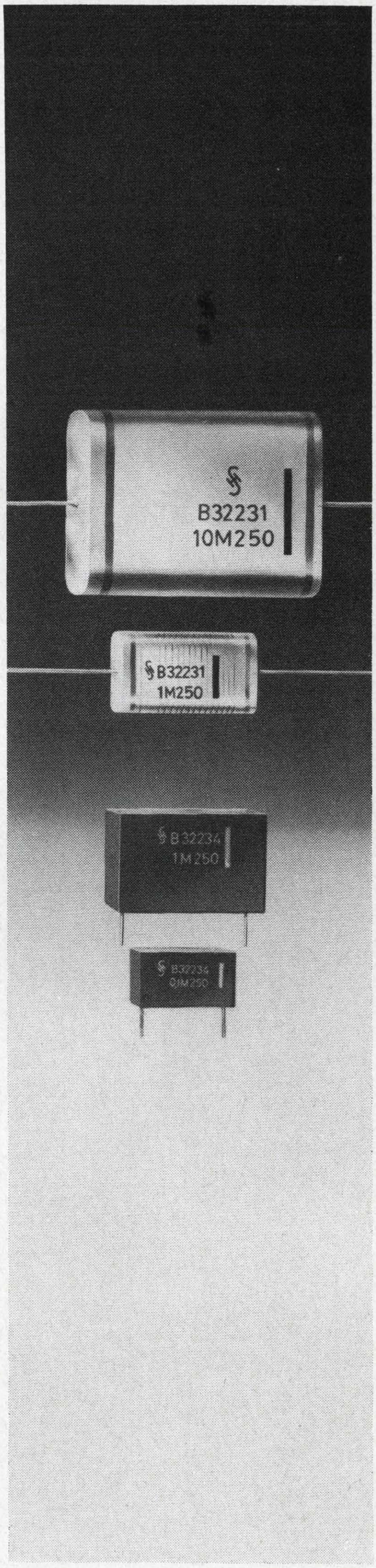

Small size and high reliability are new standards set by Siemens capacitors. Twenty years' experience in making metallized capacitors has resulted in advanced precision techniques which closely control every capacitor property, making them 100% "foolproof" in service.

Less than one breakdown (self-healing) per year and per mF—that is the consistent average shown by tests at nominal voltage.

Two-way self-healing gives double protection. Internal voltage breakdown very rarely occurs. If it does, the thin metal coatings at the breakthrough point, vaporize immediately, eliminating the breakthrough point within microseconds.

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ON READER-SERVICE CARD CIRCLE 30

How To Use The Cross Index

Types are listed in numerical sequence. EIA-registered types come first, followed by house-numbered types. The code following each type identifies its application category and the block of 10 types in which it is located. A3, for example, means the type can be found in the third block of the Audio section. Key to the letter codes is: A = audio and general-purpose, P = power, HF = high-frequency, LL = low-level switching, HL = high-level switching, FET = field-effect, UJT = unijunction.

2N35	A49
2N94	HF2
2N94A	HF3
2N102	A4
2N104	A23
2N109	A32
2N117	A4
2N118	A12
2N119	A24
2N120	A37
2N122	P22
2N128	HF17
2N139	HF3
2N140	HF8
2N144	HF94
2N156	P31
2N158	P31
2N158A	P31
2N169	A27
2N173	P84
2N174	P84
2N174A	P84
2N175	A30
2N176	P64
2N178	P64
2N211	HF3
2N212	HF3
2N213	A32
2N213A	A40
2N214	A25
2N215	A23
2N217	A32
2N218	HF3
2N219	HF8
2N219A	HL36
2N220	A30
2N231	HF94
2N233	HF2
2N233A	HF2
2N234A	P34
2N235A	P34
2N235B	P34
2N236A	P54
2N236B	P54
2N243	A7
2N244	A17
2N250A	P64
2N251A	P64
2N257	P64
2N262	HF94
2N268	P64
2N268A	P64
2N270	A31
2N274	HF12
2N277	P85
2N278	P85
2N279	A14
2N280	A24
2N281	A31
2N282	A31
2N284	LL37
2N284A	LL37
2N285A	P34
2N285B	P34
2N297A	P64
2N301	P26
2N301A	P26
2N306	A14
2N315	LL6
2N315A	LL6
2N315B	LL6
2N316	LL12
2N316A	LL12
2N317	LL15
2N317A	LL15
2N326	P22
2N327A	LL1
2N328A	LL1
2N328B	LL1
2N239	LL1
2N329A	LL1
2N329B	LL2
2N330A	A12
2N331	A50
2N332	A4
2N332A	A3
2N333	A12
2N333A	A8
2N334	A19
2N335	A24
2N335A	A19
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2N337	LL37
2N337A	LL13
2N338	LL37
2N338A	LL16
2N339	P2
2N339A	A12
2N340	P2
2N340A	A12
2N341	P2
2N341A	P1, A12
2N342	P2
2N342A	P2
2N342B	P2
2N343	P2
2N343A	P2
2N343B	P3
2N344	HF12
2N345	HF12
2N346	HF20
2N350A	P64
2N351A	P64
2N356	LL4
2N356A	LL4
2N357	LL7
2N357A	LL7
2N358	LL11
2N358A	LL11
2N370	HF20
2N371	HF13
2N372	HF13
2N374	HF94
2N375	P65
2N376A	P65
2N384	HF30
2N388	LL6
2N388A	LL7
2N389	P61
2N393	HF15
2N398	LL37
2N398A	LL18
2N399	P34
2N400	P45
2N401	P34
2N404	LL5
2N404A	LL6
2N405	A17
2N406	A17
2N407	A30
2N408	A30
2N409	HF5
2N410	HF5
2N411	HF8
2N412	A32
2N414	LL10
2N418	HL40, P34
2N419	P35
2N420	HL40, P35
2N420A	HL40, P35
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2N424A	HL41
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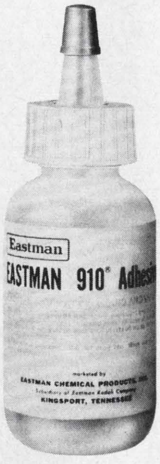
2N427	LL7
2N428	LL11
2N441	P85
2N442	P85
2N443	P85
2N444	HF1
2N444A	HF1
2N445	HF2
2N445A	HF2
2N446	HF3
2N446A	HF3
2N447	HF8
2N447A	HF8
2N447B	HF8
2N449	A27
2N456A	P51
2N456B	HL18
2N457A	P51
2N457B	HL18
2N458A	P52
2N458B	HL18
2N463	P52
2N470	A4
2N471	A4
2N471A	HF6
2N472	A4
2N472A	A4, HF6
2N473	HF6
2N474	HF6
2N474A	HF7
2N475	HF7
2N475A	HF7

There is no adhesive like EASTMAN 910® Adhesive



SETS FAST—Makes firm bonds in seconds to minutes.
VERSATILE—Joins virtually any combination of materials.
HIGH STRENGTH—Up to 5,000 lb./in.^{2} depending on the materials.
READY TO USE—No catalyst or mixing necessary.
CURES AT ROOM TEMPERATURE—No heat required to initiate or accelerate setting.
CONTACT PRESSURE SUFFICIENT.
LOW SHRINKAGE—Virtually no shrinkage on setting as neither solvent nor heat is used.
GOES FAR—One pound contains about 30,000 one-drop applications. (Or in more specific terms, approximately 20 fast setting one-drop applications for a nickel).

The use of EASTMAN 910 Adhesive is not suggested at prolonged temperatures above 175°F., or in the presence of extreme moisture for prolonged periods.

SHEAR STRENGTH OF BONDS

Bond Type	Time to Firm Set (minutes)	Representative Shear Strength† (psi)	Age of Bond
Aluminum-Aluminum	2	1,484 2,188 2,700 2,800 (Tensile)	10 mins. 1 hr. 48 hrs. 24 hrs.
Steel-Steel	2	1,362 2,224 2,800 5,030 (Tensile)	10 mins. 1 hr. 48 hrs. 48 hrs.
Aluminum-Steel	10 ½ (with surface activator*)	84 173 1,007 1,653	10 mins. 1 hr. 10 mins. 1 hr.
Butyl Rubber-Butyl Rubber	½	51[1] 63	10 mins. 4 yrs.[2]
Butyl Rubber-Steel	1	52[1] 76[1]	10 mins. 4 yrs.[2]
Butyl Rubber-Aluminum	1	73[1] 69[1]	10 mins. 4 yrs.[2]
SBR Rubber-SBR Rubber	½	90[1] 56[1] 88[1]	10 mins. 4 yrs.[2] 30 days, salt spray cycle (ASTM B 117-57T)
Neoprene Rubber-Neoprene Rubber	½	54[1] 45	10 mins. 4 yrs.[2]
Natural Rubber-Natural Rubber	½	46[1] 39	10 mins. 4 yrs.[2]
SBR Rubber-Butyrate	½	95[1] 110[1] 112[1]	10 mins. 2 yrs.[2] 30 days, salt spray cycle (ASTM B117-57T)
SBR Rubber-Phenolic	½	105[1] 110[1]	10 mins. 2 yrs.[2]
Butyl-Polyester	½	102[1] 154	15 mins. 2 yrs.[2]

Bond Type	Time to Firm Set (minutes)	Representative Shear Strength† (psi)	Age of Bond
Butyl-Phenolic	½	114[1] 178[1]	15 mins. 2 yrs.[2]
Neoprene-Polyester	½	112[1] 136	15 mins. 2 yrs.[2]
Nylon-Nylon	1	327 1,400	10 mins. 48 hrs.
Nylon-Aluminum	1	500 1,436 956 1,024	10 mins. 48 hrs. 1 yr.[4] 2 yrs.[4]
Phenolic-Phenolic	1	747 600[3]	10 mins. 4 yrs.[4]
Phenolic-Aluminum	1	647 920 348	10 mins. 48 hrs. 2 yrs.[4]
Polyester-Stainless Steel	1	696 664 432	48 hrs. 6 mos.[4] 2 yrs.[4]
Acrylic-Stainless Steel	1	620[3] 484[3] 488	6 mos.[4] 1 yr.[4] 2 yrs.[4]
Flexible Vinyl-Aluminum	1	207[3] 192[3] 200[3]	6 mos.[4] 1 yr.[4] 2 yrs.[4]
Polystyrene-Polystyrene	2 ½ (with surface activator*)	327 70 447[3]	10 mins. 1 yr.[2] 10 mins.
Polypropylene-Polypropylene	2 2 ½ (with surface activator*)	180 411[3] (Flame treated polypropylene) 401[3] (Flame-treated polypropylene)	24 hrs. 24 hrs. 15 mins.

†Laboratory test results [1]rubber failure [2]weathered outdoors [3]plastic failure [4]50% Relative Humidity and 75°F.

*In certain cases, most notably those involving polystyrene, pickled or dissimilar metal surfaces, bonding with EASTMAN 910 Adhesive is sometimes slow. EASTMAN 910 Surface Activator is designed to restore the rapid polymerization of the adhesive. It is also quite valuable in maintaining consistent results in production line bonding situations. Further information on this product is available.

Other materials that can be bonded successfully with EASTMAN 910 Adhesive are: polyurethanes, acetal resins; most hard woods; brass, copper. Recent work indicates that polyolefin and acetal plastic bonds are significantly improved by flame treatment of the plastic material prior to bonding (shear strengths up to 500 psi).

If you have applications in which extreme speed of setting is needed, or where design requirements involve small joining surfaces, complex mechanical fasteners, or heat sensitive assemblies, EASTMAN 910 Adhesive may save you many man-hours of production time. Send $10 for a trial kit to use on your *toughest* bonding job. Kits and further information are available from Armstrong Cork Co., Industry Products Division, Lancaster, Pennsylvania, or from Chemicals Division, EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, Kingsport, Tennessee.

See Sweet's 1966 Product Design File 8a/Ea.

ON READER-SERVICE CARD CIRCLE 31

2N476	HF10
2N477	HF10
2N478	HF11
2N479	HF11
2N479A	HF11
2N480	HF11
2N480A	A21
2N489	UJT2
2N489A	UJT1
2N489B	UJT3
2N490	UJT2
2N490A	UJT1
2N490B	UJT3
2N490C	UJT3
2N491	UJT2
2N491A	UJT1
2N491B	UJT3
2N492	UJT2
2N492A	UJT1
2N492B	UJT3
2N492C	UJT3
2N493	UJT2
2N493A	UJT1
2N494	UJT2
2N494A	UJT1
2N494B	UJT3
2N494C	UJT3
2N495	HF7
2N495B	UJT3
2N496	HF12
2N497	P14
2N497A	P15
2N498	P14
2N498A	P15
2N499	HF57
2N499A	HF57
2N501	HF29
2N501A	HF39
2N502	HF80
2N502A	HF85
2N502B	HF86
2N503	HF70
2N504	HF17
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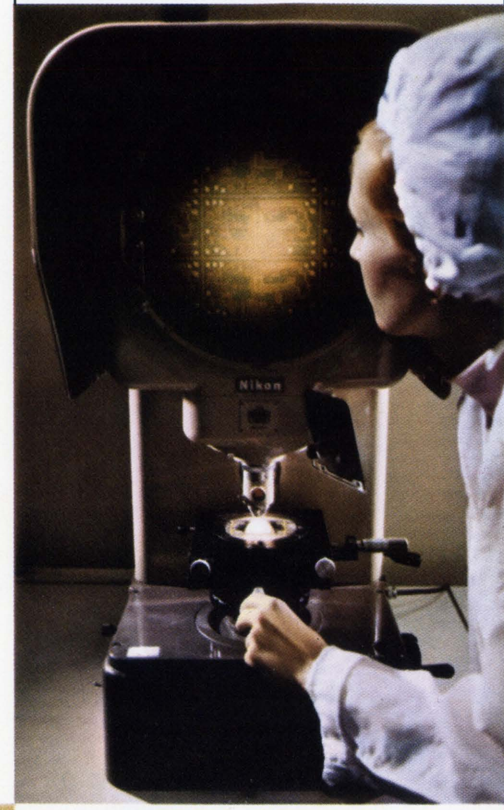
Westinghouse makes things happen in integrated circuits.

A unique new way to prevent hidden defects in IC's.

Only Westinghouse production lines use anything like this 18-wafer carrier (cover and below). It vastly reduces a major cause of hidden potential failures in IC's...the oxide faults and scratches from tweezer-handling of wafers. At Westinghouse, 18 wafers at a time go from one mechanized work station to another without being touched by tweezers. The benefit for you: a new order of reliability in IC's.

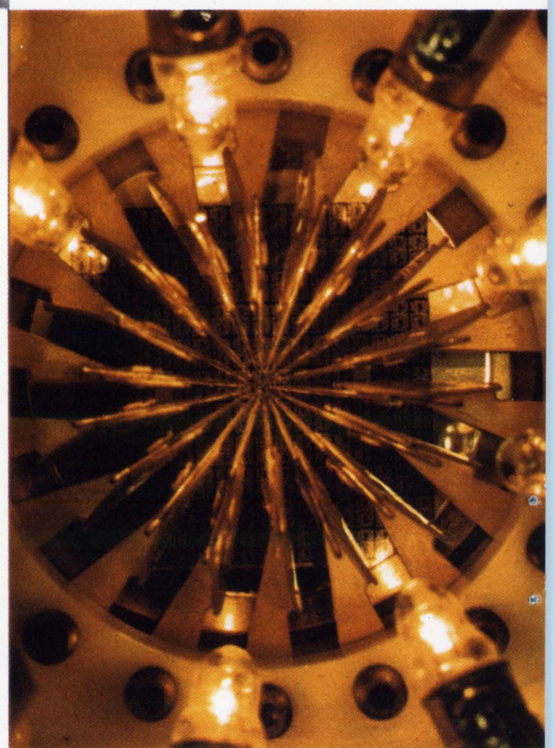


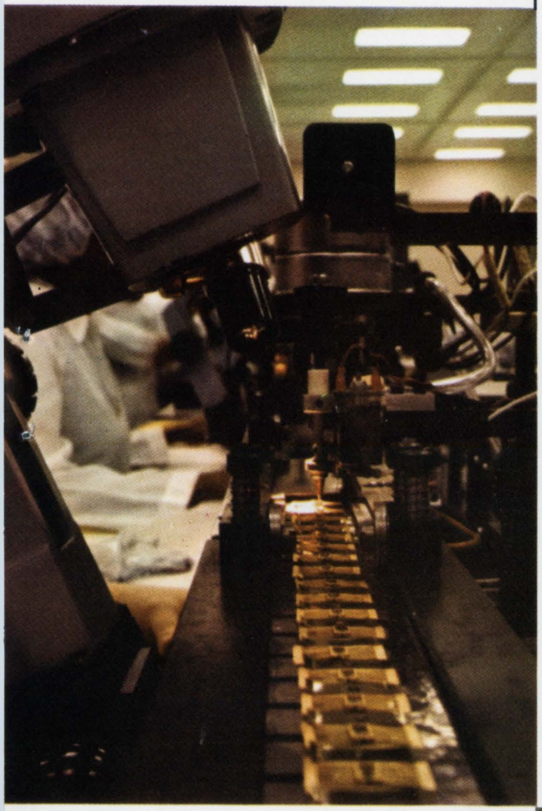
100% electrical testing.

You're looking through a microscope as 18 electrical probes contact active test points on an IC wafer. Once aligned, this automatic machine indexes precisely...running elaborate electrical tests for every device on the wafer. Every circuit. Not just samples.

A 200X eye on alignment and contacts.

This is how closely Westinghouse quality control people look at every IC wafer. Each one undergoes microscopic inspection. If any diffusion pattern or metallized contact isn't in perfect alignment, it shows up 200 times life size. Westinghouse takes a big look at quality.



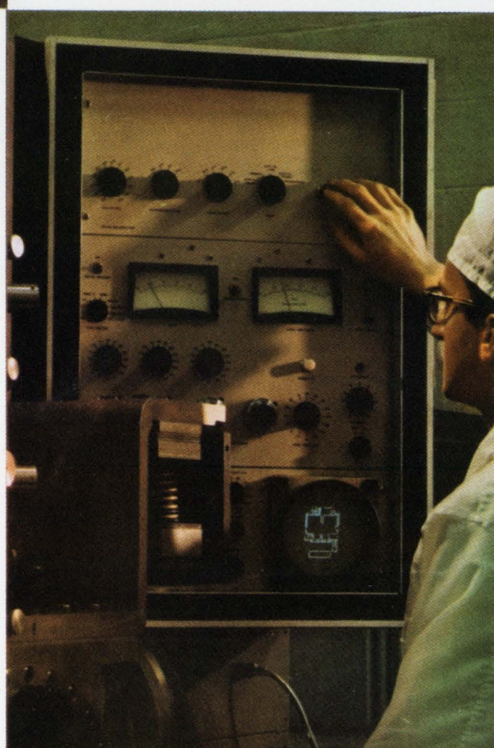


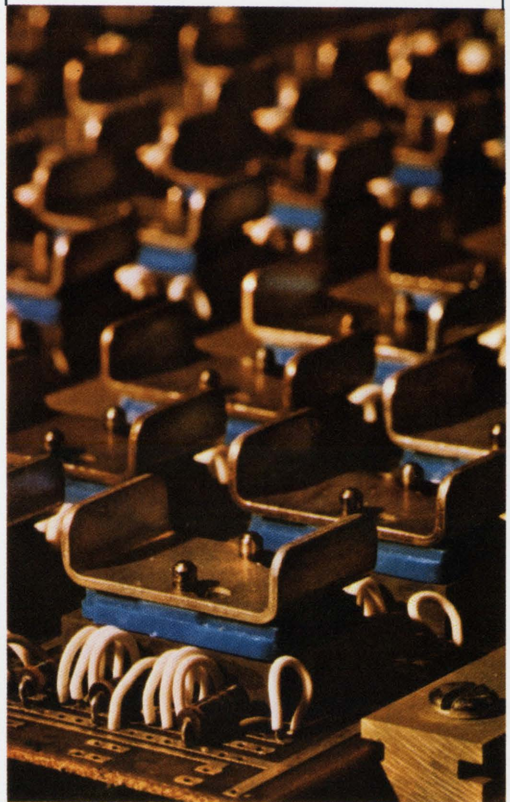
Continuous strip bonding of IC's.

Here's another mechanized Westinghouse production step that eliminates defects caused by manual handling of assemblies. Glass and Kovar® packages are fed on strips through final assembly, not handled one by one. They come out as finished flat packs. Result: no mangled leads, scratched gold plating, or stresses in the glass-to-metal seal which could later cause hermetic failure.

Unique inside look at an operating integrated circuit.

The exclusive Westinghouse Scanning Electron Microscope is the only one in the integrated circuit field. On a CRT, it displays what's happening 5, 10, or any number of microns inside the solid silicon of an operating IC chip. The picture here shows the isolation wall p-n junction of a typical flip-flop. It could be seen in no other way without cutting apart the silicon circuit. Such pictures reveal imperfections which elude all conventional electrical and visual tests. They lead to design changes for even more reliable IC's.



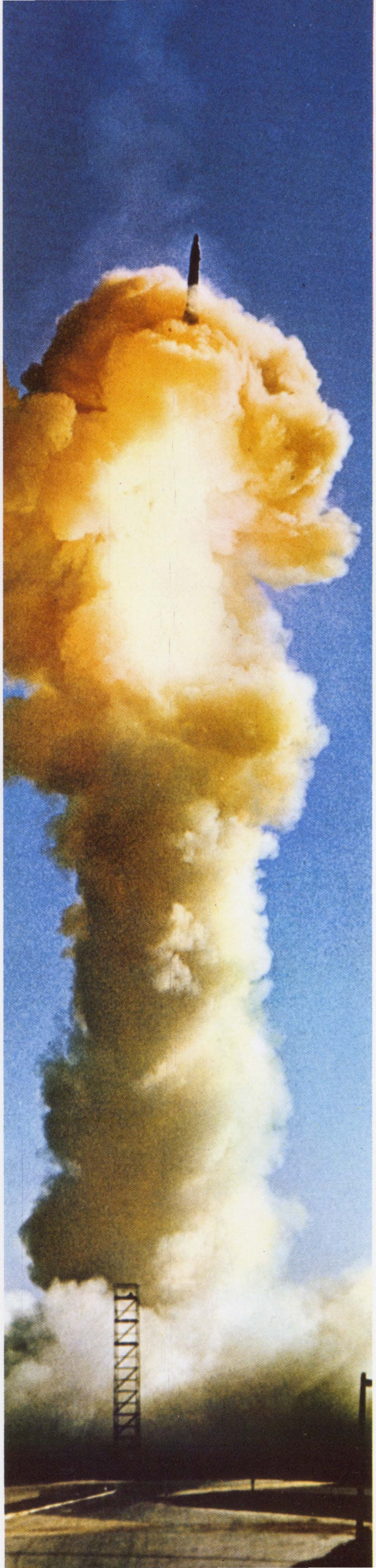


Exhaustive high-temperature test cycles.

Exposed to elevated temperatures for up to 1000 hours, Westinghouse integrated circuits undergo batteries of actual power-on tests. After this workout, the IC's are put through even more complex electrical and mechanical tests checking dozens of parameters. During all phases of environmental and final testing, the IC's are completely protected against handling damage. They remain in AUTO-PAK® carriers and test board systems, as shown here. Here's extra assurance they will be shipped to you in perfect "as tested" condition.

You can be sure
if it's Westinghouse

Space projects and you both get ultimate IC reliability from Westinghouse



The Westinghouse IC's you buy are virtually as reliable as those used in missiles and satellites. The reason: production and quality control steps developed for Defense Department reliability programs...particularly with North American Aviation's Autonetics Division for the Minuteman program...are standard Westinghouse procedures.

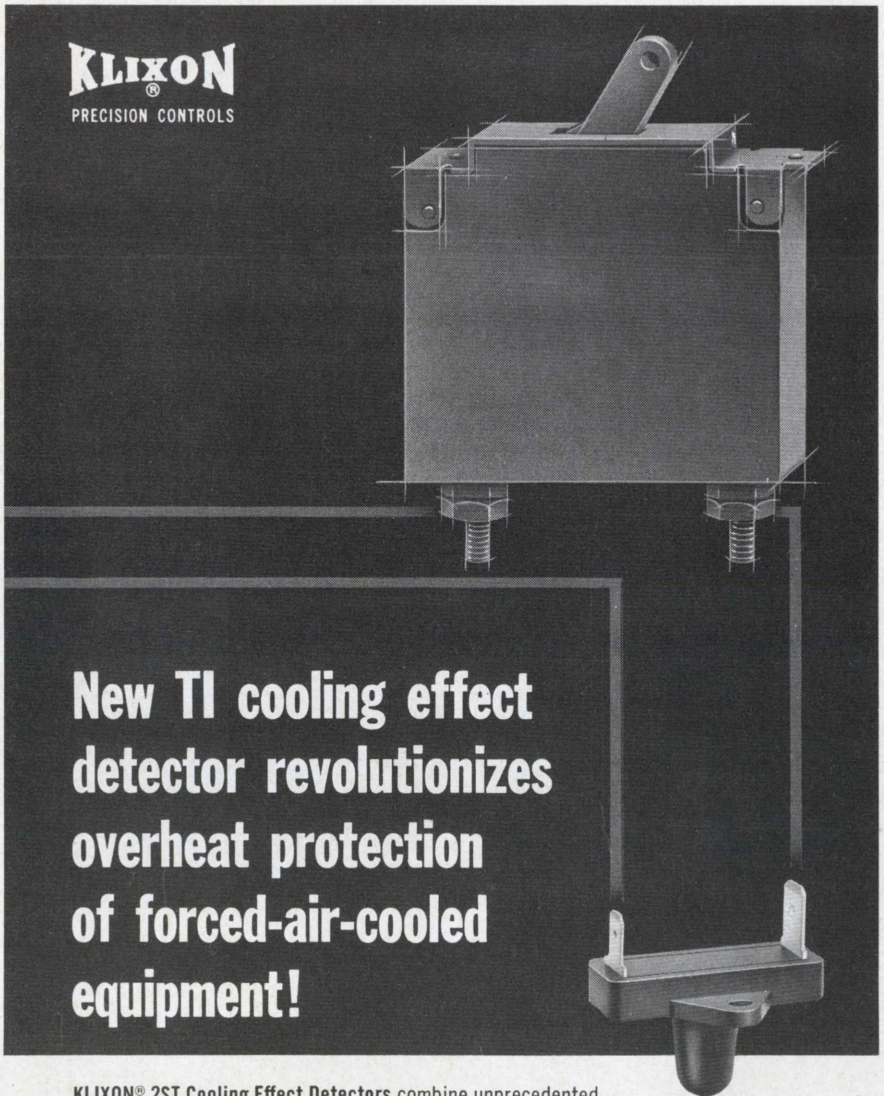
On the previous pages, you've just seen four examples. The 18-wafer carrier, the continuous strip bonders, the unique scanning microscope, and our high-temperature test cycles all resulted from development contracts with the Air Force Materials Laboratory, Manufacturing Technology Division. All contribute reliability by helping us prevent hidden defects. All raise IC production yields, thus making Westinghouse IC's more economical.

The happy result is unmatched reliability and value...both yours at once when you specify Westinghouse integrated circuits.

Let us send you information on Westinghouse integrated circuits. Write Westinghouse Electric Corporation, Molecular Electronics Division, Box 7377, Elkridge, Maryland 21227.

You can be sure if it's Westinghouse

◄ ON READER-SERVICE CARD CIRCLE 34



KLIXON® 2ST Cooling Effect Detectors combine unprecedented sensitivity, reliability, simplicity and economy to prevent harmful overheating in computers, radar and microwave systems, copying machines, film projectors and other fan-cooled equipment. They completely eliminate the need for vane switches and thermostats.

Reliable solid-state sensing makes the difference! The sensor is a self-heated NTC (negative temperature coefficient) resistor. Mounted in the air stream and connected in series with a special rating of the KLIXON 4MC magnetic circuit breaker, it monitors the cooling capacity of the air stream. Loss of cooling effect as a result of clogged inlets, fan failure, air conditioner loss, or any combination of these causes a sharp drop in sensor resistance. The resultant increased current will trip the circuit breaker.

Unlike conventional thermistors, KLIXON 2ST Detectors sense over their entire surface, instead of only one point. This simplifies installation and mounting. Moreover, they can handle directly a current large enough to actuate a circuit breaker without intermediate amplification. They can be designed to operate at any voltage between 3 and 24 v-dc/60 cycle ac.

Bulletin PRET-16 gives you all the facts you need to evaluate these exclusive TI developments. Write for your copy today.

METALS & CONTROLS INC.
5105 FOREST ST., ATTLEBORO, MASS.
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INCORPORATED

ON READER-SERVICE CARD CIRCLE 35

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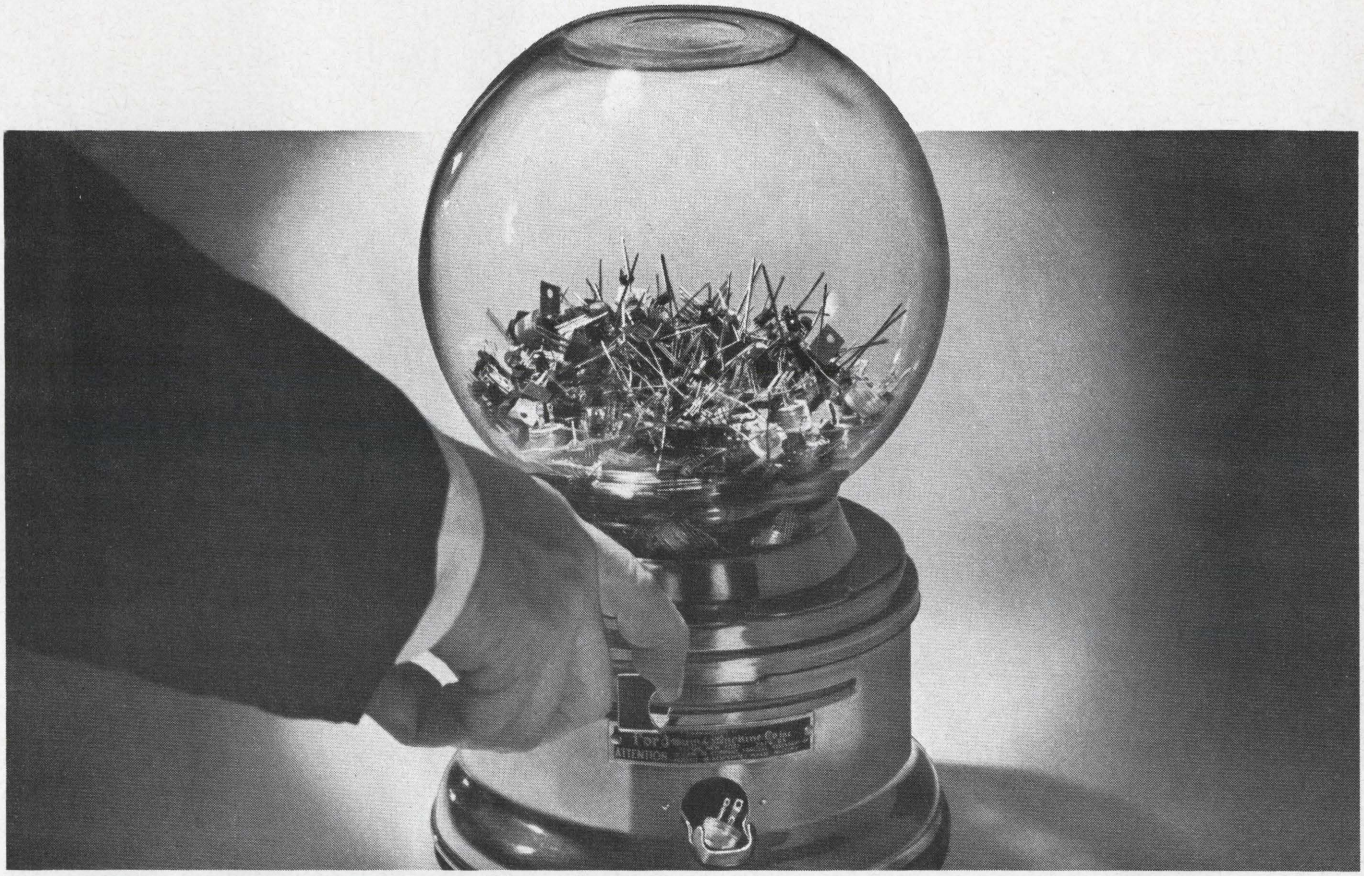
ELECTRONIC INNOVATIONS IN ACTION

Low-cost way to solid state



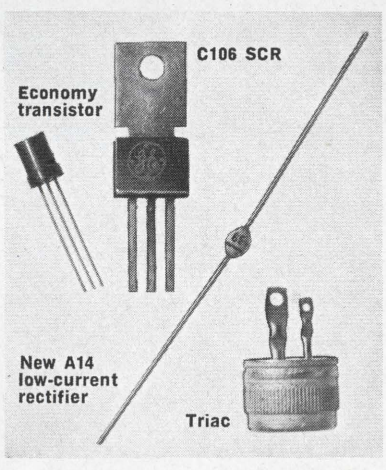
G-E economy line semiconductors

■ Today, low-cost solid state is a reality for dozens of applications never before thought possible. The reason: G-E economy line semiconductors.

Now, for under $2.00, a single G-E Triac can control a 600-watt load. Yet, less than 10 years ago, it would have taken two $145.00 SCR's.

G-E economy transistors cost as little as 15¢ each. Many high-sensitivity SCR's, less than half a dollar.

And today you can buy one kind of rectifier to perform a number of different functions. New G-E A14 rectifiers will work almost anywhere you need dependable, low-power rectification.



Actual size General Electric economy line semiconductors

Surely you have at least one application problem that ought to be solved by low-cost solid state. Ask your G-E engineer/salesman or semiconductor distributor about it . . . and the application experts they can call on to help you.

Or write to Section 220-32, General Electric Company, Schenectady, N. Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: Electronic Component Sales, IGE Export Division, 159 Madison Ave., New York, N. Y.

SEMICONDUCTOR PRODUCTS DEPARTMENT

GENERAL ELECTRIC

ON READER-SERVICE CARD CIRCLE 48

Selecting a thyristor to fill a control need doesn't have to be a difficult choice. These guidelines to the why, where and how of applications simplify the job.

When it comes to switching power or controlling phase, think thyristor. No other family of semiconductor devices offers such a wide choice of suitable designs with comparable efficiency, reliability, flexibility and simplicity.

In most cases the differences between thyristors and other semiconductor types is clear-cut. However, many users are not nearly as confident when it comes to selecting from among thyristors alone. At first glance, there appears to be some overlap in the differing thyristor roles. For example, one might ask, "Where does the SCR end and the Triac begin?"

The answer to this and similar questions lies in a detailed examination of the thyristor family tree:

- The silicon-controlled rectifier (SCR).
- The silicon-controlled switch (SCS).
- The gate-turn-off switch (GTO).
- The four-layer (Shockley) diode, the silicon-unilateral switch (SUS) and the silicon-bilateral switch (SBS).
- The light-activated SCR (LASCR).
- The three-element, static, ac switch (Triac).

In each case let us consider first the salient characteristics of the device, then its governing design parameters, and, finally, the major application areas for which each has been tailored.

Understanding and using SCR parameters

The SCR is a regenerative device of pnpn construction with three external connections.[1] To get the most out of this unit and to be able to select the best SCR for an application, one must have a good working knowledge of the basic parameters. The maximum allowable ratings of thyristors are listed on manufacturers' specification sheets, so the designer sees at a glance the one or two devices that are within his specifications. Here are the definitions of the maximum allowable ratings that are usually encountered on the specification sheets:

- PFV—The peak forward voltage rating is the maximum allowable instantaneous value of forward voltage that may be applied between anode and cathode without risking damage to the device if switching to the ON state occurs.
- V_{FXM}—The peak forward blocking voltage rating is the maximum allowable instantaneous value of forward blocking voltage, including transient voltages, which will not switch the SCR to the ON state. This specification usually states a definite impedance between gate terminal and cathode, or a specific bias voltage.
- $V_{ROM(rep)}$—The repetitive peak reverse voltage rating (with the gate open) is the maximum allowable instantaneous value of reverse voltage, including all repetitive transient voltages—but excluding all nonrepetitive transient voltages—that may occur across the SCR.
- $V_{ROM(non\text{-}rep)}$—The nonrepetitive peak reverse voltage rating (with the gate open) is the maximum allowable instantaneous value of reverse voltage, including all nonrepetitive transient voltages—but excluding all repetitive transient voltages—that may be applied across the SCR. This rating is slightly higher than $V_{ROM(rep)}$ for each specific voltage rating of an SCR type.

Narrow down thyristor selection problems. Optimize and simplify your power and control designs by using Author Brookmire's guide to distinguishing between members of the thyristor family.

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■ V_{GT}—The gate trigger voltage rating is the dc voltage between the gate and the cathode required to produce the dc gate trigger current.

■ I_F *rms*—The rms forward current is the maximum steady-state rms current that the device is rated for. The rms or effective value in this specification is independent of waveform.

■ $I_{F(AV)}$—The maximum average forward current depends upon the conduction angle and is usually given in chart form. The chart shows maximum allowable case temperature vs average current for either dc or various conduction angles of a sinusoidal waveform.

■ $I_{FM(surge)}$—The peak one-cycle surge forward current, nonrepetitive, is the maximum allowable peak current through the collector junction for a positive anode to cathode voltage. This specification is for a single, forward, half cycle (8.3 ms) in a 60-Hz resistive load system. The surge may be preceded and followed by maximum reverse rated voltage, current and junction temperature conditions, and maximum allowable gate power may be concurrently dissipated. However, limitations on anode current during switching should not be exceeded.

■ I_{HX}—The holding current is the minimum current through the collector junction required to maintain the SCR in the ON state for specified conditions and load. The gate terminal is tied to the cathode through an impedance or bias voltage.

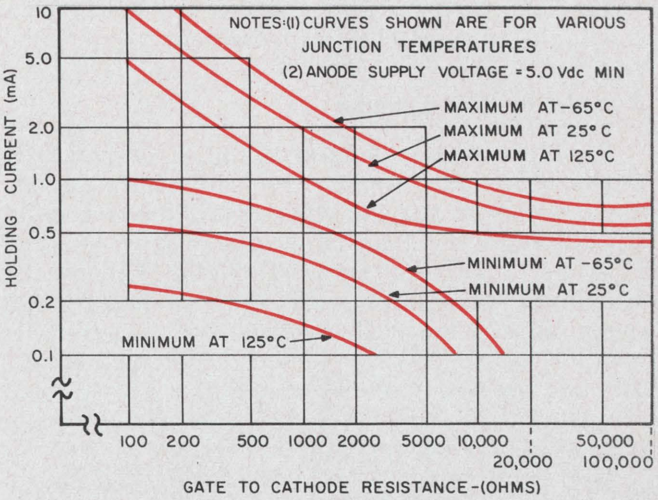
■ I_{GT}—The dc gate trigger current is the minimum dc gate current required to cause switching from OFF to ON for a specified anode-to-cathode voltage, junction temperature and gate impedance. This is one of the most important specifications, for one should always design for the maximum gate current required to fire the particular device, unless selected units are desired.

■ I^2t—This is the maximum allowable forward nonrecurring overcurrent capability for pulse durations greater than a specified time (usually given in milliseconds). Unit I is the rms amperes, and t is the pulse duration in seconds. This specification is for applicable fusing of the device used.

■ t_{off}—The circuit-commutated turn-off time is the interval between the time when the forward current decreases to zero and the device voltage reaches zero and is rising to a stated value of forward blocking voltage (at a stated rate of rise without turning on during switching). This is usually stated for specific conditions of junction temperature, gate impedance, etc.

Don't underestimate rate of rise

Two other SCR specifications that are very important in device selection are dv/dt and di/dt. Dv/dt is the rate of change of voltage, with respect to time, that is applied to the anode-cathode junction. Note that any pn junction has capacitance, and the larger the junction area the higher this capacitance. It follows then that the charging current to this capacitance is equal to $C\ dv/dt$. If a step function of voltage (line transient) is impressed across the anode to cathode of the thyristor, the device may inadvertently switch on, due to the triggering action of this charging current.



1. Holding current is what keeps an SCR in the conducting state. It is a function of gate-to-cathode resistance and temperature, and is a critical parameter in low-power systems and switching circuits.

The definition of the rate of rise of the anode voltage (dv/dt) is the slope of a straight line starting at zero anode voltage and extending through the one-time constant point on an exponentially rising anode voltage. Methods used to increase the SCR's dv/dt capability are: select a higher voltage unit for the application; reverse-bias the gate with respect to the cathode, or provide a series-RC network across the anode-cathode junction to slow the rate of rise of the anode voltage transient.

Di/dt is the rate of rise of the anode current with respect to time. In some cases where di/dt is faster than the time required for the junctions to reach a state of full forward conduction (at uniform current density), localized hot-spot heating will occur in the junction region that has begun to conduct. This may cause excessive temperature rise and subsequent device failure.

Several methods may be utilized to reduce the harmful effect of di/dt.[2] To cite a few: series-saturable reactors that limit the rise of current during the initial period of turn-on; small resistances placed in series with the anode-cathode, and combinations of these two remedies.

Other parameters, such as storage temperature, delay times, leakage currents, turn-on times and other voltage ratings, are generally less important in most applications. Moreover the specification sheets usually contain several charts that refer to these factors and to the instantaneous voltage-current relationships, power dissipation vs conduction angles, maximum allowable ambient temperature vs average forward current for rectangular waveshapes, and gate trigger current vs gate pulse width, among others. These charts or graphs are usually self-explanatory and give insight into how the device will perform in (specific) applications. An example of such a graph is one showing holding current vs gate-to-cathode impedance for the C5 SCR (Fig. 1). This characteristic is especially important in low-power control logic and switching applications.

A model of SCR behavior

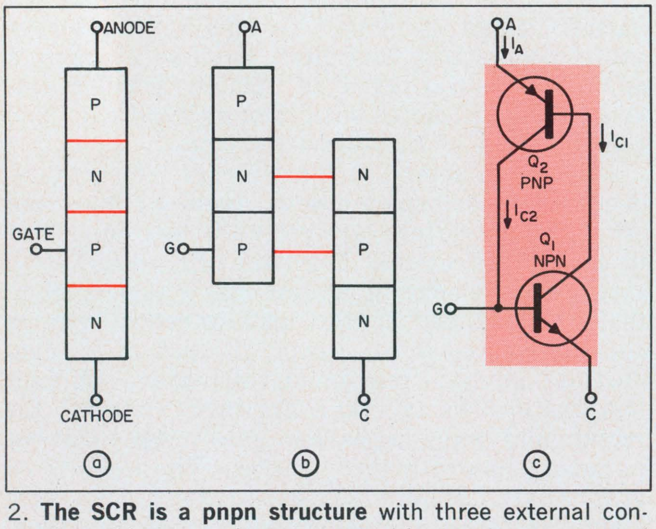
To obtain a basic understanding of how an SCR works, one may analyze its equivalent circuit. Since the SCR and all other thyristors are pnpn structures, a two-transistor analog may be used (Fig. 2).[3] Figure 2a (from left to right) shows the four-layer structure with the three external connections. Figure 2b displays the two complementary transistors tied in such a way that collectors and bases of like material, either p or n, form a regenerative feedback connection. The complete transistor analog appears in Fig. 2c.

The total anode to cathode current, I_A, equals the sum of I_{C1} and I_{C2}. It is expressed as

$$I_A = \frac{(1+h_{FE_1})(1+h_{FE_2})(I_{CO_1}+I_{CO_2})}{1-(h_{FE_1}h_{FE_2})}. \qquad (1)$$

With proper bias applied to the transistor pair (positive anode to cathode voltage), h_{FE1} and h_{FE2} are both low, and their product is much less than unity. This condition exists because the only currents involved are the leakage currents, which are innately small. And because h_{FE} is directly proportional to the collector current, these current gains are also small. Thus the equation develops a value of I_A that is only slightly higher than the sum of I_{CO1} and I_{CO2}. This mode of operation in a pnpn structure is referred to as the forward blocking state, or the OFF condition.

Now, if the product of h_{FE1} and h_{FE2} is made to approach unity, the numerator of Eq. 1 approaches infinity and rapid regeneration takes place. Here the current builds up and drives both transistors to their saturated states, causing the thyristor to unblock or turn ON. The anode-to-cathode voltage becomes low and is the total drop of the three junctions indicated in Fig. 2a.



2. **The SCR is a pnpn structure** with three external connections (a). It may be represented by two interconnected complementary transistors (b). The complete 2-transistor analogy (c) shows current flow and the regenerative feedback connection.

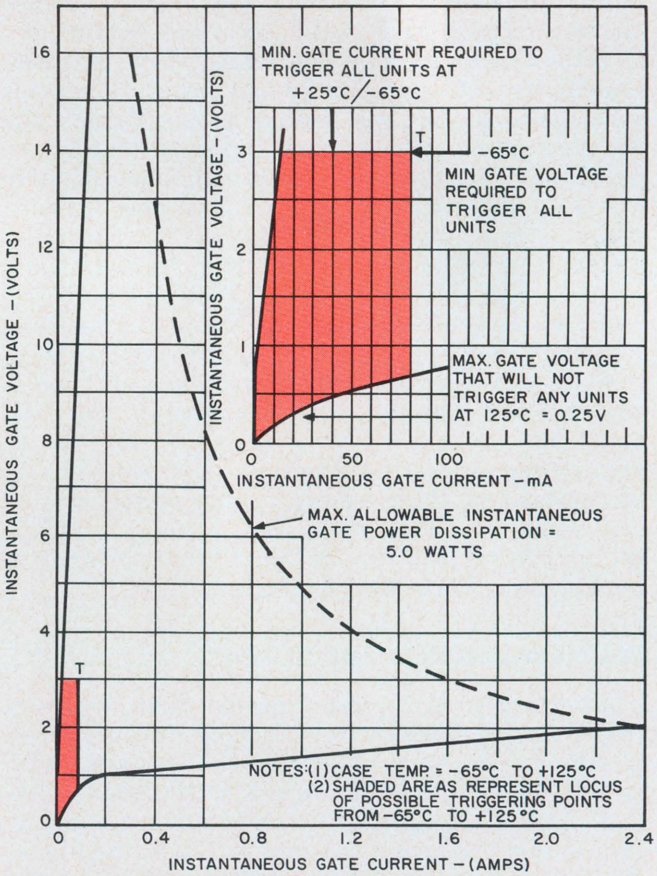
This condition of regeneration may be made to occur by increasing the temperature of the pnpn junction in such a way that the leakage currents become high enough to provide switching action by themselves. Another method is to increase the anode-to-cathode voltage, which again increases the leakage currents. The technique mainly used in the SCR is to provide a positive gate-to-cathode voltage (external base current to Q_1), which causes an unblocking state to be reached by transistor action.

It is interesting to note that in some SCR specifications a maximum impedance to be applied between gate and cathode is usually specified. This is to insure that the SCR will block under a specific junction temperature and for a given forward voltage between anode and cathode. This impedance is necessary to divert part of I_{C2} (mostly leakage current) away from the base of Q_1, so that regeneration will not occur during the blocking mode.

Charting the application course

Let us now see how to use the parameter data given on specification sheets. We may consider the SCR as a two-circuit link—the gate section (input) and the anode portion (output). Note that the cathode is common to both.

Figure 3 shows the gate-triggering characteris-



3. **Gate triggering characteristics** for a typical SCR (type C35). Note that a locus of firing points exists. Observe that temperature, a major factor on the triggering requirements, should be accounted for in the design.

tic of the C35 SCR family. The equivalent circuit between the SCR's gate and cathode terminals consists of a low-voltage pn junction with some series resistance. Thus the gate characteristics may be considered to be those of a modified silicon pn junction.

The small shaded area in Fig. 3 is enlarged in the upper portion of the graph. This area represents the locus of all points where triggering of all types of SCRs in the C35 family (C35U through C35N) will occur over the junction temperature range of $-65°C$ to $+125°C$. The boundaries of the locus are also shown for operation over lesser temperature ranges. For example, note that a minimum gate current of 40 mA is required at 25°C to fire all units, whereas at $-65°C$, 85 mA is needed. A minimum gate signal of three volts is required for reliable triggering at both temperatures. It is imperative that the circuit designer stay out of "shaded areas" to guarantee that 100 percent of the units will trigger. It is recommended that the trigger point be slightly above and to the right of the top-right corner of the shaded area (point T).

The preferred trigger area is bounded by the dotted peak-power dissipation curve and the outer limits of the shaded area. When operating with dc trigger signals, be sure that the steady average gate power dissipation rating isn't exceeded.

The load line of the trigger source should pass through the preferred area of the gate characteristic graph so that the triggering signal is as close as possible to either the average power dissipation (for dc triggering) or to the peak power dissipation (for pulsed cases). The rise time of the trigger signal's leading edge should also be as fast as possible. Fast-rising, high-amplitude gate signals reduce anode switching time and minimize switching dissipation and jitter. This is especially desirable when switching into high anode currents. When the gate is driven with some intermediate type of waveform, such as a rectangular pulse, the average gate power is determined by computing the duty cycle and multiplying it by the peak power value of the pulse. The product should be less than the rated average gate power dissipation of the SCR.

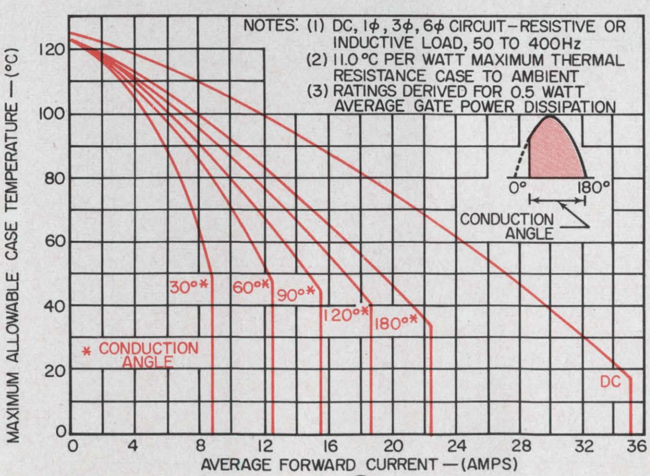
The gate source is established by the open-circuit, gate-source voltage at zero current and the shorted circuit current that is produced by the source voltage, divided by the source impedance.

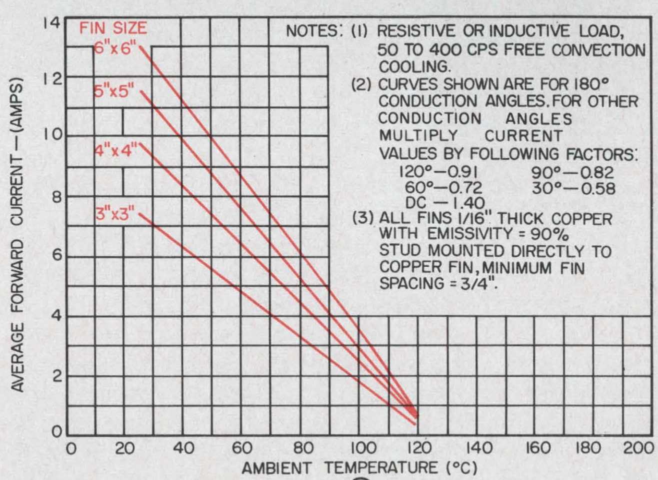
One may easily visualize what actually occurs during a pulsed-gate triggered condition. The E—I dynamic curve before triggering starts at the origin of the graph and sweeps out to intersect the trigger source load line. At some lesser value of current than that given by the intersection of these two curves, the SCR triggers.

The case for dc over rms

For another example of how to use the specification sheet in designing with SCRs, refer to Fig. 4a. This graph shows the maximum allowable case temperature vs average forward current for different current conduction angles for a sinusoidal voltage waveform applied between the anode and cathode of the C35 SCR. Note that the current is not rms but average dc. One reason average values are used is that it is much easier to measure average current with a dc ammeter than to find a meter that will read the rms value of a phase-controlled current. Curves are available that easily convert the average value to an rms value for any conduction angle. The specification sheets for lead-mounted SCRs (like the C5 and C106 types) also give the curves for ambient temperature vs average current, since separate heatsinks are not generally used with these devices.

It is very important to appreciate the difference between case temperature and junction temperature. Junction temperature always is higher than case by an amount determined by the thermal resistance (Θ) of the device. Parameter Θ is





4. **Maximum allowable case temperature** for sinusoidal currents is a function of conduction angle. Note that the current decreases (for a given case temperature) as the conduction angle decreases. This is because the ratio of rms to average current increases as the conduction angle decreases. Thus, average current must be derated to keep T_{case} constant. Data in a plot of maximum forward current vs ambient temperature for various fin sizes (b) is used to help maintain the junction at a proper operating temperature.

expressed in degree C rise—junction to case—per watt of dissipated junction power.

Since average heating in the device is determined to some extent by the rms current flowing, the more watts that are generated, the higher the average temperature difference will be between the junction and case. Since the ratio of rms current to average current increases at smaller-conduction angles, the allowable average current for a given case temperature must decrease as the conduction angle decreases, if constant rms is to be maintained. This derating at small conduction angles also ensures that the peak junction temperature of the device is not exceeded. Remember that small conduction angles lead to high peak power as well as high average power and that high peak power means high peak junction temperatures. A similar derating is necessary with rectangular current pulses.

Note in Fig. 4a that the case temperature is absolute and defines the thermal gradient between case and junction. For example, if one selected an average current of 8 A at a 30° conduction angle, the maximum allowable case temperature would be 60°C, and one could assume that the junction was close to its rated value of 125°C. Since this particular device usually requires a heatsink to achieve any practical efficiency, the thermal resistance from case to heatsink (°C/watt) and the thermal resistance from heatsink to ambient must be known before values of current for specific ambients can be selected. The curve shown in Fig. 4b has already accomplished this for various fin sizes. It shows the maximum allowable average current, for various conduction angles and different heatsinks, that may be used with the SCR, so as to maintain proper junction temperature.

So much for the input circuit design. Let us turn now to the output circuit, starting with the role of the load.

Device trade-offs based on load

A realistic method for selecting the right device is to investigate the characteristics of the load. Let us then look at three types of typical loads and examine the requirements of each. They are:

1. Incandescent lamp load operating from ac supplies.

2. Resistance loads of a power factor greater than 99 percent, also operating from ac supplies.

3. Inductive loads (phase control of motors, static switching, etc.) with both ac and dc supplies.

- **Incandescent lamps or tungsten loads.**

Two major problems exist for the lamp load applications. First, the in-rush current due to a cold filament condition can be 15 to 20 times more than the steady-state current of the lamp for a single cycle of operation. This means that the SCR or Triac selected should be able to handle the transient in-rush current.

The second problem occurs when the lamp burns out. In this case the lamp filament at burnout has a tendency to arc, thus drawing large amounts of current for a short time interval. An example of a potential misapplication would be to select an SCR that satisfied the steady-state load requirements of the lamp, plus in-rush conditions due to a cold filament, but was unable to handle the burnout condition with high enough reliability. Therefore an SCR of higher power than that required for steady-state conditions should be selected to handle the burnout.

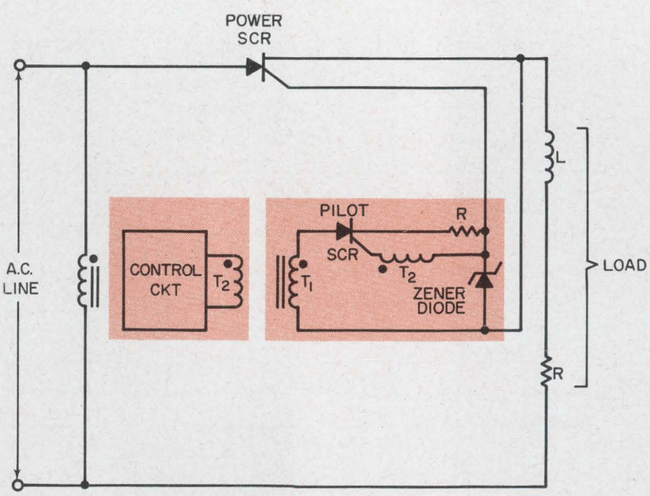
- **Non-incandescent resistive loads with a power factor of 99 percent or greater.**

With resistive load applications, di/dt and I^2t are generally not problems, since there is no in-rush or burnout condition. The device must be selected on the basis of rms-supply voltage and load current. Sufficient heat-sinking must be provided to keep the junction temperature within specifications. In some cases especially when using Triacs) the system inductance (leakage reactance of transformers for instance) can cause some concern. If enough inductance exists in the voltage source supplying the load, commutation dv/dt can be a problem.

The inductance causes a leading phase shift between the voltage applied to the thyristor and the current through it. This means that at the instant the current becomes zero for one polarity of conduction, a voltage is suddenly applied across the device in the opposite polarity. At this instant the thyristor to which forward voltage is applied may conduct, if the rate of rise of the applied voltage is higher than the dv/dt rating of the device. Since control is lost if this happens, external circuitry would be needed to suppress the rate of rise of the applied voltage to within the prescribed dv/dt rating of the device. A simple RC network in parallel with the thyristor does this.

- **Inductive loads.**

One good example of an inductive load is a dc motor driven from an ac supply. Here, an SCR would normally be the logical choice for the following reasons:



5. **Time-extended trigger signals** must be supplied to the gate of the power SCR in inductive load circuits. Achieved by a separate control transformer, it permits sufficient current build-up in the power SCR to guarantee latching. Alternatively, a series of pulses or a rectangular pulse may be applied to the gate.

Table 1. Classifying SCRs by application

Category	SCR properties	Device characteristics
Light-industrial SCRs	Narrow temperature ranges. Low to medium current ratings. Normal turn-off times.	Passivated structures. Available in plastic case. Typical features (C106): 2 A rms, 25-200 volts. Typical medium current unit (C35): 35 A rms, 25-800 volts.
Heavy industrial and Military SCRs	Wide temperature ranges. Highest current-handling capability. High voltage ratings.	Usually a metal-encased unit. Typical features (2N2542): 235 A rms, 25-800 volts, -40°C to +125°C.
High-frequency SCRs	Rapid turn-off. High current-handling capability. Medium voltage ratings.	Frequency response approaches 50 kHz. Typical features (C141): 35 A rms, 25-400 volts, 10 μs turn-off.

1. With the larger dc motors, the voltage requirement is beyond the range of power transistor technology.

2. The power transistor for the smaller motor applications requires separate rectification of the ac voltage supply. If SCRs are used instead, they rectify as well as control.

3. In most cases of dc motor speed control, the power loss in the SCR is minimal, compared with the needs of a power transistor operating from a dc supply.

4. The locked rotor condition at turn-on is a severe problem, because the only circuit resistance at this time is the motor armature resistance. The SCR inherently has a higher multicycle surge-current rating than that of a power transistor of comparable steady-state ratings. Therefore it is more capable of handling this problem.

For most motors, ac or dc, the problem of commutation dv/dt exists. The use of an RC circuit across the SCR or Triac will limit the rate of rise of the voltage across the device. In full-wave bridge applications for dc motors, the motor inductance causes a holding current to flow through the SCR during the time the supply voltage goes through zero, thus preventing commutation. A free-wheeling diode placed across the load shunts this current away from the SCR, thereby permitting it to commutate properly.

One must also consider the effect of the gate circuit when an inductive load is to be driven. If pulse firing is used, the inductance of the load may prevent sufficient current build-up through the thyristor to ensure that it stays on when the gate pulse is finished. To eliminate this possibility, it is necessary to supply the gate with a sustained trigger signal that lasts as long as the thyristor is conducting (during each forward half-cycle). A typical way of doing this is shown in Fig. 5. The pulse transformer fires into the resistive gate-cathode of the pilot SCR, which in turn fires the power SCR at the desired time. This method is suitable regardless of load power-failure.

Next consider the application itself. Here, factors other than load are used to categorize SCRs. The primary determinants are current, voltage, temperature and switching speed.

SCRs breakdown into 3 types

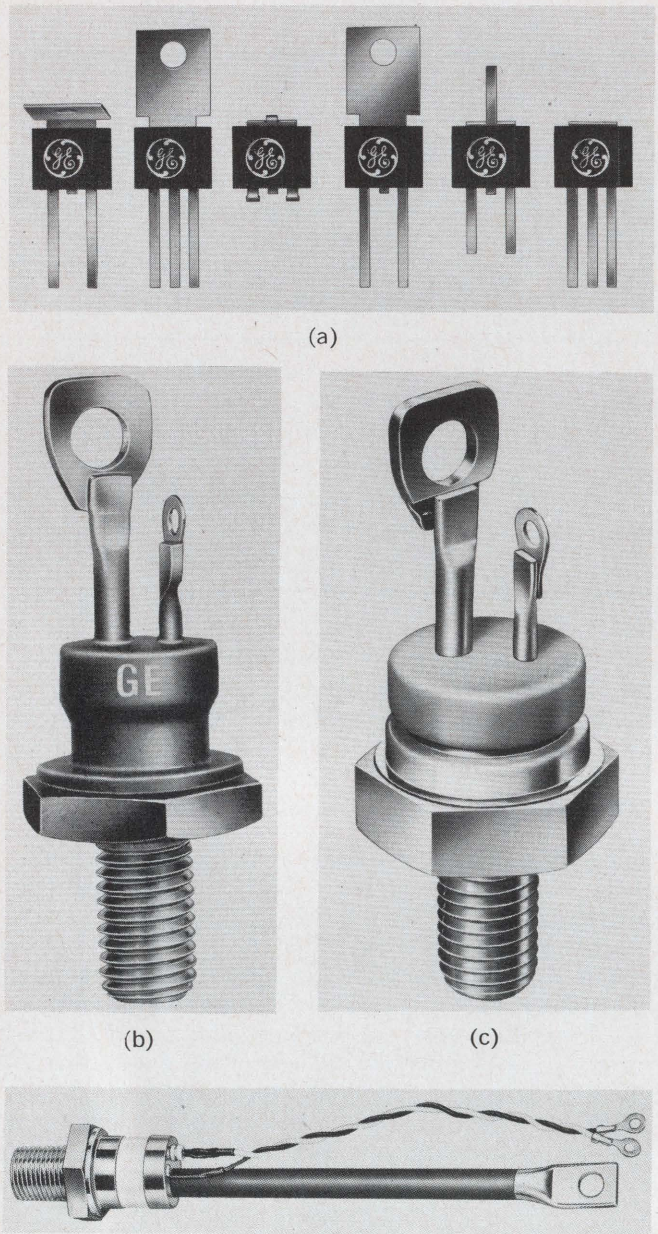
Today's SCRs can be generally classified under three basic categories: light-industrial types, heavy industrial and military units, and high-frequency devices (see Table 1).

The light industrial SCRs (Fig. 6a) are usually characterized by narrower temperature ranges, low-to-medium current ratings, and normal turn-off times. Low-current devices of planar-passivated structure are now entering this field. These SCRs are characterized by plastic molded cases and are relatively low priced. The planar construction gives a much higher gate-drift stability with junction temperature than the normal, diffused types. Note that this type of SCR may be selected with a tab heatsink. One may visualize the difference in size, case construction, and costs involved by comparing it with the medium-current unit (Fig. 6b).

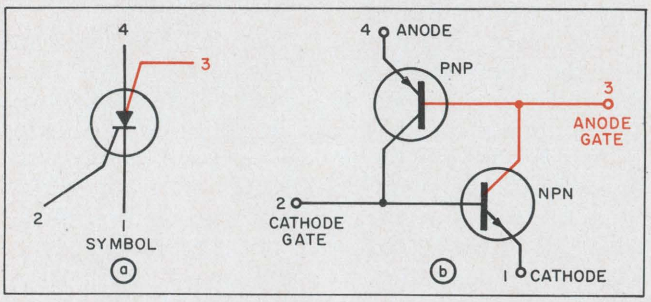
The heavy industrial and military types are characterized by wide temperature ranges, high current handling capacities, and high voltage ratings. Representative of this SCR family is the unit shown in Fig. 6c.

The third general unit is the high-frequency or inverter type of SCR. While this device may generally be classified as a heavy industrial type, it is uniquely characterized by its ability to turn-off rapidly. Figure 6d depicts a typical unit in this category. Note that high-frequency types differ from the heavy industrial units in their application; the former are the only SCRs used in inverters, choppers, cyclo-converters and other higher-frequency applications. Their frequency response is nearing the 50 kHz level; the upper limit for heavy industrial units is closer to 2.0 kHz.

Thus the case is made for the leading member of the thyristor family, the SCR. We now turn to



6. **Thyristors may be classified according to application.** Shown are light-industrial (a) and medium-industrial (b) types, a high-frequency unit (c), and a heavy industrial type suitable for military use (d). Type (a) has low-current ratings (to 2 A rms), (b) medium current ratings (to 35 A rms), (d) highest current ratings (typically 235 A rms) and (c) the fastest turn-off time (10μs).



7. **The SCS is a four-terminal device** similar to the SCR. It is suitable for low-voltage and low-power applications (a). The equivalent circuit (b) shows the extra gate (terminal 3), which is sometimes used for preventing dv/dt effects from mistriggering the switch.

its relatives, the SCS, GTO, 4-layer diode, SBS and SUS, LASCR and Triac devices.

Spotlighting the rest of the thyristor family

The remaining thyristor devices are suited for a number of specialized, SCR-like applications (see Table 2). They have not as yet been made available in as wide a variety of package sizes or with as high a power-handling capability as the SCR.

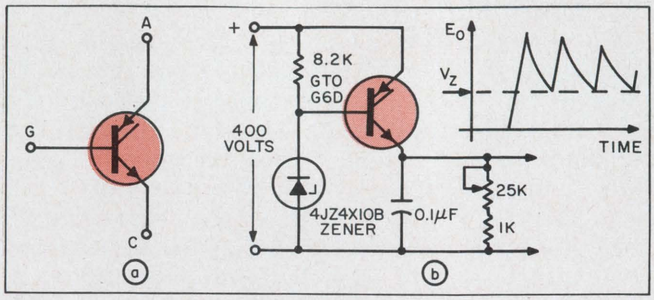
The silicon-controlled switch (SCS), like the SCR, is a pnpn structure. However, it has four accessible leads (Fig. 7). The SCS is a device similar to two complementary transistors connected in a regenerative feedback arrangement. Therefore the normal parameters that cause beta to increase in a transistor, such as V_{CE}, I_C, V_{BE} and temperature, will cause the SCS to unblock (as was the case with the SCR).

The main difference between the SCR and the SCS is that the latter is a four-terminal device used for low-voltage and low-power applications. The extra lead (anode gate) can be effectively used to prevent dv/dt triggering, by returning this gate to the positive supply through a large resistance. The anode gate may also be used as a second gate trigger.

The transient response time of the SCS is dependent on the frequency response of the two transistors and the magnitude of the gate drive current. The larger the gate drive, the less the delay time with low anode currents, and thus the fastest response.

Recovery time, or turn-off time, is a function of diverting the npn base drive current in such a way that this transistor will turn off. This may be accomplished by providing a negative signal to the cathode gate or by placing a short between the anode and the anode gate. By reverse-biasing the anode-cathode junction and tying the cathode gate to a negative polarity or ground, a fast recovery results.

One of the unique features of the SCS is its high triggering sensitivity. At moderate temperatures, where leakage is negligible, very large input resistances may be utilized to provide extremely sensitive triggering levels. Some of the more important parameters of a typical SCS (type 3N82) are:



8. **The gate turn-off switch (GTO)** is a pnpn device tailored to dc switching application needs (a). It has a higher voltage rating than comparable bipolar transistors, as exemplified by this sawtooth generator application (b). Moreover, its trigger-power requirements are small.

- Anode to cathode (forward and reverse) voltage — 100 volts (max)
- Continuous dc forward current — 200 mA (max)
- Total power — 400 mW (max)
- Operating junction temperature — −65°C-150°C
- Holding current — 1.5 mA (max)
- Cathode gate current to trigger — 1 μA (max)
- Turn-on time — 1.5 μs (max)
- Recovery time — 15 μs (max)

The SCS may be used as a bistable device, such as a Schmitt trigger; as a latching device, with negative gate turn-off; like an SCR, with no *dv/dt* problems, or as a signal SCR, with an extremely fast recovery time.

GTO a natural for dc switching

The gate turn-off switch (GTO) is a pnpn switching device with three terminals (Fig. 8). The GTO was designed primarily for dc switching applications, where it has these advantages over the transistor: a higher voltage capability and a lower triggering power requirement.

Like an SCR, it may be latched by a positive pulse between gate and cathode; unlike the SCR, it may be unlatched by a negative pulse. A typical GTO is rated up to 400 volts in dc forward-blocking voltage, and it has a 25-volt (dc) reverse-voltage rating. A series diode in the anode lead enables the device to tolerate high reverse voltages when needed. But since the GTO is largely used in dc applications, the diode is a rare necessity. For fast turn-on and turn-off, the positive and negative gate pulses should have steep leading edges and slow decay times. These result in good turn-on and fast recovery times.

SUS and SBS have two states

The unilateral pnpn switching diode, commonly known as the Shockley (or four-layer) diode, is designed to block voltage until the breakover region is attained. The diodes may be obtained at various breakover voltages up to approximately 400 volts. Like the SCR, the switching level is dependent upon the build-up of the breakover current to the threshold point of regeneration. The device then switches to a low saturation voltage level between anode and cathode. This results in a large voltage swing at the time of

Table 2. Other members of the Thyristor cast

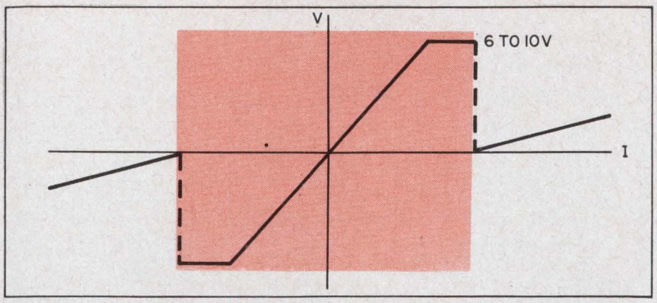
Type	Major application areas	Characteristics
Silicon-controlled switch (SCS) (see Fig. 7)	Sensitive voltage-level detectors. Binary and ring counters. Oscillators. Time-delay generators. Pulse generators. Relay drivers. Alarm systems.	A 4-terminal device. Used in low voltage (<250 V) and low power (<1.0 w) applications. High triggering sensitivity. Fast recovery time.
Gate turn-off switch (see Fig. 8)	High voltage flip-flops. Ring counters. Dc converters. High-speed solenoid devices. High-frequency chopping.	A 3-terminal device. Used in dc switching applications typified by higher voltages than transistors and low trigger-power requirements.
4-layer diode (Shockley diode) unilateral switch; Silicon bilateral switch (SBS) (see Fig. 9)	Thresholding control. SCR/Triac phase control. Pulse sharpening. Voltage clipping.	Two regions: blocking and saturation. Forms part of UJT device. Rapid regeneration results in fast response time.
Light-activated SCR (LASCR)	Optical relay control. SCR triggering. Power switching. Alarm systems. Fiber optic programming. Slaved light-activation.	An SCR with a built-in infrared and visible light-sensing capability. Rated to 200 volts at 440 mA dc.
Triac (see Fig. 10)	Ac phase control. Synchronous switching. Motor-speed control. Lamp dimmers. Automotive systems. Temperature control. Electric heating.	Equivalent to two, inverse-parallel connected SCRs. Immune to voltage transients. May be triggered by ac or dc signals. Maximum peak one-cycle forward current rating is 80 A. Holding current is 50 mA dc (at 25°C). Typical dv/dt rating is 2 V/μs.

switching, and since the regeneration is very rapid, the response time is much faster than with similar devices.

Another generation of pnpn switches has succeeded the four-layer diode. These devices are the silicon-unilateral switch (SUS) and the silicon-bilateral switch (SBS). They display excellent leakage characteristics, a low breakover voltage and a very good temperature coefficient of threshold voltage. The threshold level is approximately 7 volts, with switchdown to approximately 1 volt. Other representative characteristics are as follows:

▪ Power level	350 mW (max)
▪ Forward current	200 mA
▪ Peak reverse voltage	30 volts (SUS)
▪ Operating temperature	−65°C to 150°C
▪ Threshold voltage temperature coefficient	0.05%/°C (max)

These devices show promise for applications where accurate control of thresholding (triggering level) under widely varying ambient temperatures is needed. They are also useful in lower voltage phase-control applications. Some units are available with a third lead for low voltage triggering and resetting, such as the UJT. The SBS voltage-current relationship is shown in Fig. 9.



9. **The silicon bilateral switch (SBS)** is a pnpn symmetrical device exhibiting two regions; blocking (high V, low I) and saturation (low V, high I). These are bordered by the breakover limit (point of changing state).

Focus on LASCR for optical control

The light-activated SCR (LASCR) is another device in the thyristor family. It is a small SCR, typically mounted in a hermetically sealed TO-5 transistor case, with a glass window to permit triggering by means of light as well as by the normal gate signal. Typical devices are available up to 200 volts and are rated to 440 mA dc.

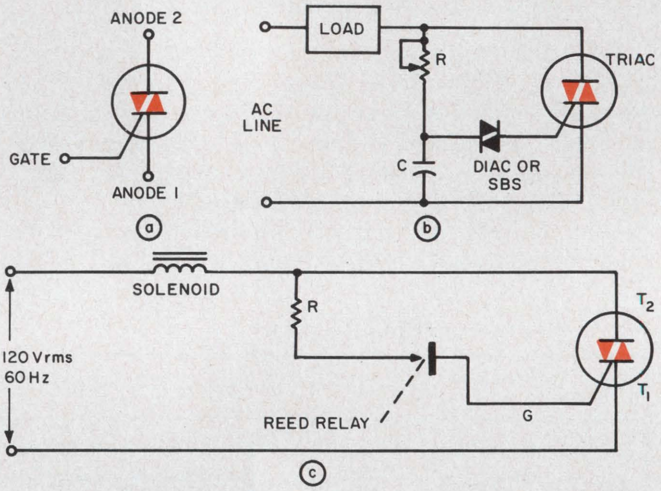
These units were not developed to be highly accurate, threshold light-sensing devices, but they can be used in many applications where the sensing of infrared and visible light spectrums is needed. A typical unit (L8 type) will trigger with an incident irradiation of 0.01 watts/cm^2 from a tungsten lamp producing 750 footcandles of illumination at the LASCR sensing surface.

The sensitivity of the device depends upon the external gate-to-cathode impedance, the junction temperature and ambient conditions. Moreover the anode voltage, anode current and frequency conditions also affect sensitivity.

Turn to the Triac for ac control

This recently developed thyristor provides low-cost control in many light-industrial applications. It is used when ac phase control and zero-voltage switching applications demand lower cost than can be provided with inverse-parallel SCRs. The Triac features bi-directional switching of load current with low power gate control (Fig. 10a). Unlike the SCR, the Triac cannot be damaged by voltage transients of either polarity, since excess voltage or *dv/dt* causes it to conduct, with unwanted power being dissipated into the load.

The Triac may be triggered by ac or dc gate signals, with bi-directional gate voltages for each



10. **The Triac is the equivalent of two SCRs** placed in an inverse-parallel configuration (a). In a simple phase-control application (b), the Triac is triggered by an SBS. As a solenoid driver (c), the Triac is easily controlled by a simple reed relay.

anode polarity. For example, when anode 2 is positive with respect to anode 1, the most sensitive triggering polarity is gate-positive with respect to anode 1. Note that a maximum gate current specification for a typical Triac is 50 mA. This is referred to as first-quadrant positive firing. With the same respective anode polarities, the identical Triac may be triggered with negative polarity on the gate, with a maximum specification of 75 mA. This firing mode is referred to as Quadrant I^-.

Similarly, Quadrant III refers to the opposite anode polarities; III^- being the most sensitive (maximum is 50 mA) and III^+ being the least sensitive of the four cases, with no maximum gate current guaranteed. However, 75 mA in III^+ will trigger the majority of Triacs. The greatest percentage of Triacs will trigger in Quadrant I^+ and I^- with gate currents between 5 and 25 mA. Selected units may also be obtained for guaranteed specific maximum triggering levels.

At present, typical Triacs may be obtained in two voltage levels, namely 200 and 400 volts, with 6 and 10 A rms forward ratings in each voltage group. For resistive loads, single Triacs can switch up to 2.4 kW on a 240-volt rms line. Triacs are capable of being slave-driven in both phase-control and zero-voltage switching circuits. Thus large amounts of power may easily be controlled. The limiting point in power-handling capability is an economic factor that dictates a comparison between the cost of additional Triacs vs the cost of two high-current SCRs connected inverse-parallel (with their associated firing circuits).

The typical *dv/dt* capability is 4 volts per microsecond under the conditions of maximum rated rms current, a case temperature of 75°C, and a peak voltage of 200 applied at an exponential rate. Fig. 10b shows a Triac being triggered by a Diac (or SBS) in a simple phase-control application. In this circuit the Triac is being fired in Quadrants I^+ and III^-. For each half cycle, the capacitor begins to charge up to the line voltage until the threshold of the trigger switch is reached. At this time the capacitor discharges through the gate circuit of the Triac, switching the Triac ON. It remains latched until the end of the half cycle, at which time the process repeats.

Let us now run through the step-by-step design procedure for a representative thyristor circuit. We choose the Triac device because it typifies a second-generation SCR.

Step-by-step design of solenoid driver

Let us assume we have a solenoid that will be energized with the contacts of a reed type switching relay. We will use a Triac in such a way that the contacts of the reed switch open and close the gate circuit of the Triac, thereby directly switching the solenoid ON and OFF.

The parameters of the solenoid coil are $L = 0.1$ H and $R = 1.0$ Ω. Line voltage is 120 volts 60 Hz. Since this is a problem of static switching we first draw the proposed circuit diagram (Fig. 10c).

A quick calculation for the full wave, steady state value of inductive reactance is: $X_L = j\omega L = j2\pi f L = j\ 37.7$ Ω. Since the coil R is 1.0 Ω, the circuit impedance (Z) is approximately j38 Ω. The rms current is

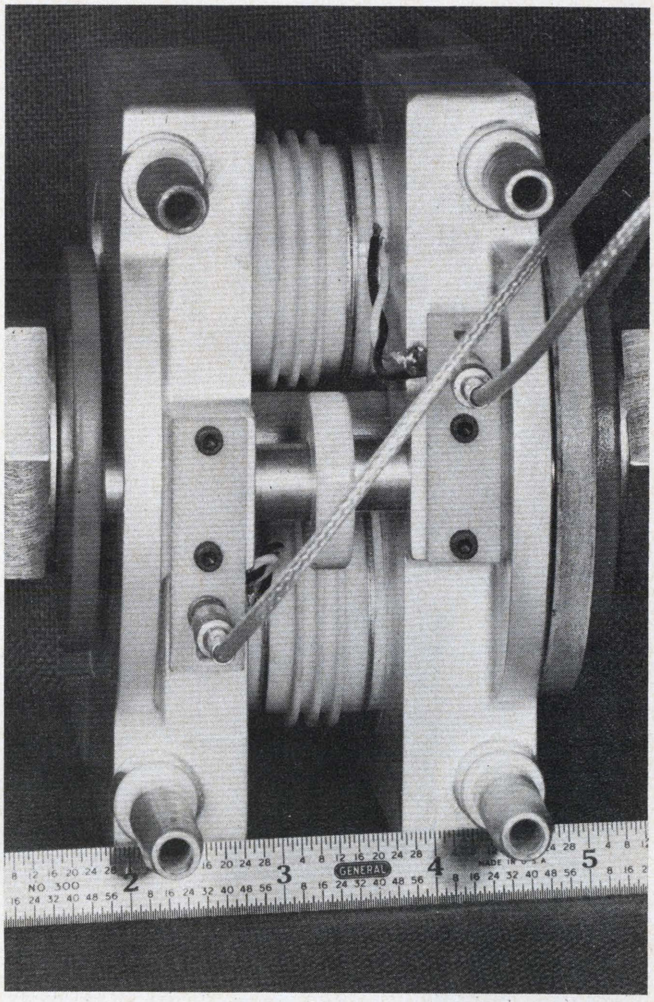
$$I = \frac{120 + j\ 0}{j38} = \frac{120 \angle 0°}{38 \angle 90°} = 3.15 \angle -90° \text{ A} \qquad (2)$$

Thus we find that the rms current in the anode circuit lags the applied voltage by 90°. We also know that we may use a 200-volt, 6-A rms Triac with a reasonably small heat sink, since the ambient requirement is normal room temperature. The Triac will be triggered in the first quadrant positive (I^+) and third quadrant negative (III^-) and the maximum gate trigger current needed for either quadrant is 50 mA to insure reliable triggering of all Triacs used.

We select R to be 150 Ω. This insures that the peak gate current is less than the 3-A rating; that the gate power dissipation is not excessive, and that the gate load line provides high gate current for fast switching. To test our final design, we construct the circuit in the laboratory.

After switching on the circuit by energizing the reed switch, we find that we can't turn it off when the reed switch contacts are opened.

Could we have neglected the commutation *dv/dt* of the Triac?



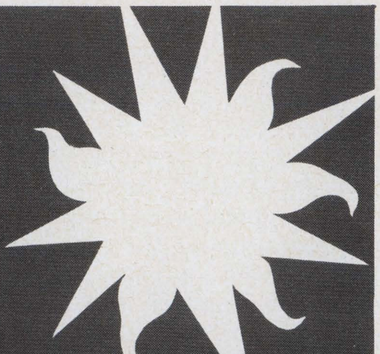
Don't rule out high-power SCRs! This industrial SCR unit is water-cooled, operates directly from 480-volt distribution lines and can switch 1.5 MW loads. It blocks 1800 volts and can handle 1200 A rms.

The answer is yes. When the relay contacts are turned off, the Triac will conduct until the load current becomes zero. At this time the line voltage is at a leading phase angle of approximately 90° and the solenoid coil voltage is zero such that the applied voltage is felt directly across terminals $T_1 - T_2$. Depending upon the distributed capacity of the solenoid, the rate of rise of this applied peak line voltage could very easily be greater than the *dv/dt* capability of the Triac (typical value = 2 volts/μs). A *dv/dt* suppression network may be required.

The circuit is retested with a new Triac and the *dv/dt* is checked oscilloscope for the condition of circuit turn-off. Several trials indicate that *dv/dt* is approximately 5 volts/μs and that the Triac remains ON, even though the gate switch is OFF. A suppression network of 0.1 μF in series with a 100 Ω resistor is placed in parallel with $T_1 - T_2$ and the circuit performs satisfactorily for all Triacs tested. ■ ■

References:

1. General Electric SCR Manual, Third Edition
2. "Di/dt failures in SCR circuits—their cause and prevention," By R. Weschler, ELECTRONIC DESIGN, Aug. 16, 1965, pp 140-145.
3. General Electric Transistor Manual, Seventh Edition



Hoffman provides semiconductors of inherent reliability completely compatible with the manufacturer's needs.

The Hoffman "N" series solar cell, an N/P, shallow diffused, photovoltaic device is optimized for operation in the spectrum of space. These cells are tested and qualified for radiation resistance in accordance with GSFC (NASA) Specification No. 63-106. An electrically conducting grid has been sintered to the active surface to reduce sheet resistance and thus increase conversion efficiency.

These physical characteristics are manufacturing tolerances for all Hoffman Semiconductor Solar Cell Types.

1. OHMIC CONTACT: (A) Electrically continuous and mechanically bonded. (B) Extends to .032 inches from the edge of the cell.
2. GRID LINES: Guaranteed to .100 inch tolerance. Hoffman's photo masking technique assures complete mechanical tolerances.
3. EDGE CHIPS: .010″ wide, .100″ long not to exceed one such chip per top and one per bottom edge of cell.
4. CORNER CHIPS: .030″ on the hypotenuse of the chip.
5. WEIGHT: N120CG .18 Gr. Avg. N220CG .36 Gr. Avg.
   N210CG .18 Gr. Avg. N230CG .54 Gr. Avg.

Typical Electrical Specifications

2 x 2cm cell..................430 mV @ 135 mA
1 x 2cm cell..................430 mV @ 65 mA

Test Temperature: 28°C ± 2°C.

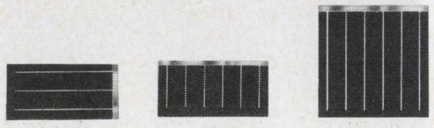
Hoffman solar cells are coated with silicon monoxide to render the active area anti-reflective to obtain maximum use of solar energy. These cells withstand temperature excursions from −196°C to +200°C.

STANDARD ENVIRONMENTAL TEST: Each lot of cells is immersed in boiling DI water for periods to one hour followed by a live steam test for a comparable period.

a little...

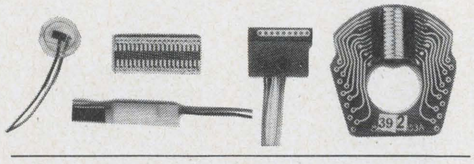
All of these advantages insure complete compatibility of products for industrial uses.

or a lot



N210CG N120CG N220CG

Hoffman solid state photo-sensing devices are now being used for measuring, cloth cutting, sequence counting, liquid level gauging, data processing and other manufacturing functions requiring absolute accuracy.



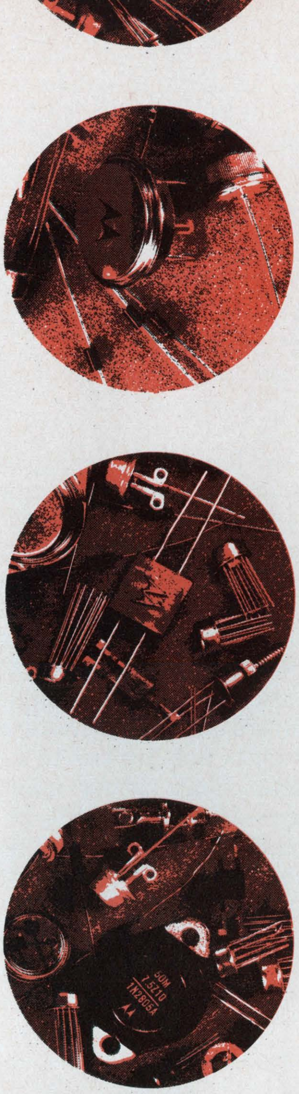
TYPICAL INDUSTRIAL COMPATIBLE PRODUCTS: A shaft encoder is currently being produced to mechanical tolerances of ±.0005″ and electrical parameters matched within 2%. Data processing readouts are being produced with an I_d of 3 μA max. at 1.5 volts reverse bias. Other sensing elements are being made with active areas as small as .002″ x .023″ and as large as 2.5″ x 1.0″.

For additional information regarding these products write: Hoffman Electronics, Dept. A, El Monte, Calif.

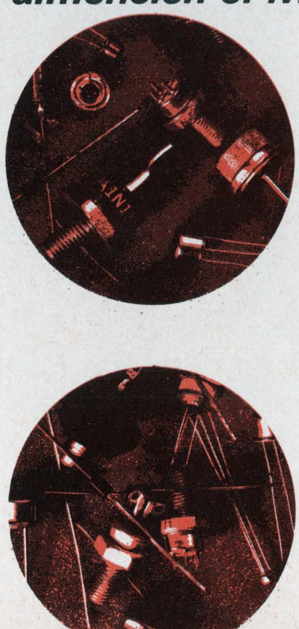
Hoffman

SEMICONDUCTORS

ON READER-SERVICE CARD CIRCLE 49



the full dimension of Motorola semiconductors, with instant capability



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ON READER-SERVICE CARD CIRCLE 50

In choosing diodes, don't settle for second best. Nearly all are optimized for a specific characteristic, so use this application guide to pick a winner every time.

Few engineers realize that each diode type, including general-purpose, has been tailored to meet the needs of a specific class of applications. This "application-fitness," achieved by V-I characteristic, electrical parameter control, package, or wafer construction, is the governing criterion for choosing the best diode for the job.

In line with this we have drafted a table of the major diode categories to help with selection.* It contains information on key application areas, critical design parameters and salient characteristics for the most popular diode types.

Although a diode may be used with some measure of success in an application other than the one it has been optimized for, chances are that one or more of its parameters will be compromised and efficiency, life, or some other vital characteristic shortchanged. By contrasting the characteristics of different types, the table should give a clue to their suitability for any application.

To supplement this contrast and selection information, here is a breakdown of the maximum ratings and electrical characteristics common to nearly all diode types. This examination includes the definition and procedures used in calling out these diode parameters.

Maximum ratings

- $V_{RM(wkg)}$—Reverse voltage rating; the rated repetitive peak working voltage of a device is usually specified below the avalanche breakdown voltage to provide the safety factor required in the application for which it is designed. Higher voltage devices must sometimes be derated as a function of operating temperature due to forward and reverse power dissipation and increase leakage at elevated junction temperatures.
- I_o—Average rectified forward current; this rating defines the current rating of diodes designed for use primarily in rectifying applications. It is determined by the manufacturing process, wafer size, and package design, and is rated as a function of operating temperature.
- I_{FM}—Peak forward current; this rating defines the recurrent peak forward current which may be seen by the diode. An example of a severe case is operation of the diode in a capacitive-input filter circuit. I_{FM} is usually derated as a function of temperatures.
- $I_{FM(surge)}$—Surge current; this is the non-repetitive current rating. It is usually specified as the current which a rectifier may be subjected to for a given number of times (usually 100) without failure, and as such, is a fault-condition rating. Some manufacturers provide a more conservative surge rating which is not limited to a given number of occurrences. That rating may be used to determine the safe inrush current in capacitive-filter type applications. It normally assumes that the device is allowed to return to thermal equilibrium prior to re-application of the surge.
- P—Power dissipation; the maximum power dissipation capabilities of the device under the conditions defined on the data sheet.

Electrical characteristics

- V_{BR}—Reverse breakdown voltage; this is specified as a minimum characteristic of the diode, usually at a low leakage current and at a specific temperature.
- I_R—Static reverse current; the reverse leakage current under specified reverse bias and temperature.
- V_F—Static forward voltage; the forward voltage drop at a stated forward current and temperature. Usually measured with pulse techniques to overcome junction heating errors. ■ ■

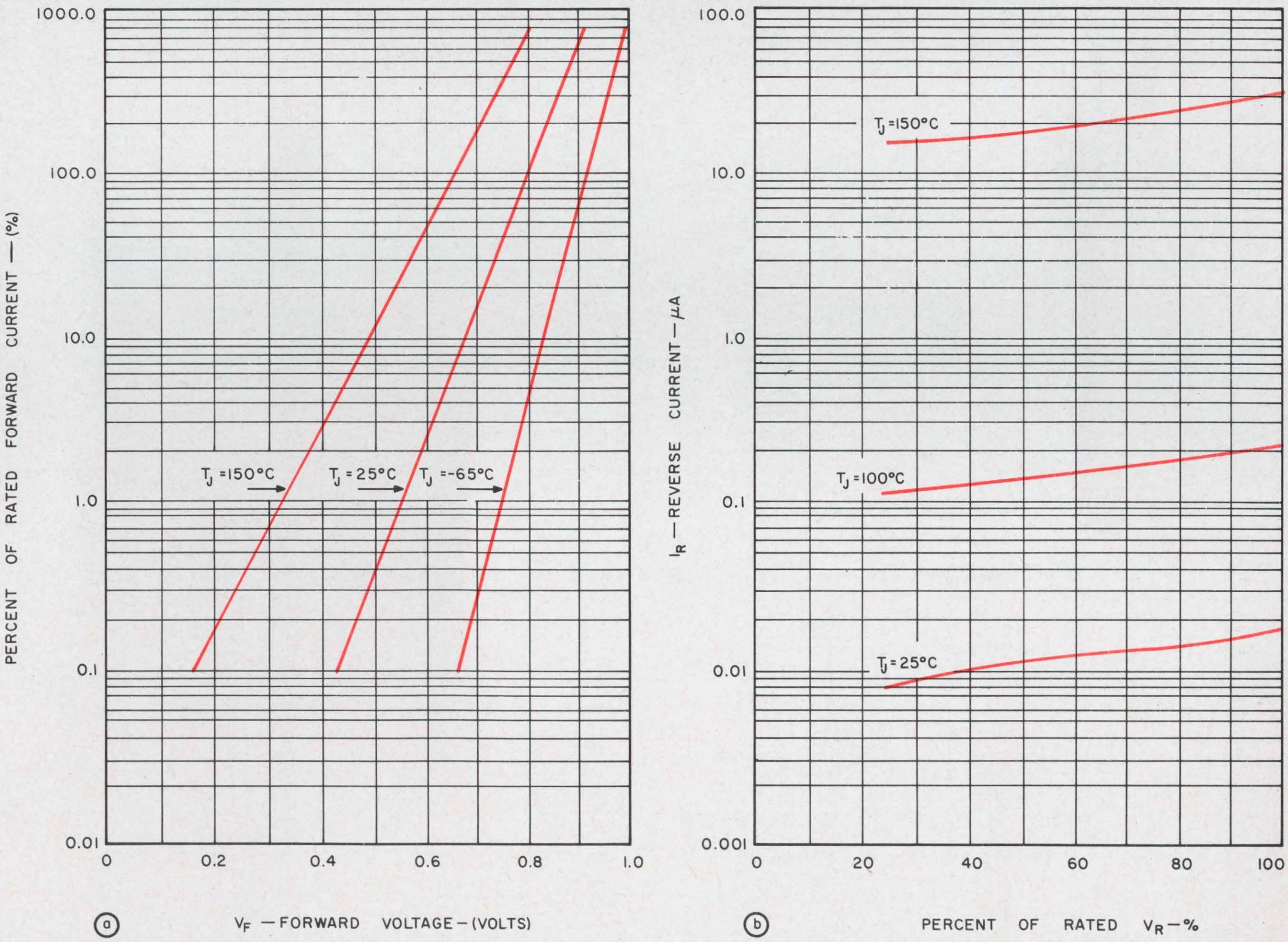
Pinpointing diode parameters. Author McKenna works out the design of a diode circuit. He developed the applications-oriented guide to selecting diodes and rectifiers so as to save time and optimize circuit performance.

*This table is tailored to the "who-makes-what" chart in the diode section of this Directory (pp. 164). The table does not include thyristors, which are covered in a separate article (see p. 144).

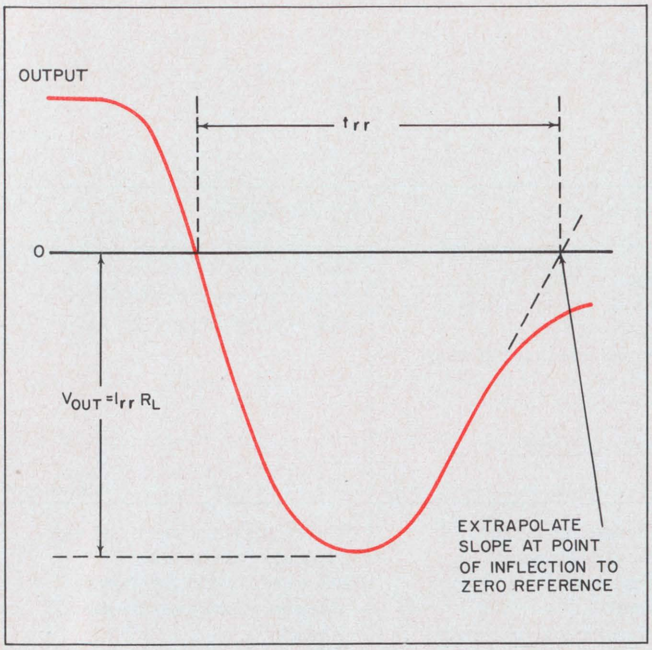
Robert G. McKenna, Senior Engineer, Texas Instruments Inc., Semiconductor Division, Dallas, Tex.

Applications - Oriented Parameter Study

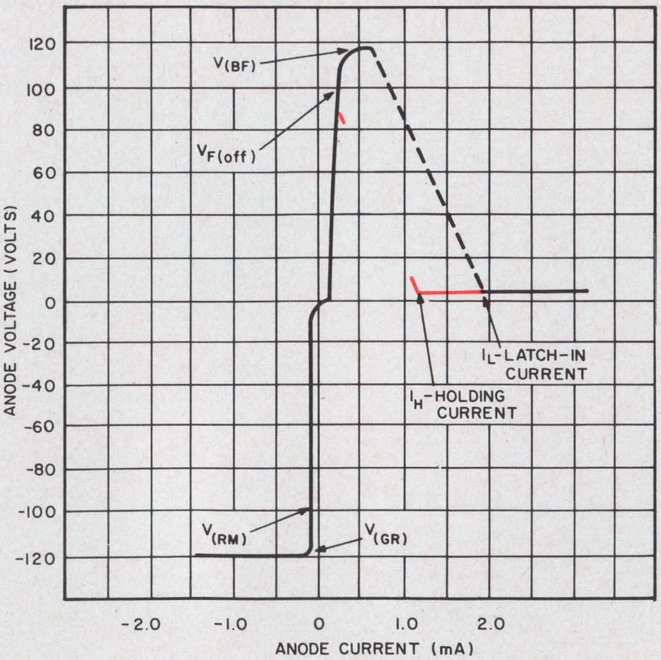
Device type	Major applications	Governing parameters	Key characteristics
General purpose diodes (Fig. 1)	Low-power rectification with capacitive inputs (voltage-doublers, triplers). Low-power rectification with inductive inputs (L-filters, high-L transformers, magnetic amplifiers). Clamping, decoupling, biasing circuits, dc relay networks.	$I_{FM\,(surge)}$ for inrush current. I_{FM} for peak, recurrent operating current. Peak transient reverse voltage rating. Forward transconductance.	Devices optimized for high-forward transconductance. Application typified by medium voltage levels (1 - 600 volts).
Rectifiers (Fig.2)	Power rectification (includes conventional rectification, high-voltage power supplies, photomultiplier tube biasing, radar and infrared systems).	Average forward current rating. Peak reverse voltage rating. Power dissipation. Surge current. Peak transient reverse voltage rating. Thermal resistance. Transient thermal impedance.	Devices are high-power diodes especially packaged for rectifier service. Units are optimized for high forward-conductance and minimum thermal impedance.
Fast-recovery rectifiers	High-frequency converters, multiphase rectifiers and high-speed power switching.	Reverse recovery time. Reverse recovery current. Total device capacitance.	Typified by recovery times of the order of 100 ns.



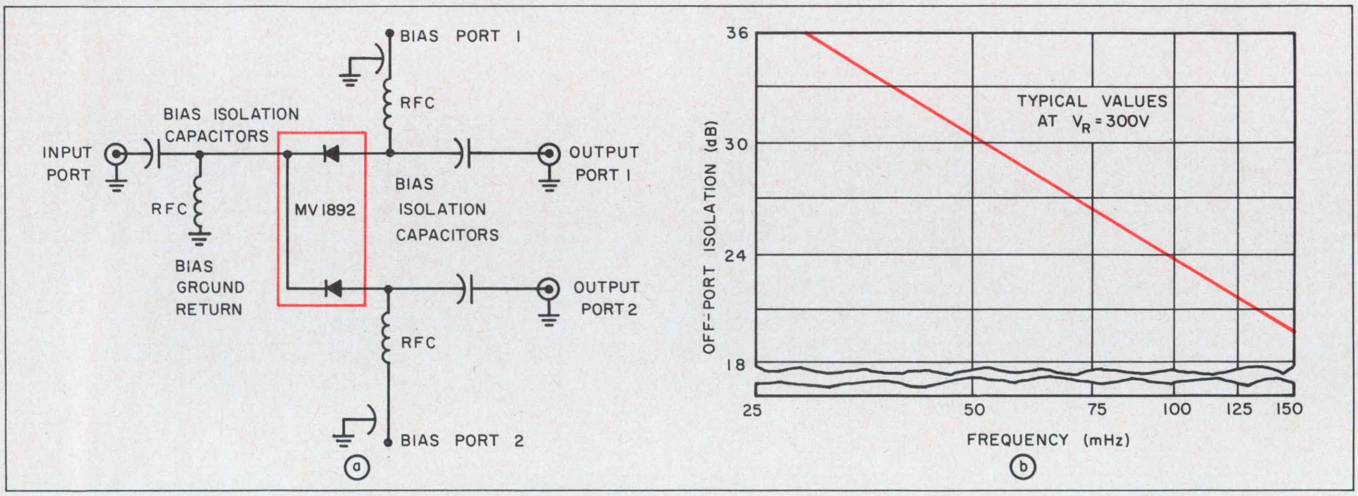
1. **Forward-biased diode characteristics** for a general-purpose type show how temperature affects the V-I relationship (a). The reverse-biased characteristics demonstrate that junction temperature has a greater influence on the reverse current than that due to the applied reverse voltage (b).



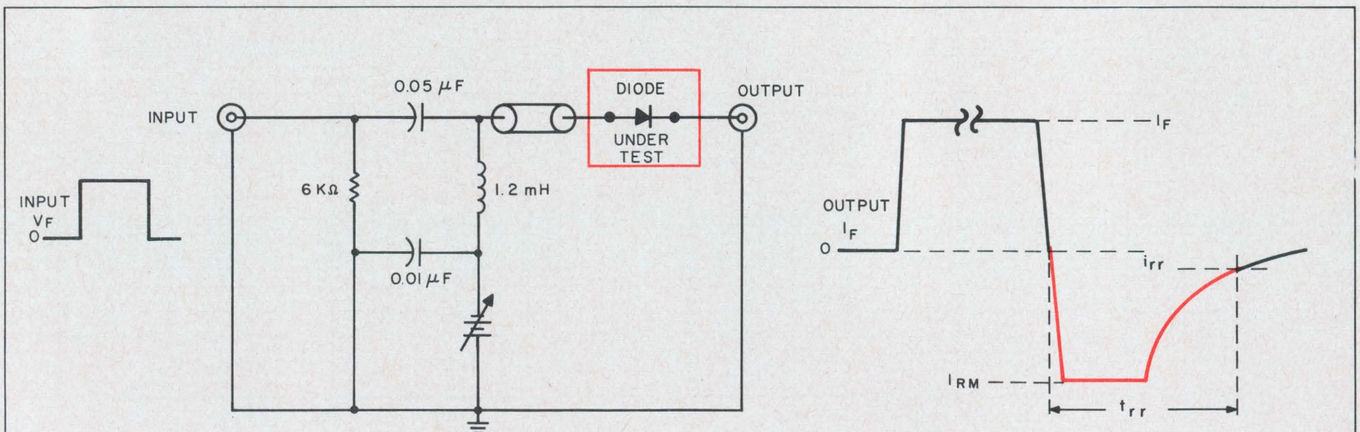
2. **Reverse recovery time** is a critical parameter in rectifiers. Denoted by t_{rr}, its measurement requires that a slope extrapolation be made.



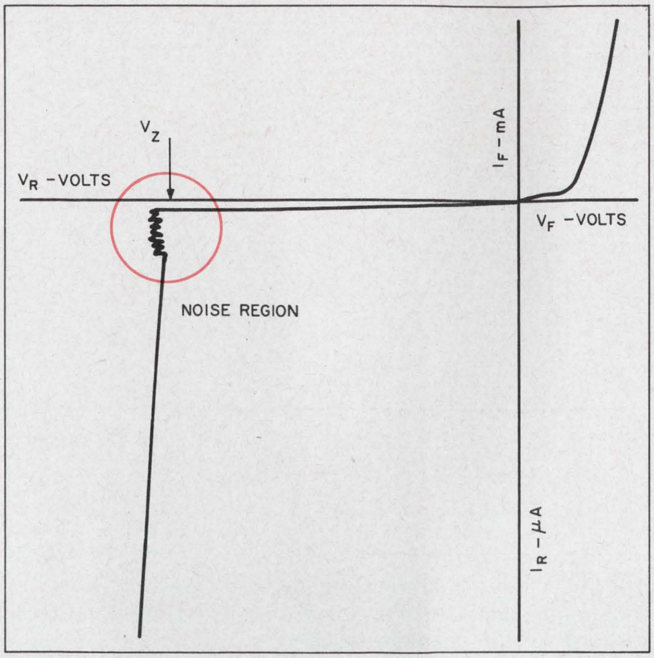
5. **Current vs voltage relationship** for a reverse-blocking diode thyristor shows how a blocking characteristic is achieved in this device.



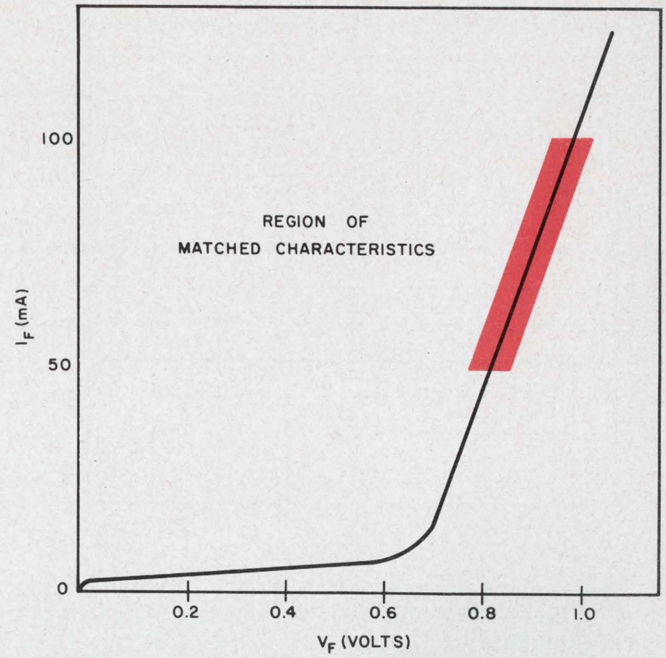
3. **RF diodes** are often used to switch high-frequency signals (a). Plot of off-port isolation vs frequency (b) shows that the series resistance of the diode at 1 kHz is within 15% of its value at 50 MHz. This magnitude is usually less than 1.0 Ω. Note that V_R refers to the reverse voltage.



4. **A critical parameter** for computer and high-speed diodes is the reverse recovery time, t_{rr}. Measured by the test circuit (a), it is calculated from observations of the output-current waveform (b).



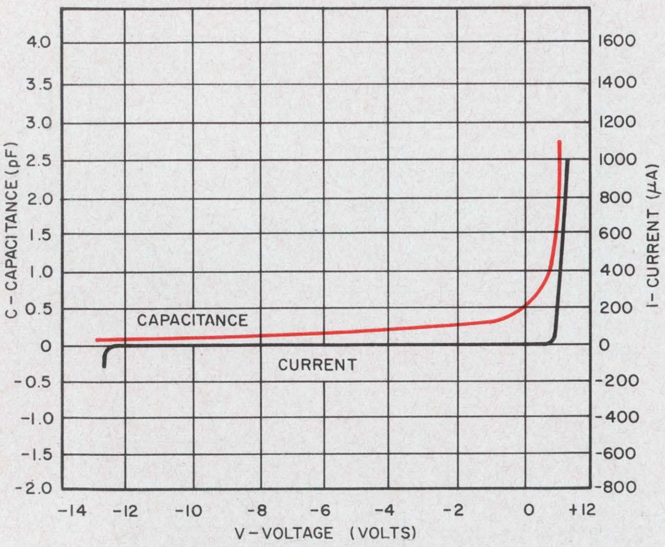
6. **Noise diode characteristic** shows the useful operating region (at the point of avalanche breakdown) for white noise generation.



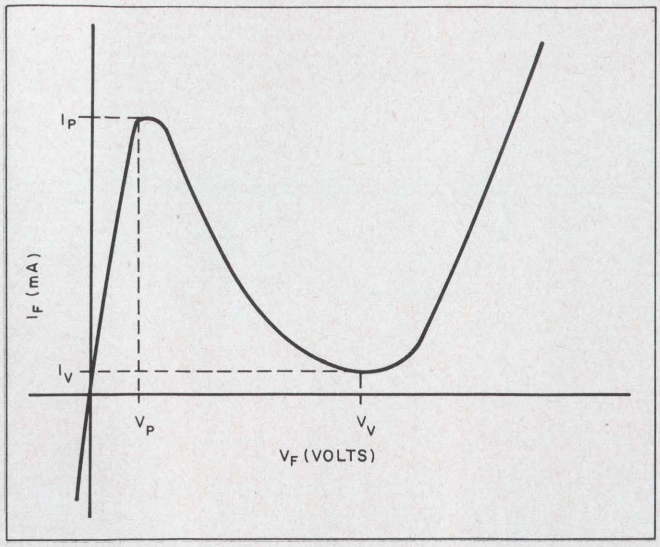
7. **Forward voltage drop** is the criterion for establishing the region of matched characteristics for matched-diodes. Current level and temperature are the other key factors.

Applications - Oriented Parameter Study (continued)

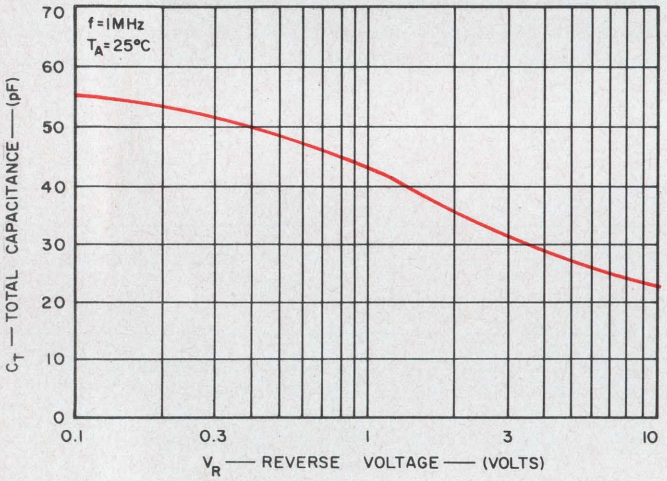
Device type	Major applications	Governing parameters	Key characteristics
RF diodes (Fig. 3)	RF detection circuits. Small-signal, low-voltage diode applications.	Reverse recovery time.	Units have small-area junctions for minimum capacitance.
Computer and high-speed diodes (Fig. 4)	Diode gates, diode-capacitor storage, low-power diode switching and other "speed" applications.	Reverse-recovery time (<300 ns). Low junction-capacitance (<4 pF at zero volts).	Typified by reverse voltage ratings <100 volts and forward voltage drops of 1 volt (approx.) at 10 - 50 mA. Note that forward transconductance, surge current ratings and reverse voltage ratings are relatively poor here.
Reverse-blocking diode thyristors and 4-layer diodes (Fig.5)	Low-power circuits (bistable circuits, switching circuits, ring counters and SCR triggering). High-power circuits (power switching, squib firing, pulse-forming, tone generators, proportional power control).	Working blocking voltage. Anode breakover voltage. Average forward current. Peak recurrent forward current. Power rating. Conducting voltage drop. Holding current. Latching current. Allowable rate of dv/dt.	Blocking characteristic exists until a breakover value is reached; then devices switch through a negative-resistance region into a low-impedance conducting state.
Noise diodes (Fig. 6)	White noise generation. Random noise source in ECM jamming equipment. Random function generator (vibration table drives).	Available noise level. Bias voltage requirements.	White noise is generated at the point of avalanche breakdown.
Matched diodes (Fig. 7)	Critical biasing circuits. Differential circuits. Logarithmic attenuators. Signal limiters.	Forward voltage drop.	Matched at several different current levels and (if required) at various temperatures.
Microwave diodes (Fig. 8)	Parametric amplifiers. Parametric limiters. Microwave switches. Phase-shifters. Harmonic generators. Sub-harmonic oscillators.	Total capacitance, C_T. Cutoff frequency, f_{co}. Figure of merit, Q. Noise figure, NF. Package inductance. Power and voltage ratings.	Optimized for use at frequencies above 1 GHz.



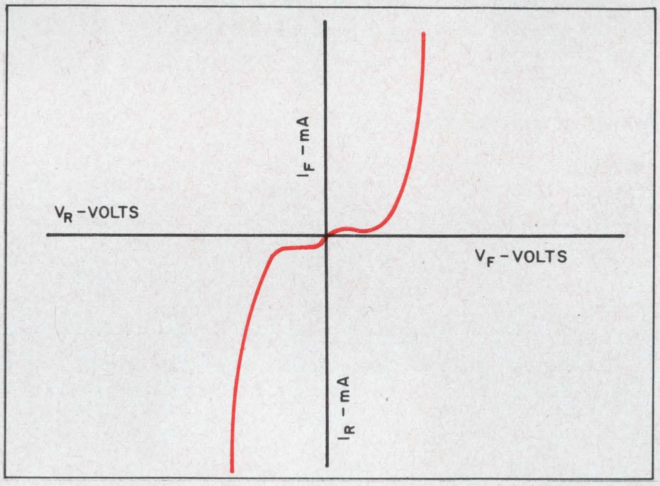
8. **Junction capacitance,** a key design parameter, and diode current are non-linear functions of voltage in the microwave diode.



10. **The various operating regions** and threshold levels of the tunnel diode are depicted in this forward current-forward voltage characteristic.



9. **In varactor diodes,** the total capacitance C_T is inversely related to reverse voltage V_R. Two to five times the nominal capacitance is the range available.



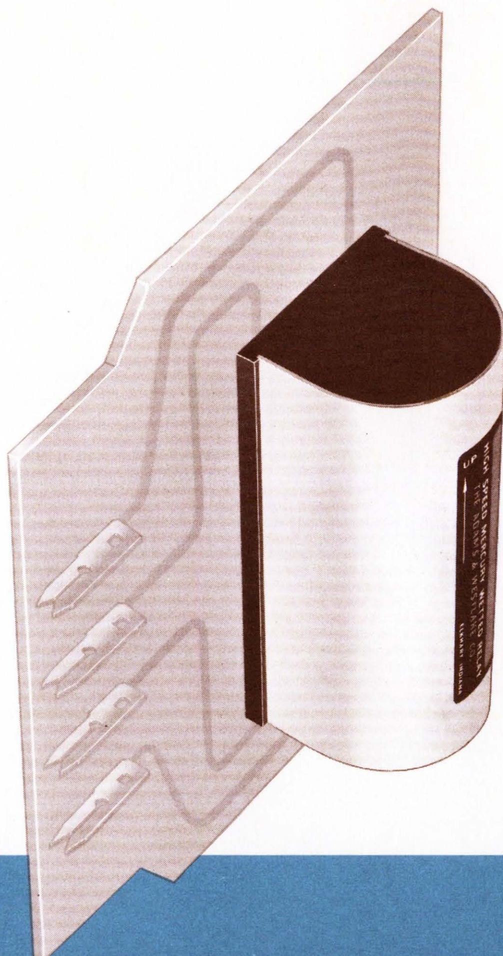
11. **Symmetrical characteristics** in varistors are obtained when two identical diode junctions are placed in an inverse-parallel configuration.

Applications - Oriented Parameter Study (continued)

Device type	Major applications	Governing parameters	Key characteristics
Varactor diodes (includes variable reactance types) (Fig. 9)	Automatic frequency-control. Voltage-variable tuning circuits. Harmonic generation. FM modulators.	Normal peak reverse voltage. Power dissipation. Total device capacitance, C_T. Capacitance ratio, C_{V1}/C_{V2}. Figure of merit, Q.	Optimized for their voltage - variable junction capacitance. Peak reverse-voltage ratings range between 15 and 100 volts. Device capacitance is between 2 and 50 pF and capacitance ratio range is 2.0 to 5.0.
Tunnel diodes (Fig. 10)	Memory units. Logic circuits. Oscillators. Amplifiers.	Peak current, I_P. Valley current, I_V. Current ratio, I_V/I_P. Valley voltage, V_V. Delta voltage, $V_V - V_P$.	Provide a negative-resistance characteristic in the forward-bias region below the stand-off voltage.
Varistors (Fig. 11)	Signal-limiters. Audio-clipper circuits. Noise and transient suppression. Meter protection.	Non-linear impedance vs voltage characteristic.	Usually two diode junctions connected in an inverse-parallel configuration.

Adlake
SINCE 1857

BULLETIN AW66



high speed mercury wetted relays

Intended for printed circuit board mounting, relay types AWNA, AWPB, AWCA, AWCL, and AWCS introduce a new concept in relay design. Created to serve as an alternate for currently available Single and Two Switch mercury wetted contact relays, this feature, plus the inherent superior characteristics of Adlake mercury wetted contact relays, make these devices sought after by circuit and equipment designers.

Available in either neutral, form D, bridging type or sensitive, form C, non-bridging type, the devices represent another group of Adlake quality mercury wetted contact relays. Single and dual windings-bifilar and/or concentric wound are available for all relay types.

A few of the advantages of mercury wetted contact relays, such as freedom from contact bounce, high operating speeds (up to 200 times per second), long life and adequate current ratings add to the attractiveness of these new devices. See Bulletin No. 1263AW—193A20M for explicit data on current ratings. For contact protection network data see back cover of this bulletin.

Simplicity of design has eliminated costly and weight-adding parts. Gone are base plates fabricated from insulating materials that can be responsible for unexplained failures. Solder joints are held to a minimum, as additional insurance against relay malfunction.

Covers are fabricated in a simple form from soft iron. A finish is provided to insure the esthetic quality of the relay throughout the device's life. The cover serves to protect the switch element and coil. Magnetic interaction between adjacent relays is minimized through the use of moderate gauge metal. (See interaction chart on reverse side for detailed dimensions).

Relays are potted with either silica filled epoxy or polyurethane compounds. No wax is used, which eliminates the possibility of wax contamination under high operating temperatures. If desired, the relays can be supplied less the cover—available upon special order. (Note: For applications demanding excellent chemical resistance of its components, we recommend the epoxy filled relay).

The following chart describes the relays in this series in general terms and identifies them with the presently available single switch mercury wetted contact relays.

Catalog Type	Contact Form	Related to Adlake Catalog Type
AWNA-1600	Neutral, Form D	MW-1600
*AWPB-16000	Polarized, Form D	MWP-16000
*AWCA-16000	Sensitive, Form C	MWS7 & MWSA-16000
*AWCL-16000	Sensitive, Form C	MWSL-16000
AWCS-26000	Sensitive, Form C	(None)
AWNA-2600	Neutral, Form D	(None)

*Available as single-side-stable; bi-stable or chopper.

THE ADAMS & WESTLAKE COMPANY • ELKHART, INDIANA 46514 • U.S.A.

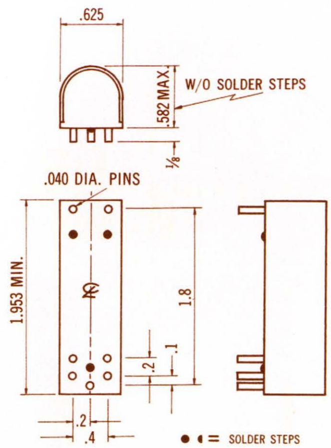
Phone: (219) CO 4-1141

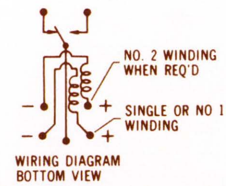
SINCE 1857

form C *sensitive mercury wetted contact relays*

type AWCA - 16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCA-16011	2,400	7,700	7.8	1.3
AWCA-16021	4,000	15,000	4.0	0.67
AWCA-16041	675	5,200	11.6	1.9
AWCA-16121	115	2,000	30.0	5.0
AWCA-16261	450	4,650	12.9	2.1
AWCA-16351	940	5,800	10.4	1.7
AWCA-16511	65	1,575	38.1	6.3
AWCA-16541	1,250	6,400	12.1	1.6
AWCA-16571	1,950	7,375	8.2	1.3
AWCA-16581	1,425	7,125	8.4	1.4

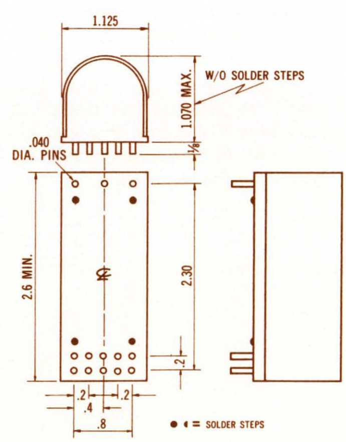


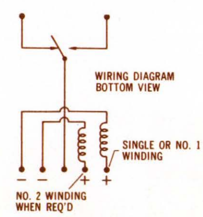


To prevent the accidental bridging of terminal pins with accumulated solder, solder steps or standoffs are used. When included in the relay design the front to back dimension (projection) is increased by 1/32". Note: This feature is optional and will be included upon request, at no increase in cost.

type AWCL - 16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCL-16011	2,500	18,800	1.43	0.17
AWCL-16021	4,000	23,400	2.0	1.0
AWCL-16091	7,000	31,675	0.87	0.14
AWCL-16121	130	4,900	5.58	0.96
AWCL-16191	40	2,800	12.2	3.8
AWCL-16241	25,000	53,000	0.52	0.09
AWCL-16261	500	9,450	2.89	0.50
AWCL-16421	350	7,660	3.56	0.61
AWCL-16431	1,000	12,350	2.21	0.38
AWCL-16721	11,000	38,050	0.72	0.12

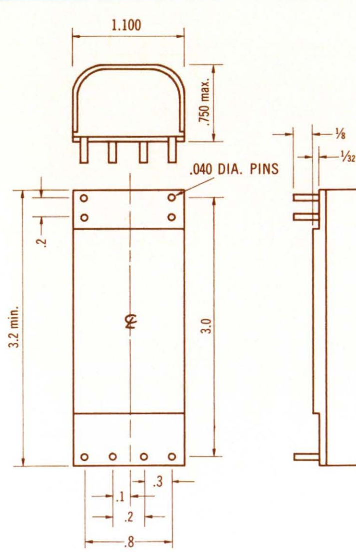


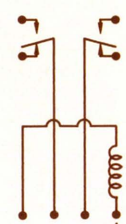


To prevent the accidental bridging of terminal pins with accumulated solder, solder steps or standoffs are used. When included in the relay design the front to back dimension (projection) is increased by 1/32". Note: This feature is optional and will be included upon request, at no increase in cost.

type AWCS-26000 (two switch)

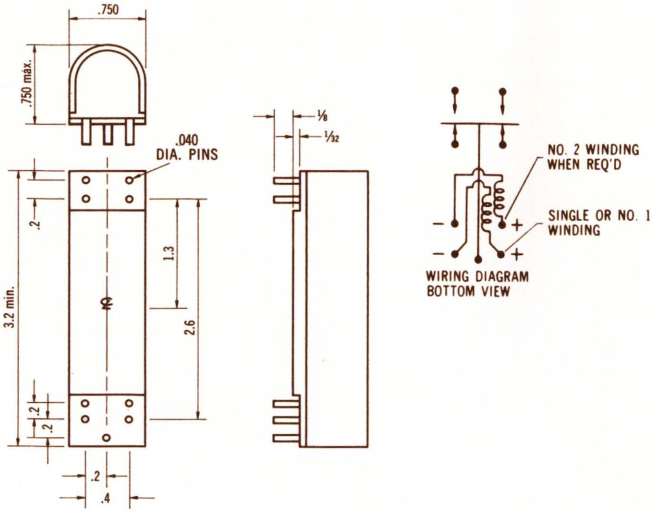
catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWCS-26021	540	7,800	11.5	1.3
AWCS-26071	2,350	14,000	6.4	0.7
AWCS-26121	140	3,500	25.7	2.8
AWCS-26451	40	2,000	45.0	5.0
AWCS-26541	1,250	10,000	9.0	1.0



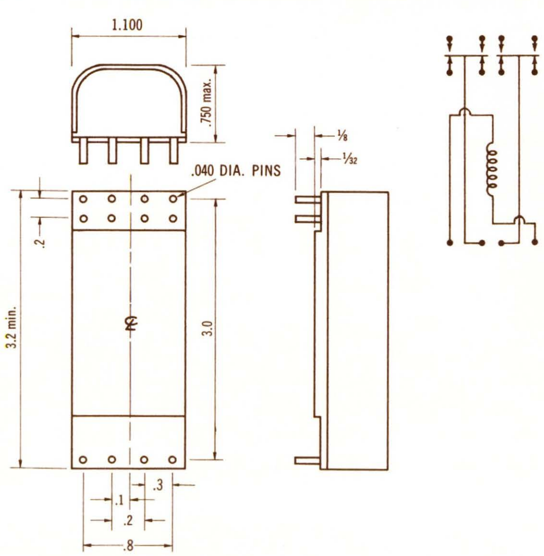


form D neutral mercury wetted contact relays

Adlake SINCE 1857



Relay types AWNA and AWPB are identical in size and configuration. Each is a single switch-Form D-neutral (bridging) type relay, and is available with either single or dual wound coil. Relay type AWPB is polarized by means of permanent magnets and is available in Single-Side-Stable, Bi-Stable or Chopper form.



type AWNA-1600 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWNA-1601	2,000	10,550	18.0	8.0
AWNA-1604	750	7,825	24.3	10.7
AWNA-1605	50	2,000	95.0	42.0
AWNA-1613	200	3,800	50.0	22.1
AWNA-1615	1,500	9,580	19.9	8.8
AWNA-1626	450	5,675	33.5	14.8
AWNA-1648	20	1,225	155.0	68.6
AWNA-1651	70	2,250	84.5	37.3
AWNA-1653	4,300	14,200	13.4	5.9
AWNA-1654	1,100	8,350	22.8	10.0

type AWPB-16000 (single switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWPB-16011	2,000	10,650	6.7	0.5
AWPB-16041	750	7,825	8.9	0.7
AWPB-16051	50	2,000	35.0	2.9
AWPB-16131	200	3,800	18.4	1.4
AWPB-16151	1,500	9,580	7.3	0.6
AWPB-16261	450	5,675	12.3	0.7
AWPB-16481	20	1,225	57.2	4.5
AWPB-16511	70	2,250	31.0	2.4
AWPB-16531	4,300	14,200	4.8	0.4
AWPB-16541	1,100	8,350	8.4	0.6

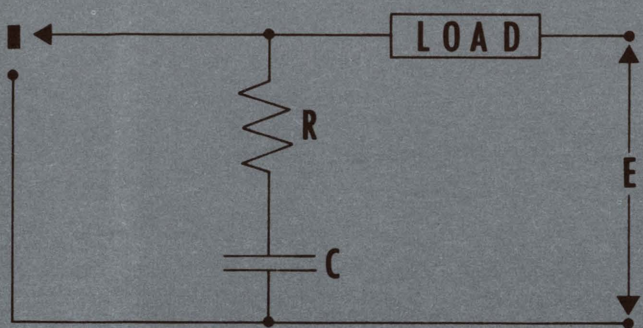
type AWNA-2600 (two switch)

catalog no.	coil		coil current milliamperes	
	resistance ohms	turns	must operate	must release
AWNA-2602	540	7,800	27.5	12.0
AWNA-2607	2,350	14,000	15.7	6.9
AWNA-2612	140	3,500	62.8	27.7
AWNA-2645	40	2,000	110.0	48.5
AWNA-2654	1,250	10,000	22.0	9.7

high speed mercury wetted relays

contact protection

Except for specific instances of light loads, the relay contacts must be protected by a network composed of a resistor and a capacitor in series as shown in the following diagram. This protection should be physically located as close as possible to the relay terminals.



Contact Protection Network to be used with ADLAKE Neutral Type MW and Sensitive Type MWS Relays

The preferred values of R and C, except for the conditions stated subsequently, can be evaluated from the following equations:

$$(1)\quad C = \frac{I^2}{10}\ \text{microfarads}$$

$$(2)\quad R = \frac{E}{10\,I^{x}}\ \text{ohms}$$

$$X = 1 + \frac{50}{E}$$

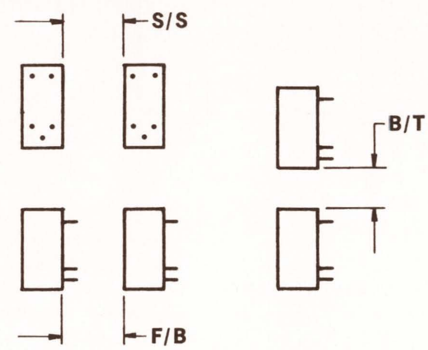
where I = load current in amperes immediately prior to opening of contacts.
E = source voltage immediately prior to closing of contacts.

A	B	C	D
Less than 50	Less than 2.5 amperes	Use calculated value	May be omitted
Up to 70	All other conditions	Use calculated value	3 X calculated value permissible
@ 100 v.	All other conditions	Use calculated value	Within 50% of calculated value
@ 150 v.	All other conditions	Use calculated value	Within 10% of calculated value
Above 150 v.	All other conditions	Use calculated value	Follow calculated value closely

Note: For any voltages more than 50, the value of R must not be less than 0.5 ohm.

magnetic interaction data

Magnetic interaction is described as the unauthorized operation or variation in characteristics of a relay adjacent to another relay, when either device is energized or is being removed from the equipment. The following dimensions must be observed to insure that interaction between relays is eliminated.

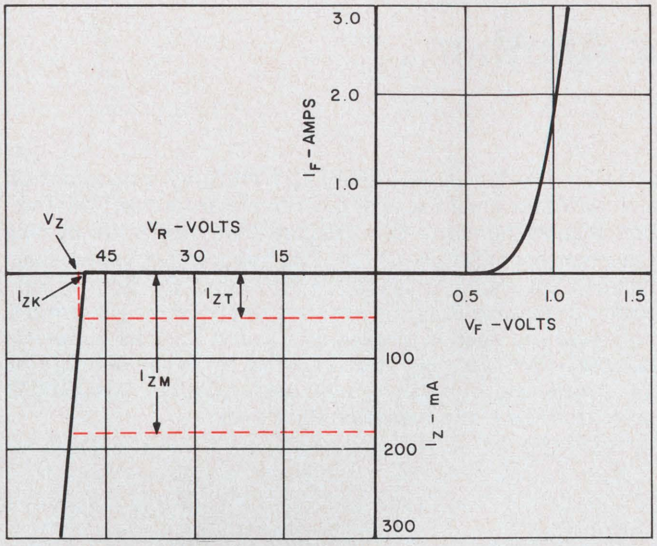


key

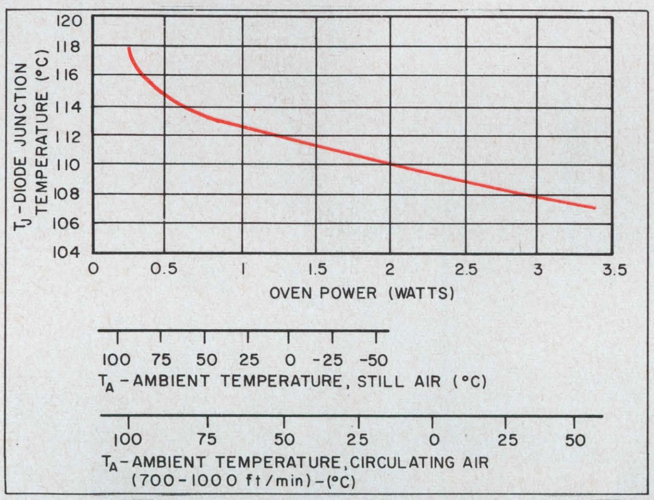
F/B = Front to Back Clearance
S/S = Side to Side Clearance
B/T = Bottom to Top Clearance

Catalog Type	F/B	S/S	B/T
AWNA	0″	0″	¼″
AWPB	0″	0″	⅜″
AWCA	0″	0″	¼″
AWCL	0″	0″	¼″
AWCS-26000	0″	0″	¼″
AWNA-2600	0″	0″	¼″

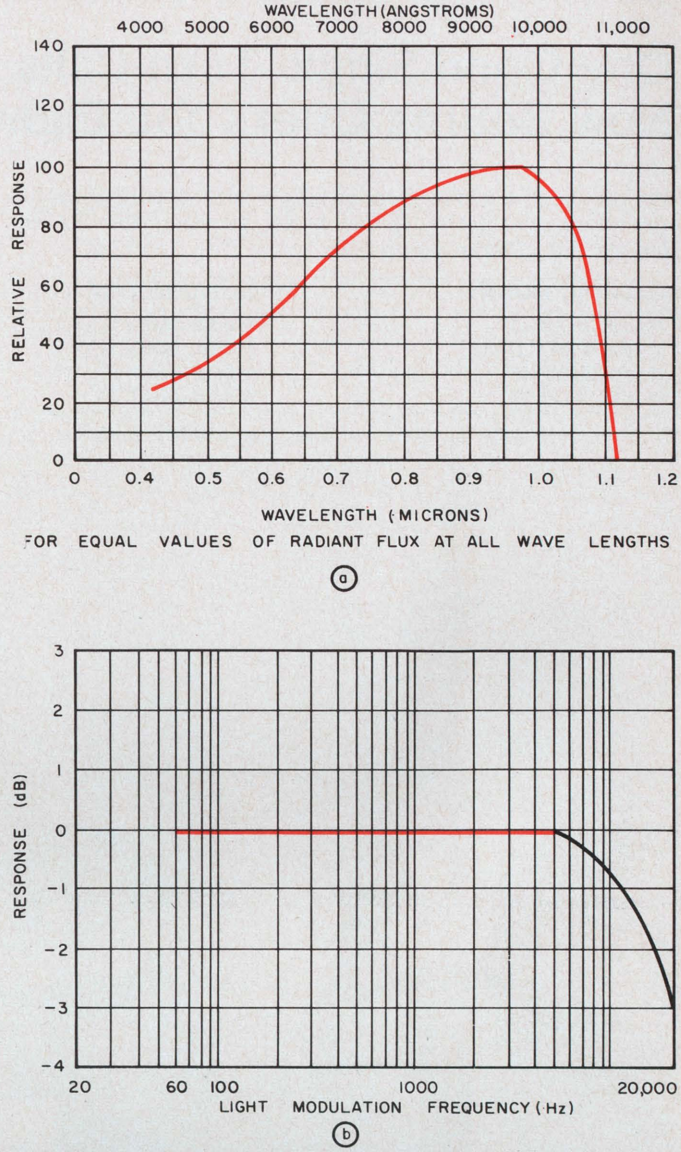
Litho in U.S.A. 20M—4-66



12. **Normal operating region** in a typical zener diode characteristic is between $\mathbf{I_{ZK}}$ and $\mathbf{I_{ZM}}$. The normal quiescent bias point is at $\mathbf{I_{ZT}}$.



13. **Wide-range ambient temperature excursions** ($\mathbf{\Delta T_A}$) have little influence on the junction temperature (T_j) and oven power (W) in this compensated reference diode.



14. **Photo diodes** exhibit a variable response (impedance) over a portion of the wavelength spectrum (a). Note, however, that their frequency response (b) is fairly flat.

Applications - Oriented Parameter Study (continued)

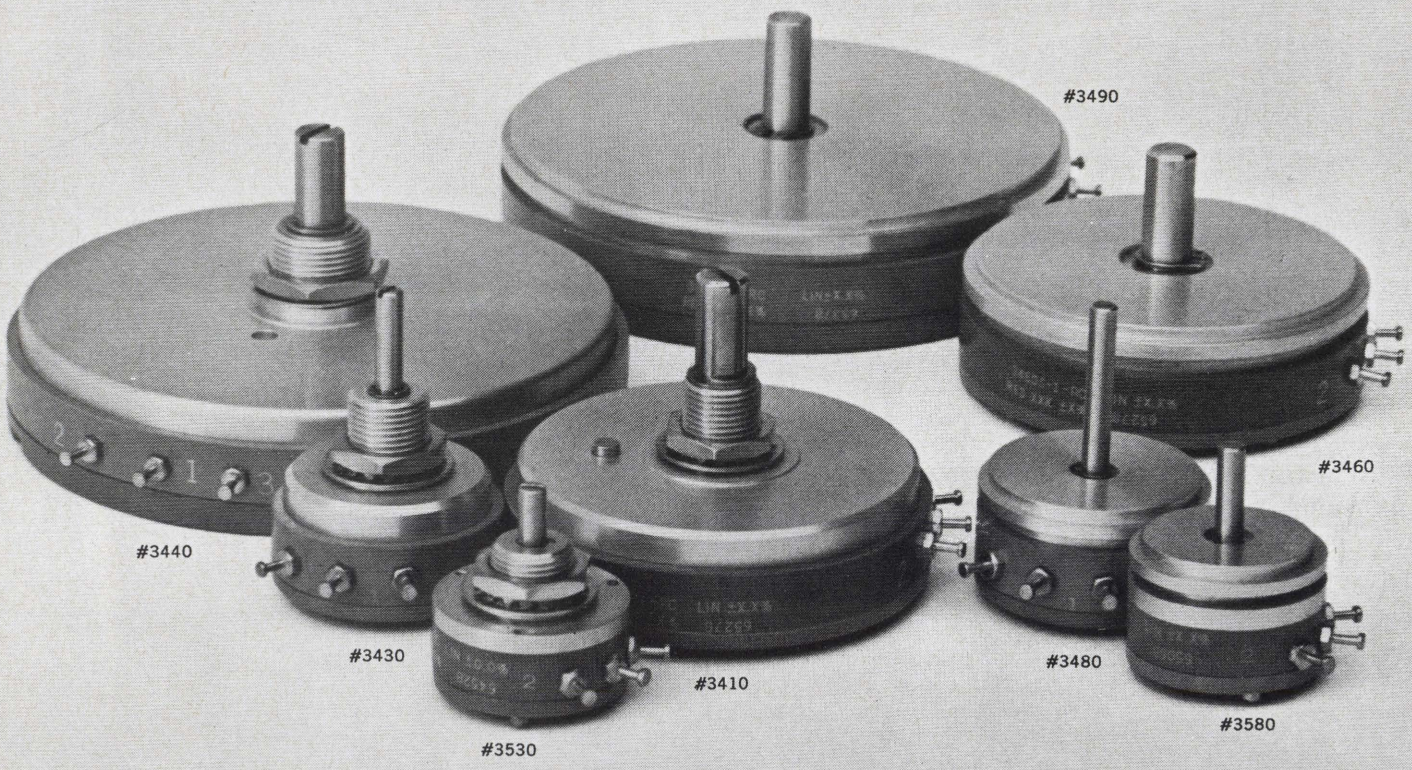
Device type	Major applications	Governing parameters	Key characteristics
Zener diodes (Fig. 12)	Reference elements. Shunt-voltage regulators. Voltage-reference elements. Biasing networks. Interstage coupling. Suppression circuits. Voltage clipping.	Zener breakdown voltages, V_Z. Temperature-coefficient of zener voltage, $\Delta V_Z/\Delta T_A$. Dynamic Zener impedance, Z_Z. Power rating, P_D.	Operate in avalanche-breakdown region. Voltage ranges between 3 and 250 volts; power rating is from 150 mW to 50 W.
Low temperature-coefficient reference diodes (Fig. 13)	Voltage reference elements. Standard cell replacements. Critical voltage regulators.	Zener voltage, V_Z. Temperature coefficient, $\Delta V_Z/\Delta T_A$. Power requirements.	Usually a series combination of selected low-voltage Zener diodes and forward-biased diodes. Fixed bias current operation is recommended.
Photo diodes (Fig. 14)	Character recognition. Card/tape readouts. Photoswitching. Proportional control systems. Difference amplifiers. Latching networks. Light-sensing. Photo-modulation.	Light current, I_L. Dark current, I_D. Total capacitance, C_T. Rise time and fall time. Spectral response.	Output impedance is usually inversely proportional to radiated light power levels.

One Good Single-Turn Calls for Another... Now Bourns Offers You Eight!

Whenever it's a question of single-turn precision potentiometers, you get more and better answers from Bourns. Here's the all-star lineup:

BUSHING MOUNT	SERVO MOUNT
Model 3530, 7/8"	Model 3580, 7/8"
Model 3430, 1 1/16"	Model 3480, 1 1/16"
Model 3410, 2"	Model 3460, 2"
Model 3440, 3"	Model 3490, 3"

In this complete single-turn line, the quality matches the quantity. Exclusive SILVERWELD® multi-wire termination eliminates the chief cause of potentiometer failure. Construction insures humidity performance that meets the cycling requirements of MIL-R-12934. One hundred per cent inspection and the double-check follow-through of the Bourns Reliability Assurance Program are your final quality guarantees. Whatever you need in single-turns, you'll find the answer at Bourns — the complete source! Write for technical data on our entire line of bushing and servo models, KNOBPOT® potentiometers, and turns-counting dials.



Bourns' thin design lets you gang units in minimum depth; for example, Model 3580 allows 24 cup sections in less than 6 inches.

BOURNS INC.

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ON READER-SERVICE CARD CIRCLE 52

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EXAMPLES OF AS-FIRED TOLERANCES HELD BY COORS IN REGULAR PRODUCTION

HOLE PATTERN DIA. .200 ± .0005

.205 x .257 x .030 LOCATION OF .016 DIA. HOLES HELD WITHIN .001

.060 DIA. .030 I.D. .001 CONCENTRICITY

.097 x .222 .007 THICKNESS ± .0005 .001 CAMBER

.143 DIA. .013 THICKNESS ± .0005 .001 CAMBER

.186 DIA. .013 THICKNESS ± .0005 .001 CAMBER

.268 DIA. .002 FLATNESS

.008 SLOT WIDTH

.010 THICKNESS ± .001 .001 MAX. CAMBER

.015 THICKNESS ± .001 .001 MAX. CAMBER .230 I.D.

ON READER-SERVICE CARD CIRCLE 53

Coors CERAMICS

ALUMINAS • BERYLLIAS • MAGNESIAS • SPECIAL OXIDES

Coors Porcelain Co., Golden, Colo.

1966 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	RF	Computer & Hi-Speed	Four Layer	Noise	Matched	Microwave	Varactor & Varicap	Tunnel	Varistor	Zener (Regulator)	Reference (Low Temp. Coefficient Types)	SCRs	SCSs & Gate-Controlled Types	Photo	Special Purpose
Airtron Div., Litton Industries							•	•	•								
Alpha Industries Inc.			•					•	•								N, P
American Electronics Labs. Inc.			•					•	•								N, R
American Semiconductor Inc.							•					•	•				
Amperex Electronic Corp.	•	•	•	•	•		•		•			•	•			•	D, F
Atlantic Semiconductor Inc.		•															B, H, St
Bell, F. W., Inc.																	Ha
Bendix Semiconductor Div.	•	•															
Bradley Semiconductor Corp.	•	•															
Burroughs Corp.	•			•											•		
C B S Laboratories												•	•			•	
Chatham Electronics	•													•			B
Computer Diode Corp.	•	•	•	•			•	•	•		•	•	•				C
Conant Labs.		•															B, Se
Continental Device Corp.	•	•	•	•		•	•	•				•	•	•			
Crystalonics Inc.							•		•								
Delco Radio Div., Gen. Motors	•	•															D
Delta Semiconductors Inc.	•	•	•	•		•	•	•	•			•	•				F
Dickson Electronics Corp.		•					•			•		•	•				
Diodes Inc.	•	•		•			•					•					B, D, H, St, S
Eastern Delta Corp.		•									•						B, S, St
Eastron Corp.							•		•			•					C, St
Edal Industries	•	•					•				•						B, Df, H, S
Edgerton, Germeshausen & Grier																•	R
Electro-Optical Systems Inc.																•	
Electronic Devices Inc.	•	•										•					B, D, H, M, V
Erie Technological Products	•	•		•			•										B
Fairchild Semiconductor	•	•		•		•	•	•	•			•	•	•		•	A, E
Fansteel Metallurgical Corp.		•															Se
General Electric Co.	•	•	•	•	•		•	•		•	•	•	•	•	•	•	La, P

Key to special purpose diodes category

A	= Arrays	N	= Pin diodes
B	= Bridges, stacked, or special assemblies	P	= Snap diodes
Bi	= Bilateral switch	Ph	= Photo SCRs
C	= Multi-junction forward regulators	R	= Radiation detectors
CC	= Constant-current source	S	= Suppressors
D	= TV dampers	Se	= Selenium rectifiers
Df	= Specially diffused silicon diodes	St	= Stabistors
E	= Light emitting diodes	Sym	= Symmetrical switch
F	= Controlled forward conductance diodes	T	= Thin-film applications types
H	= High voltage elements	Tr	= Trigger diode
Ha	= Hall effect generators	U	= Multi-current reference
La	= Lasers	Y	= Relay diode

Manufacturer	General Purpose	Rectifiers	RF	Computer & Hi-Speed	Four Layer	Noise	Matched	Microwave	Varactor & Varicap	Tunnel	Varistor	Zener (Regulator)	Reference (Low Temp. Coefficient Types)	SCRs	SCSs & Gate-Controlled Types	Photo	Special Purpose
General Instrument Corp.	•	•	•	•			•		•			•	•	•		•	
General Semiconductors Inc.	•	•					•		•			•	•				B, C, H, U
Green Rectifier Corp.		•									•						B, S, St
H P Associates	•		•	•			•	•								•	E, N, P, F
Heliotek Div. Textron Electronics Inc.																•	
Hoffman Electronics Corp.	•	•		•		•				•		•	•	•			
Hughes Aircraft Co. Microelectronics Div.	•	•		•			•	•	•			•					A
Hunt Electronics Co.																	Bi, Sym
I T T 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
Korad Corp.																	La
Ledex		•															
M S I Electronics Inc.								•	•								
Mallory Semiconductor Co.		•										•					B, Tr, St
MicroSemiconductor Corp.	•	•	•	•			•	•	•			•	•				T
Microstate Electronics Corp.				•			•	•	•	•							E, N, X
Microwave Associates Inc.			•				•	•	•	•							N, P, Df
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, Ph, R, Sym, T, U, Y
Power Components Inc.	•	•			•		•		•			•	•				St

Key to special purpose diodes category

A	= Arrays	N	= Pin diodes
B	= Bridges, stacked, or special assemblies	P	= Snap diodes
Bi	= Bilateral switch	Ph	= Photo SCRs
C	= Multi-junction forward regulators	R	= Radiation detectors
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Radiation, Inc.																	A
Radio Corp. of America		•								•			•	•		•	B, La
Raytheon Co.	•		•	•			•	•	•	•		•	•			•	E, N
Rectico Inc.		•															
Saratoga Semiconductor Div., Espey Mfg.												•	•				
Sarkes Tarzian Inc.	•	•										•		•	•		B, H, Ph
Schauer Mfg. Corp.							•				•	•	•				
Semcor Div., Components Inc.	•					•	•					•	•				
Semicon Inc.		•												•			H
Semiconductor Devices Inc.				•				•	•								N, P
Semiconductor Specialists Inc.							•					•	•				
Semi-Elements Inc.	•	•	•		•		•	•	•			•				•	E, La
Semtech Corp.	•	•		•			•					•	•				B, H, St
Silicon Transistor Corp.														•	•		
Slater Electric Inc.		•															
Solar Systems Inc.																	Df
Solid State Products Inc.					•									•	•	•	Ph
Solitron Devices Inc.	•	•	•			•	•		•		•	•	•				N
Sylvania Electric Products	•	•	•	•		•	•	•	•	•	•				•		N
Syntron Co.		•													•		B, H
TRW Semiconductors	•	•	•	•			•	•	•			•	•				St
Texas Instruments Inc.	•	•	•	•	•		•	•	•	•	•	•		•	•	•	E, L, St
Transitron Electronic Corp.	•	•	•	•		•	•	•		•		•	•	•	•		U
Trio Laboratories Inc.												•					CC
Unitrode Corp.	•	•		•	•		•					•	•				B, C, H, N, S
Vactec Inc.																•	
Varian/Bomac Div.							•	•	•								N, P
Varo, Inc., Special Products Div.		•		•													H, B, D, Df
Western Semiconductor Inc.	•	•		•	•	•	•		•		•	•	•	•	•		B
Westinghouse Electric Corp., Semiconductor Div.	•	•		•								•	•				

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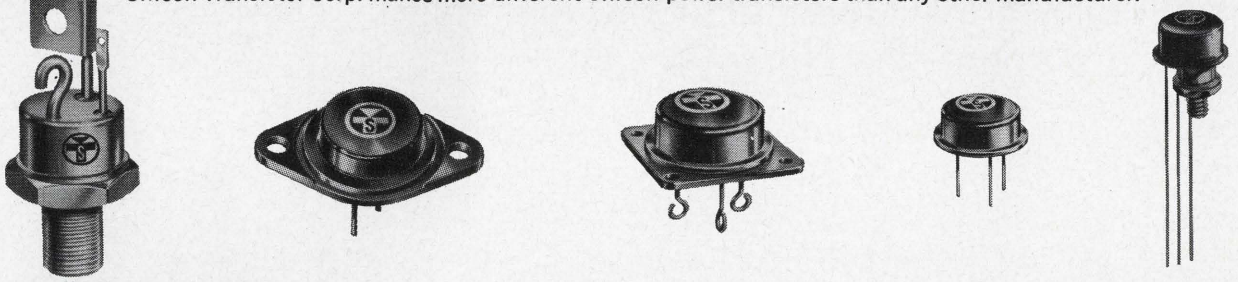
Silicon Transistor Corp. makes more different silicon power transistors than any other manufacturer.



NPN Types

Type	Case Type	Pd Watts 100°C Case	BV_{CEO} Volts	h_{FE} Min.	@ I_C Amps.	V_{CE}(sat.) Volts Max.	@ I_C Amps.
2N1016B	150W	71	100	10	5	2.5	5
2N1016C	150W	71	150	10	5	2.5	5
2N1016D	150W	71	200	10	5	2.5	5
2N1483	TO-8	14.1	40	20	0.75	2.0	0.75
2N1484	TO-8	14.1	55	20	0.75	2.0	0.75
2N1485	TO-8	14.1	40	35	0.75	0.75	0.75
2N1486	TO-8	14.1	55	35	0.75	0.75	0.75
2N1487	TO-3	43	40	15	1.5	3.0	1.5
2N1488	TO-3	43	55	15	1.5	3.0	1.5
2N1489	TO-3	43	40	25	1.5	1.0	1.5
2N1490	TO-3	43	55	25	1.5	1.0	1.5
2N1618	TO-61	45	80	15	2.0	2.0	2.0
2N1722	TO-53	50	80	20	2.0	1.0	2.0
2N1724	TO-61	50	80	20	2.0	1.0	2.0
2N1768	TO-75	22.8	40	35	0.75	0.75	0.75
2N1769	TO-75	22.8	55	35	0.75	0.75	0.75
2N2033	TO-5	5.0	60	20	0.5	0.8	0.5
2N2034	TO-5	5.0	60	20	1.0	0.3	1.0
2N2035	TO-8	14.1	60	20	1.5	0.45	1.5
2N2036	TO-37	10	60	20	2.0	1.0	2.0
2N2823	TO-63	100	80	10	20	1.1	20
2N2824	TO-63	100	100	10	20	1.1	20
2N2825	TO-63	100	150	10	20	1.1	20
2N2828	TO-59	22.8	60	20	0.5	0.4	0.5
2N2829	TO-59	22.8	60	20	1.0	0.3	1.0
2N2858	TO-5	5.0	80	20	1.0	0.3	1.0
2N2859	TO-5	5.0	100	20	1.0	0.3	1.0
2N2911	TO-5	5.0	125	20	1.0	0.3	1.0
2N3149	1 1/16" stud	200	80	10	50	1.5	50
2N3150	1 1/16" stud	200	100	10	50	1.5	50
2N3151	1 1/16" stud	200	150	10	50	1.5	50
STC2500	1 1/4" stud	300	100	10	100	1.5	100
STC2501	1 1/4" stud	300	150	10	100	1.5	100

NPN Types

Type	Case Type	Pd Watts 100°C Case	BV_{CEO} Volts	h_{FE} Min.	@ I_C Amps.	V_{CE}(sat.) Volts Max.	@ I_C Amps.
2N3237	IND. TO-3	100	75	12	10	2.0	10
2N3238	IND. TO-3	85	80	8.5	10	3.0	10
2N3239	IND. TO-3	85	80	8.5	10	1.0	10
2N3240	IND. TO-3	85	160	8.5	10	1.0	10

PNP Types

Type	Case Type	Pd Watts 100°C Case	BV_{CEO} Volts	h_{FE} Min.	@ I_C Amps.	V_{CE}(sat.) Volts Max.	@ I_C Amps.
2N2881	TO-5	5.0	60	20	0.5	0.4	0.5
2N2882	TO-5	5.0	100	20	0.5	0.4	0.5
2N3163	TO-61	45	40	12	1.0	0.75	1.0
2N3164	TO-61	45	60	12	1.0	0.75	1.0
2N3165	TO-61	45	80	12	1.0	0.75	1.0
2N3166	TO-61	45	100	12	1.0	0.75	1.0
2N3175	TO-61	45	40	10	2.0	1.0	2.0
2N3176	TO-61	45	60	10	2.0	1.0	2.0
2N3177	TO-61	45	80	10	2.0	1.0	2.0
2N3178	TO-61	45	100	10	2.0	1.0	2.0
2N3202	TO-5	5	40	20	1.0	0.3	1.0
2N3203	TO-5	5	60	20	1.0	0.3	1.0
2N3204	TO-5	5	80	20	1.0	0.3	1.0
2N3205	TO-59	22.8	40	20	0.5	0.4	0.5
2N3206	TO-59	22.8	60	20	0.5	0.4	0.5
2N3207	TO-59	22.8	100	20	0.5	0.4	0.5
2N3208	TO-5	5.0	40	20	0.5	0.4	0.5

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Choosing ICs need not be a chore. Use this directory of available circuits to eliminate those hours spent searching in vain.

As the number of available microelectronic circuits, and in particular integrated circuits (ICs), becomes greater and greater, the task of selecting the best circuit for a given application becomes correspondingly more difficult and time-consuming. By listing the available integrated circuits by major logic categories and a key parameter, ELECTRONIC DESIGN's Microelectronic Data Charts will save you many hours of needless searching.

Data charts make selection easier

These data charts provide a method of comparing available standard devices within the limitation of manufacturers' available data. For convenience, the charts are separated into the following categories:

- Section 1—Diode Transistor Logic (DTL).
- Section 2—Direct-Coupled Transistor Logic (DCTL) and Resistor-Transistor Logic (RTL).
- Section 3—Transistor-Transistor Logic (TTL).
- Section 4—Emitter-Coupled Logic (ECL).
- Section 5—Resistor-Capacitor Transistor Logic (RCTL).
- Section 6—Complementary Transistor Logic (CTL).
- Section 7—Miscellaneous Digital Circuits
- Section 8—Linear Circuits

The attached table gives a fast run-down of the major parameters associated with digital circuits. As an example of circuit designs, a two-input NOR gate circuit is shown for each of the logic types. The parameter values given are based on typical values and serve only as a guide.

To further aid your search, the first three sections of the directory, because of their extreme length, also contain a dot chart listing of logic circuits and the names of the manufacturers making them.

The data charts are each divided into circuit sub-categories with headings such as Gates, Binary Elements, and Expanders for the digital circuits and Operational Amplifiers, Comparators, and Voltage Regulators for the linear circuits. The listings are again divided up, especially for the gate circuits, into AND, NAND, NOR, etc., subgroups. Within any group or subgroup, the listings are in order of increasing propagation delays.

As is often the case, a particular model number may be known and it is the data listing that has to be found. The Cross-Reference Index, following Section Eight, provides a fast method for locating this information. The first column of the index lists all of the model numbers in an alpha-numerical sequence. The second column consists of a two or three digit listing which calls out the section, category and subgroup where the device is located. On the charts, these cross-references are listed in the first two columns. For example, suppose you wished to locate a device whose model number you know to be MC1114. The cross-reference listing is 1E1. In the first section (DTL), you would scan down the first column until you came to E (Gates). You then scan down the second column until you come to 1(AND). The device will be listed in this grouping.

The charts are only a guide to the most useful circuits for a particular application. Though they will help to bring some order to the immense problem of selecting and purchasing integrated circuits, a thorough check of manufacturers' data sheets is imperative.

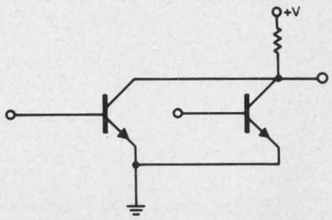
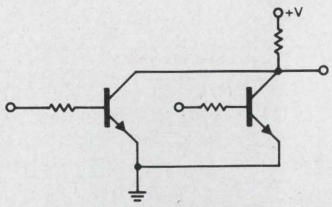
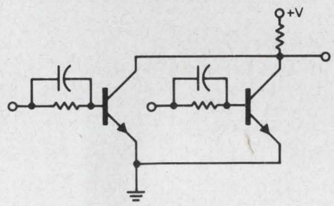
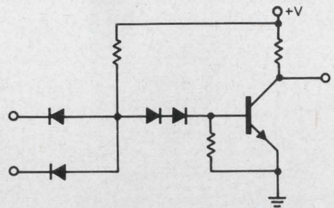
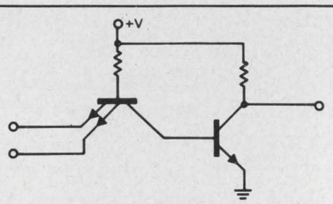
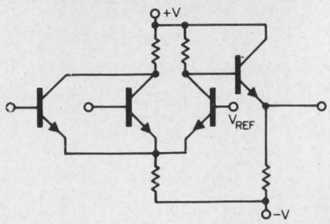
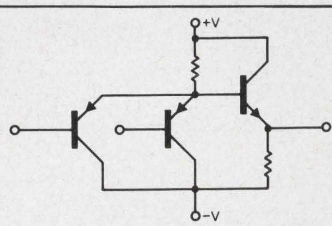
Understanding the specs is a must

Before analyzing the data listings, an understanding of what the various parameters mean is helpful. Manufacturers use various test methods, and though their reasons for doing so are usually meaningful, the design engineer should be aware of these different methods and understand their meaning in relation to his particular application.

Propagation delay, loosely defined as the time required to transfer a pulse through the integrated circuit device, is one of the most important measures of circuit performance. Since different methods of testing this parameter exist, manufacturers' data sheets must include both a description of the test circuit and a full definition of the waveforms measured. In addition, data sheets should spell out switching times as well, and some indication should be made of variations in these

Rene Colen, Microelectronics Editor

Typical IC characteristics and circuits

Symbol	Circuit diagram	Speed*	Power*	Fan-out*	Noise immunity*	Remarks
DCTL		Medium	Medium	Low	Low	Variations in input characteristics result in base-current "hogging" problem. Proper operation not always guaranteed. More susceptible to noise because of low operating and signal voltages.
RTL		Low	Low	Low	Low	Very similar to DCTL. Resistors resolve current "hogging" problem and reduce power dissipation. However, operating speed is affected and also reduced.
RCTL		Low	Low	Low	Low	Though capacitors can increase speed capability, noise immunity is affected by capacitive coupling of noise signals.
DTL		Medium	Medium	Medium	Medium to High	Use of pull-up resistor and charge-control technique improves speed capabilities. Many modifications of this circuit exist, each having specific advantages.
TTL		Medium	Medium	Medium	Medium to High	Very similar to DTL. Has lower parasitic capacity at inputs. With the many existing variations, this is becoming very popular.
CML		High	High	High	Medium to High	Similar to a differential amplifier, the reference voltage sets the threshold voltage. High-speed, high fan-out operation is possible with associated high power dissipation. Also known as emitter-coupled logic (ECL).
CTL		High	High	Medium	Medium	More difficult manufacturing process results in compromises of active device characteristics and higher cost.
	*Legend Low = Medium = High =	 <5 MHz 5 to 15 MHz >15 MHz	 <5 mW 5 to 15 mW >15 mW	 <5 5 to 10 >10	 <300 mV 300 to 500 mV >500 mV	

measurements as a function of loading (fan-out) and temperature.

Fan-in refers to the number of inputs that the device takes. A carry-over from older times, this rating, where given, many provide additional information to that given in the "Type" column in the data charts.

Fan-out is the measure of a circuit's capability to drive a specified number of the same circuit from its output. Though both typical and maximum values may be listed, only the latter value can realistically be used in making comparisons.

Power dissipation may be given per node, gate, stage, circuit, or package; or it may be given without any qualifications. Any reasonable comparison of this rating is greatly complicated by this lack of a standard. In the data charts, a slash following a power rating indicates a per-gate value, if in the gates section, and a per-stage value, if in the binary elements section. Note that the power dissipation is a function of the supply voltage and that it varies directly with operating speed; in looking at manufacturer's data sheets, check that all the test data are taken under the same operating conditions.

Noise margin or noise immunity indicates the minimum amount of noise voltage that will cause an "error" in the output of a logic circuit. Normally, noise immunity for a "0" logic state is defined as the difference between the minimum "0" input threshold and the maximum "0" output signal. For a "1" logic state, it is the difference between the minimum output signal and the maximum "1" input threshhold. With logic errors possible in either of two available states, the noise immunity rating should be checked for both logical "0" and "1" conditions. Also, since supply voltage and loading conditions affect this circuit characteristic, only the worst-case measurement should be used.

Temperature ratings are for a −55°C to +125°C range unless otherwise noted.

Package types for integrated circuits basically fall into three categories: the flat-pack, the ten-lead TO-5, and the dual-in-line packages. Though a number of manufacturers have registered their particular package designs with the JEDEC Semiconductor Device Council (JEDEC Publication 12E) there are still no standards set in the industry. The data charts in this directory use a letter code for the various packages, as follows:

- A = TO-5
- B = TO-47
- C = 1/4 in. sq. flat-pack (TO-86, TO-91)
- D = 1/4 x 1/8 in. flat-pack (TO-84, TO-85, TO-89, TO-90)
- E = 3/8 in. sq. flat-pack
- F = 1/4 x 3/8 in. flat-pack (TO-87, TO-88, TO-95)
- G = Special package (TO-69, TO-70, TO-71, TO-73 through TO-80, TO-96, TO-97, TO-99, TO-100, TO-101)

The numbers in parentheses refer to the JEDEC registered devices and are listed by their approximate size and style. ■ ■

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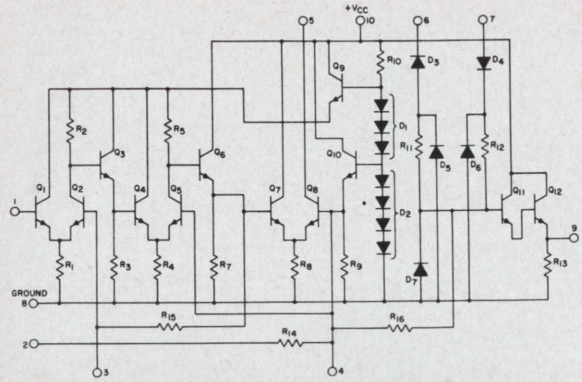

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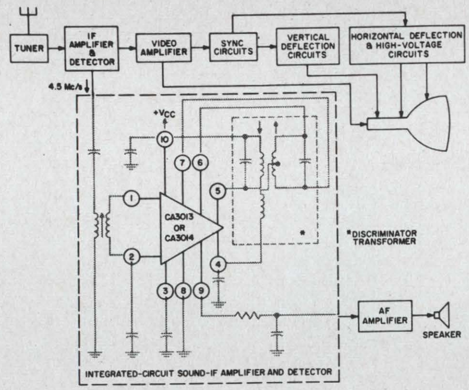
- **Power Gain:** 75 dB typical @ 4.5 MHz
- **Exceptional limiting characteristics**
- **Input Limiting Voltage (knee):** 300 μv @ 4.5 MHz typical

In TO-5 style package.

into applications like this...



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Gain dB	37 @ 1 KHz	19 @ 1 MHz	24.4 @ 1.75 MHz	12-16 @ 100 MHz	22 @ 1 KHz	60 @ 1 KHz
−3dB Bandwidth	650 KHz	16 MHz	11 MHz	100 MHz	20 KHz	300 KHz

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1. Diode-Transistor Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)[2]	Package Type	Remarks[3]
						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		R-S Flip Flop	RD-208	RAD	7	–	–	–	7	20	5	.250	4.5	800	–	D	
		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	
		–	ND1003	NA	20	–	2	–	4	20	6	0.2	4.0	750	–	–	
		–	RD-207	RAD	20	–	–	–	12	95	5	0.25	3	800	–	D	
		J-K Flip Flop	RD-307	RAD	20	–	–	–	8	95	5	0.25	3	800	–	D	
		J-K Flip Flop	RD-507	RAD	20	–	–	–	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.
		–	WM202	WH	23	3	3	–	10	15	6	0.35	2.0	550	–	A, C, D	
		–	WM212	WH	23	3	3	–	10	15	6	0.35	2.0	550	–	A, D	
		R-S	RC202T	RA	32	–	–	10	–	9.5	6	–	–	550	–	A, D	
		R-S	RC212T	RA	32	–	–	10	–	9.5	6	–	–	550	–	A, D	
		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	
		R-S, J-K	DTμL948	FA	40	–	2	–	12	45	5.0	0.2	5	600	0 to 75	A, C	
		Clocked R-S, J-K	MC831	MO	40	–	–	–	7	20	5	0.2	5	500	0 to 75	A, C	Modified 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	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
		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	–	–	
		J-K/R-S	SN15848	TI	45	–	–	–	9	35	4.5-5.5	–	–	750	0-75	D,	
		Pulse Triggered	SN15850	TI	45	–	–	–	8	–	4.5-5.5	–	–	750	0-75	D,	
		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	500	–	A, C	
		R-S, J-K	DTμL945	FA	50	–	2	–	9	35	5.0	0.2	5	600	–	A, C	
		–	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	
		R-S J-K Clocked	SW945	SW	50	2	–	9	–	42	4-6	0.4	2.6	1000	–	–	
		J-K/R-S	SN15831	TI	50	–	–	–	7	20	4.5-5.5	–	–	750	0-75	D,	
		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	
		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	
		–	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 & Clear
		Dual J-K	SN5302	TI	60	–	–	–	10	27	3-4	–	–	300	–	D	Preset
		Dual J-K	SN5304	TI	60	–	–	–	10	27/ff	3-4	–	–	300	–	D	Preset & Clear

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

DTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range (°C)[2]	Package Type	Remarks[3]
B		J-K	SN7301	TI	60	–	–	–	10	27	3-4	–	–	–	0-70	D	Preset and Clear
		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 and Clear
		–	RC203T	RA	†5MHz	–	–	4	–	75	6	–	–	550	–	A, D	†clock rate
		J-K	WM215	WH	†5MHz	–	–	–	9	45	6.0	0.35	2.0	550	0 to 125	A, C, D	†fT
		Counter	WM203	WH	†5MHz	–	–	–	4	84	6	0.35	2.0	550	–	A, C	†fc
		JK	RC215T	RA	†5MHz	–	–	9	–	56	6	–	–	550	–	A, D	†clock rate
		Pulse	RC213T	RA	†11MHz	–	–	8	–	40	6	–	–	–	–	A, D	†clock rate
		–	WM213	WH	†12MHz	–	–	–	9	35	6	0.35	2.0	550	–	A, C, D	†ft
		J-K	WM503	WH	†20MHz	–	–	10	–	47	4.5	0.40	1.8	500	–	D	†ft
		–	NC/PC19	GI	–	–	–	–	5	200	12, 4.2	0	5	–	–	A, E	RCT
		J-K	WM225G	WH	–	–	–	–	10	55	6	2	1	550	–	D	
Converters C		A to D	WS815	WH	–	–	–	–	5	60	20, 4.0	0.45	1.75	250	0 to 125	C	
		D to A	WS150	WH	–	–	–	–	–	100	10, 6.4	0.45	1.75	250	0 to 125	C	
Drivers/Buffers D		Dual 4-input	RD-209	RAD	7	–	4	–	12	22	5	0.25		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
		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	WM510	WH	15	5	5	27	–	20	4.5	0.40	1.8	500	–	D	
		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	
		8-input	WM234G	WH	19	–	–	–	16	20	6	2	1	550	–	D	
		Dual 4-input	DTμL932	FA	20	–	4	–	25	30	5	0.2	5	750	–	A, C	Expandable
		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	PL 932	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 4-input	SW932	SW	25	100	–	25	–	25	4-6	0.4	2.6	1000	–	–	Expandable
		Dual 4-input	SW944	SW	25	100	–	27	–	20	4-6	0.4	2.6	1000	–	–	Expandable
		Dual 4-input	SN5832	TI	25	–	–	–	20	15/ gate	4.5-5.5	–	–	750	0-75	D	
		Dual 4-input	SN15932	TI	25	–	–	–	20	15/ gate	4.5-5.5	–	–	750	–	D	
		Quad Inverter/ Driver	SN535	TI	30	–	–	–	10	9/ gate	3-4	–	–	300	–	D	Modified DTL
		Quad	SN7350	TI	30	–	–	–	10	9/inv	3-4	–	–	–	0-70	D, J	
		Dual	RC210T RC210Q RC210G	RA	32	–	–	11	–	9.5/ gate	6	–	–	550	–	A, D	
		–	ND1002	NA	35	–	2	20	–	20	6	0.2	4.0	750	–	–	
		Dual	WM210	WH	37	3	3	–	22	60	6	0.35	2.0	550	–	A, C, D	
		Single	SE750	SIG	40	–	2	–	20	36	+4,–2	0.4	3-9	1000	–	A, C	
		Dual	WS817	WH	50	–	3	25	–	20	4.0	0.45	1.75	250	0 to 125	C	
		Dual	WS817Q	WH	50	–	–	–	25	15	4.0	0.7	1.75	250	0-125	C	
		–	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	WS816	WH	80	–	3	10	–	60	4.0	0.45	1.75	250	0 to 125	C	
		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 E	AND 1	–	MC203	MO	4	6	–	–	–	100	6, 8	0.6	2.0	500	–	A, C	
		–	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 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	

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3) MC= Multiple Chip; TF= Thin-film hybrid.

DTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
E	AND/NAND	–	WS813Q	WH	50	–	2	10	–	20	4.0	0.7	1.75	250	0 to 125	C	
	AND/OR 2	5-input	SN532	TI	5	–	–	–	4	10	3-4	–	–	300	–	D	Modified DTL
		Dual	SN534	TI	5	–	–	–	4	10/ gate	3-4	–	–	300	–	D	Modified DTL
		–	WS810Q	WH	50	–	2	10	–	20	4.0	0.7	1.75	250	0 to 125	C	
		–	WS812Q	WH	50	–	3	10	–	15	4.0	0.7	1.75	250	0 to 125	C	
		–	WS814Q	WH	50	–	2	10	–	20	4.0	0.7	1.75	250	0 to 125	C	
	NAND 3	–	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
		Triple	WM506	WH	10	3	3	10	–	57	4.5	0.40	1.8	500	–	D	
		Dual	SWA05	SW	12	–	4	–	10	15	5	0.8	4.8	900	–	A	
		Triple	WM556	WH	12	3	3	12	–	30	4.5	0.40	1.8	500	–	D	
		–	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	1000 Pf. load & 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
		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.
		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	15	6	0.35	2.0	550	–	A, C, D	
		Triple	WM206	WH	23	3	3	–	11	22.5	6.0	0.35	2.0	550	–	D	
		Dual	WM211	WH	23	4	4	–	11	15	6	0.35	2.0	550	–	A, D	
		Triple	WM216	WH	23	3	3	–	11	22.5	6.0	0.35	2.0	550	–	D	
			WM221	WH	23	3	3	–	11	15	6	0.35	2.0	550	–	A, D	
		Dual	WM231	WH	23	4	4	–	11	15	6	0.35	2.0	550	–	D	
		Quad	WM246	WH	23	2	2	–	11	30	6.0	0.35	2.0	550	0 to 125	D	
		–	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/ gate	4.5-5.5	–	–	750	0-75	D	
		Dual 4-input	SN15844	TI	25	–	–	–	20	15/ gate	4.5-5.5	–	–	750	0-75	D	
		Quad 2-input	SN15846	TI	25	–	–	–	8	5/ gate	4.5-5.5	–	–	750	0-75	D	
		Triple 3-input	SN15862	TI	25	–	–	–	8	5/ gate	4.5-5.5						
		Dual 4-input	SN15930	TI	25	–	–	–	8	5/ gate	4.5-5.5	–	–	750	–	D	
		Dual 4-input	SN15944	TI	25	–	–	–	20	15/ gate	4.5-5.5	–	–	750	–	D	
		Quad 2-input	SN15946	TI	25	–	–	–	8	5/ gate	4.5-5.5	–	–	750	–	D	
		Triple 3-input	SN15962	TI	25	–	–	–	8	5/ gate	4.5-5.5	–	–	750	–	D	
		–	WM204	WH	28	4	4	–	11	7	6	0.35	2.0	550	–	A, C, D	
		–	WM214	WH	28	6	6	–	11	7	6	0.35	2.0	550	–	A, C, D	
		–	WM224	WH	28	8	8	–	11	7	6	0.35	2.0	550	–	A, D	
		Dual 3-input	RC201T	RA	30	–	–	11	–	9.5	6	–	–	550	–	A	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

DTL *(continued)*

Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
					Typ.	Max.	Typ.	Max.			"0"	"1"				
3	Dual 4 input	RC211T	RA	30	–	–	11	–	9.5	6	–	–	550	–	A, D	
	Dual 3-input	RC221T	RA	30	–	–	11	–	9.5	6	–	–	550	–	A, D	
	Dual 4-input	RC231G	RA	30	–	–	11	–	9.5	6	–	–	550	–	D	
	Quad 2 - input	WM246G	WH	30	–	–	–	11	38	6	2	1	550	–	D	
	Sextuple	WM286G	WH	30	–	–	–	11	57	6	2	1	550	–	D	
	Triple	RC206G	RA	32	–	–	11	–	9.5	6	–	–	550	–	D	
	3-input	RC216G	RA	32	–	–	11	–	9.5	6	–	–	550	–	D	
	4-input	RC204T	RA	35	–	–	11	–	9.5	6	–	–	550	–	A, D	
	6-input	RC214T	RA	35	–	–	11	–	9.5	6	–	–	550	–	A, D	
	8-input	RC224T	RA	35	–	–	11	–	9.5	6	–	–	550	–	A, D	
	Dual	WS811Q	WH	50	–	3	10	–	10	4.0	0.7	1.75	250	0 to 125	C	
NAND / NOR 4	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	–	–	–	5	10	5	.250	4.5	800	–	D	
	Quad 2 - input	RD - 306	RAD	7	–	–	–	5	10	5	.250	4.5	800	–	D	
	Dual 4 - input	RD - 310	RAD	7	–	–	–	5	10	5	.250	4.5	800	–	D	
	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	
	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
	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	7	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	
	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	
	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	DTμL930	FA	25	–	4	–	8	5	5	0.2	5	750	–	A, C	Expandable
	Quad	DTμL946	FA	25	–	2	–	8	5	5	0.2	5	750	–	A, C	Expandable
	Triple	DTμL962	FA	25	–	3	–	8	5	5	0.2	5	750	–	A, C	Expandable
	Dual 4-input	MC830	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	A, C	Modified DTL, Expandable
	Quad 2-input	MC846	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	C	Modified DTL, Expandable
	Triple 3-input	MC862	MO	25	–	–	–	8	5	5	0.2	5	500	0 to 75	C	Modified DTL, Expandable
	Dual 4-input	MC930	MO	25	–	–	–	8	5	5	0.2	5	500	–	A, C	Modified DTL, Expandable

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

DTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
E	4	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
		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	
		–	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	
		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 5	–	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
	Exclusive-OR 6	–	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	
		–	MC204	MO	40	3	–	–	20	40	6, -6	0.6	2.5	500	–	A, C	
		Dual 4-input	MC844	MO	40	–	–	–	27	20	5	0.2	5	500	0 to 75	A, C	Modified DTL
		Dual 4-input	MC944	MO	40	–	–	–	27	20	5	0.2	5	500	–	A, C	Modified DTL
		Dual	SN5370	TI	90	–	–	–	10	20/ gate	3-4	–	–	300	–	D	Modified DTL
		Dual	SN7370	TI	90	–	–	–	10	20/ gate	3-4	–	–	–	0-70	D	
Gate Expanders F		–	RC226	RA	2	2,3	6	–	–	–	–	–	–	–	–	–	
		–	RC246	RA	2	–	6	–	–	–	–	–	–	–	–	–	
		–	A04	SI	4	–	6	–	–	–	–	–	–	–	–	A, D	Diode Array

1) See pages 4-9 for manufacturer's name.
2) –55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
F	–	A44	SI	4	–	6	–	–	–	–	–	–	–	–	A, D	Diode Array
	–	SWA04	SW	4	–	6	–	–	–	–	–	–	–	–	–	
	5-input	SN7320	TI	5	–	–	–	4	10	3-4	–	–	–	0-70	D	
	Dual 4-input	DTμL933	FA	–	–	4	–	–	–	–	–	–	–	–	A, C	Diode Array
	Dual 4-input	MC833	MO	–	–	–	–	–	–	–	–	–	–	0 to 75	A, C	Modified 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	RD-111	RAD	–	–	4	–	–	–	–	–	–	–	–	–	Expandable
	Dual 4-input	RD-711	RAD	–	–	4	–	–	–	–	–	–	–	–	–	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	
	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	
	–	UC1005B	SPR	–	8	–	–	–	–	–	–	–	–	–	–	
	–	UC1006B	SPR	–	5	–	–	–	–	–	–	–	–	–	–	
	Dual 4-input	SW933	SW	–	4	–	–	–	–	4-6	–	–	–	–	–	
	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	
	Dual	WM217	WH	–	7	7	–	–	–	–	–	–	–	–	A, C, D	
	Triple	WM227	WH	–	11	11	–	–	–	–	–	–	–	–	D	
Inverters G	Quad	SE181	SIG	20	–	1	–	6	20	+4	0.4	3.9	1000	–	A	
	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
	2-input	DTμL951	FA	25	–	–	–	10	35	5.0	0.2	5	950	–	A, C	
	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	VAF	30	–	–	2	4	100	6, 3	0.5	3.5	–	–	–	TF
	Single-shot	SN15851	TI	50	–	–	–	–	–	4.5-5.5	–	–	750	0-75	D	
	Single-shot	SN15951	TI	50	–	–	–	–	–	4.5-5.5	–	–	750	–	D	
	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	–	–	
	–	WM205	WH	†4	–	–	–	4	84	6.0	0.35	2.0	550	0 to 125	A, C	†f_T

Who makes what in DTL

Manufacturer	Symbol	Adders	Binary Elements	Converters	Drivers/ Buffers	Gates: AND	Gates: AND/NAND	Gates: AND/OR	Gates: NAND	Gates: NAND/NOR	Gates: NOR	Gates: Exclusive-OR	Gate Expanders	Inverters	Logic Amplifiers	Multi-vibrators	Shift Bit
Fairchild	FA		●		●					●		●	●			●	
General Instrument	GI		●						●		●					●	
Motorola	MO		●		●	●				●		●	●	●			
National Semiconductor	NA		●		●							●					
Philco	PH		●		●				●				●				
Radiation	RAD		●		●					●			●				
Raytheon	RA		●		●				●				●				●
Signetics	SIG		●		●	●				●			●	●		●	
Siliconix	SI	●	●		●					●			●			●	
Sprague	SPR	●	●		●				●	●			●				
Stewart-Warner	SW		●		●				●				●				
Texas Instruments	TI		●		●			●	●	●		●	●			●	
Varo	VAR		●		●	●			●		●				●	●	
Westinghouse	WH		●	●	●		●	●	●				●				●

2. Direct-Coupled Transistor Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
Adders A		Full	μL904	FA	14	–	2	–	5	45	3	0.15	1.0	250	–	A, C	
		Full	MC908G	MO	60	–	–	–	4	10	3	0.9	0.1	–	–	A	
		Full	PL908	PH	80	2	–	–	4	10	3	0	0.8	–	–	–	
		Full	MWμL908	FA	90	–	2	–	4	10	3	0.220	0.805	350	–	A, C	
		Full	MC708G	MO	–	–	–	–	4	3	3.6	0.9	0.1	–	+15 to 55	A	
		Half	MC804G	MO	14	–	–	–	5	45	3	1.1	0.1	–	0 to 100	A	
		Half	MC904G	MO	14	–	–	–	5	45	3	1.1	0.1	–	–	A	
		Half	PL904	PH	14	2	–	–	5	45	3	0	0.8	–	–	–	
		Half	NB1004	NA	17	–	2, 2	4, 5	–	45	3	0.18	1.2	300	–	–	
		Half	H11001	AL	22	–	–	–	–	42	3	0.12	1.1	–	–	B	
		Half	H11004	AL	22	–	–	–	–	42	3	0.12	1.1	–	70	B	
		–	A11	SI	35	–	–	–	5	40	5			900	–	A, D	
		Half	MC912G	MO	66	–	–	–	4	8	3	0.9	0.1	–	–	A	
		–	SN1734	TI	70/105	–	–	–	4	8	3	–	–	150	–	A, D	
		Half	PL912	PH	80	2	–	–	4	8	3	0	0.8	–	–	–	
		Half	MWμL912	FA	90	–	2	–	4	8	3	0.220	0.805	350	–	A, C	
		Half	MC704G	MO	–	–	–	–	16	20	3.6	1.1	0.1	–	15 to 55	A	
		Half	MC712G	MO	–	–	–	–	4	3	3.6	0.9	0.1	–	+15 to 55	A	
		–	SN1729	TI	70/105	–	–	–	3	10	3	–	–	150	–	A, D	
Binary Elements B		Flip-Flop	MC702G	MO	10	–	2	–	13	–	3.6	1.1	0.1	300	15 to 55	A	
		–	μL902	FA	14	–	1	–	4	22	3	0.21 1.5	1.0	250	–	A,C	
		Flip-Flop	MC802G	MO	14	–	2	–	4	28	3	1.1	0.1	300	0 to 100	A	
		Flip-Flop	MC902G	MO	14	–	2	–	4	28	3	1.1	0.1	300	–	A	
		–	PL902	PH	14	1	–	–	4	22	3	0	0.8	–	–	–	
		–	PL916	PH	20	1	–	–	3	54	3	0	0.8	–	–	–	
		–	NB1002	NA	22	–	1	4	–	22	–	–	–	–	–	–	
		J-K	MC723G	MO	25	–	4	–	10	–	3.6	1.1	0.1	300	15 to 55	A	
		–	FμL92329	FA	40	–	3	–	10	54	3, 4	0.15	1.0	300	15 to 55	A, C	
		–	μL916	FA	40	–	2	–	3	54	3	0.15	1.0	250	–	A, C	
		J-K	MC726G	MO	40	–	5	–	16	–	3.6	1.1	0.1	300	15 to 55	A	
		Toggle	FF1514B	IN	50	1	1	–	6	96	12	0.2	<12	2500	–	G	TF
		J-K	MC816G	MO	50	–	4	–	3	54	3	1.1	0.1	300	0 to 100	A	
		J-K	MC916G	MO	50	–	4	–	3	54	3	1.1	0.1	300	–	A	
		J-K	MC826G	MO	60	–	5	–	5	56	3	1.1	0.1	300	0 to 100	A	
		J-K	MC926G	MO	60	–	5	–	5	56	3	1.1	0.1	300	–	A	
		J-K	MC720G	MO	70	–	4	–	2	–	3.6	0.9	0.1	250	15 to 55	A	
		–	MC813G	MO	70	–	4	–	3	–	3.6	0.9	0.1	250	15 to 55	A	
		–	MC913G	MO	70	–	4	–	3	12	3	0.9	0.1	250	–	A	
		–	MWμL913	FA	100	–	1	–	3	15	3	0.220	0.805	350	–	A, C	
		J-K	MC920G	MO	100	–	4	–	2	15	3	0.9	0.1	250	–	A	
		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
		gated	A17	CBS	5000	–	1	–	25	†528	7 max	0.65	0.30	–	–	G	†μW
Buffers C		–	NB1000	NA	8	–	1	5, 25	–	45	3	0.18	1.2	300	–	–	
		–	B11004	AL	15	–	–	–	–	30	3	0.12	1.1	–	70	B	
		–	BC11001	AL	15	–	–	–	–	30	3	0.12	1.1	–	–	B	
		–	MC800G	MO	15	–	–	–	25	24	3	1.3	0.1	–	0 to 100	A	
		–	MC900G	MO	15	–	–	–	25	24	3	1.3	0.1	–	–	A	
		–	PL900	PH	15	1	–	–	25	30	3	0	0.8	–	–	–	
		–	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	0.15	1.0	250	–	A, C	Modified DCTL
		–	MC909G	MO	57	–	–	–	30	10	3	1.1	0.1	–	–	A	
		–	SN1730	TI	70	–	–	–	30	15	3	–	–	150	–	A, D	
		–	MWμL909	FA	80	–	4	–	30	10	3	0.220	0.805	350	–	A, C	
		–	PL909	PH	80	1	–	–	30	10	3	0	0.8	–	–	–	
		–	MC700G	MO	–	–	–	–	80	20	3.6	1.3	0.1	–	+15 to 55	A	
		–	MC709G	MO	–	–	–	–	30	–	3.6	1.1	0.1	–	15 to 55	A	
Counter Adapters D		–	NB1001	NA	21	–	1	5	–	55	3	0.18	1.2	300	–	–	
		–	MC801G	MO	22	–	–	–	5	55	3	1.3	0.1	–	0 to 100	A	
		–	MC901G	MO	22	–	–	–	5	55	3	1.3	0.1	–	–	A	
		–	PL901	PH	22	2	–	–	25	55	3	0	0.8	–	–	–	
		–	C11001	AL	28	–	–	–	–	50	3	0.12	1.1	–	–	B	
		–	C11004	AL	28	–	–	–	–	50	3	0.12	1.1	–	70	B	
		–	MC701G	MO	–	–	–	–	16	20	3.6	1.3	0.1	–	15 to 55	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	
		3-input	MC703G	MO	10	–	3	–	16	–	3.6	1.1	0.1	300	15 to 55	A	
		4-input	MC707G	MO	10	–	4	–	16	–	3.6	1.1	0.1	300	15 to 55	A	
		Dual 2-input	MC714G	MO	10	–	2	–	16	–	3.6	1.1	0.1	300	15 to 55	A	
		Dual 3-input	MC715G	MO	10	–	3	–	16	–	3.6	1.1	0.1	300	15 to 55	A	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

DCTL and RTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in		Fan-out		Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts)		Noise Margin (mV)	Temp Range (°C)[2]	Package Type	Remarks[3]
						Typ.	Max.	Typ.	Max.			"0"	"1"				
E	1	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	μL903	FA	12	–	3	–	5	12	3	0.15	1.0	250	–	A, C	
		Dual	μL914	FA	12	–	2	–	5	24	3	0.15	1.0	250	–	A, C	
		Dual 3-input	μL915	FA	12	–	3	–	5	24	3	0.15	1.0	250	–	A, C	
		3-input	MC803G	MO	12	–	3	–	5	27	3	1.1	0.1	300	0 to 100	A	
		4-input	MC807G	MO	12	–	4	–	5	27	3	1.1	0.1	300	0 to 100	A	
		Dual 2-input	MC814G	MO	12	–	2	–	5	54	3	1.1	0.1	300	0 to 100	A	
		Dual 3-input	MC815G	MO	12	–	3	–	5	54	3	1.1	0.1	300	0 to 100	A	
		3-input	MC903G	MO	12	–	3	–	5	27	3	1.1	0.1	300	–	A	
		4-input	MC907G	MO	12	–	4	–	5	27	3	1.1	0.1	300	–	A	
		Dual 2-input	MC914G	MO	12	–	2	–	5	54	3	1.1	0.1	300	–	A	
		Dual 3-input	MC915G	MO	12	–	3	–	5	54	3	1.1	0.1	300	–	A	
		3-input	PL903	PH	12	3	–	–	5	12	3	0	0.8	–	–	–	
		4-input	PL907	PH	12	4	–	–	5	12	3	0	0.8	–	–	–	
		Dual 3-input	PL915	PH	12	3	–	–	5	24	3	0	0.8	–	–	–	
		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	MC710G	MO	25	–	2	–	4	–	3.6	0.9	0.1	250	15 to 55	A	
		4-input	MC711G	MO	25	–	4	–	4	–	3.6	0.9	0.1	250	55 to 55	A	
		Dual 3-input	MC718G	MO	25	–	3	–	4	–	3.6	0.9	0.1	250	15 to 55	A	
		Dual 2-input	MC910G	MO	25	–	2	–	4	4	3	0.9	0.1	250	–	A	
		Dual 3-input	MC918G	MO	25	–	3	–	4	4	3	0.9	0.1	250	–	A	
		Dual 3-input	GG1514B	IN	30	3	3	–	6	96	12	0.2	<12	2500	–		
		Dual 2-input	SN1731	TI	35	–	–	–	4	2.5/ gate	3	–	–	150	–	A, D	
		4-input	SN1733	TI	35/70	–	–	–	4	4	3	–	–	150	–	A, D	
		4-input	MC911G	MO	40	–	4	–	4	4	3	0.9	0.1	250	–	A	
		Dual 2-input	PL910	PH	40	2	–	–	4	4	3	–	0.8	–	–	–	
		4-input	PL911	PH	40	4	–	–	4	4	3	–	0.8	–	–	–	
		Dual 2-input	MWμL910	FA	45	–	2	–	4	4	3	0.15	1.0	350	–	A, C	
		4-input	MWμL911	FA	80	–	4	–	4	4	3	0.15	1.0	350	–	A, C	
	NOR 2	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	–	4	–	5	12	3	0.15	1.0	250	–	A, C	
		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	0.15	1.0- 3.0	300	–	–	
		–	RC123	RA	20	3	–	5	–	15	3	0.15	1.0- 3.0	300	–	–	
		Dual	RC124	RA	20	2, 3	–	2, 5	–	2, 15	3	0.15	1.0- 3.0	300	–	–	
		Dual	RC144	RA	20	2, 3	–	2, 5	–	2, 15	3	0.15	1.0- 3.0	300	–	–	
		–	RC1033	RA	20	3	–	5	–	15	3	0.2	1.0- 3.0	300	–	–	
		–	RC1233	RA	20	3	–	5	–	15	3	0.15	1.0- 3.0	300	–	–	
		Dual	RC-1243	RA	20	2, 3	–	2, 5	–	2, 15	3	0.2	1.0- 3.0	300	–	–	
		Dual	RC1443	RA	20	2, 3	–	2, 5	–	2, 15	3	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	0.15	1.0- 4.0	300	–	–	
		Dual	RC324	RA	25	2, 3	–	2, 5	–	2, 5	4	0.15	1.0- 4.0	300	–	–	
		Dual	RC342	RA	25	2, 2	–	2, 5	–	2, 5	4	0.15	1.0- 4.0	300	–	–	
		Dual	RC344	RA	25	2, 3	–	2, 5	–	2, 5	4	0.15	1.0- 4.0	300	–	–	
		–	RC1031	RA	25	3	–	5	–	15	3	0.225	1.0- 3.0	300	0 to 65	–	
		–	RC1032	RA	25	3	–	4	–	15	3	0.25	1.0- 3.0	200	0 to 65	–	
		–	RC1231	RA	25	3	–	5	–	15	3	0.225	1.0 - 3.0	300	0 to 65		
		–	RC1232	RA	25	3	–	4	–	15	3	0.25	1.0 - 2.0	200	0 to 65		
		–	WS277	WH	25	–	3	–	6	15	3	0.5	1.0	275	–	–	
		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

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

DCTL and RTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
E	2	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	
		Dual 2-input	MC721G	MO	25	–	2	–	–	–	3.6	0.9	0.1	250	15 to 55	A	
		Dual 2-input	MC921G	MO	25	–	2	–	–	–	3	0.9	0.1	250	–	A	
		Dual 2 - input	SN1732	TI	35	–	–	–	–	–	–	–	–	150	–	A, D	
		–	PL921	PH	40	2	–	–	3	0	3	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	0.220	0.805	350	–	A, C	
Inverters G		Quad	MC727G	MO	–	–	–	–	–	–	3.6	1.1	0.1	–	15 to 55	A	
		Quad	MC827G	MO	–	–	–	–	5	48	3	1.1	0.1	–	0 to 100	A	
		Quad	MC927G	MO	–	–	–	–	5	48	3	1.1	0.1	–	–	A	
Multivibrators H		Single-shot	T35-002	AL	100	–	–	–	–	20	3	0.12	1.1	–	–	A	
		Single - shot	A15	CBS	4000	–	5	–	25	†408	7 max	0.30	0.65	–	–	G	†μW
Shift Registers I		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	RC301	RA	60	–	–	5	–	4	3	–	–	300	–	A, D	
		Full	PL913	PH	80	1	–	–	3	15	3	0	0.8	–	–	–	
		Half	NB1005	NA	11	–	1	4,5	–	53	3	0.18	1.2	300	–	–	
		Half	PL905	PH	15	1	–	–	4	53	3	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	0.15	1.0	250	–	A, C	
		Half	MC705G	MO	20	–	3	–	13	–	3.6	1.1	0.1	300	15 to 55	A	
		Half w/o Inverter	MC706G	MO	20	–	3	–	13	–	3.6	1.1	0.1	300	15 to 55	A	
		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	0.15	1.0	250	–	A, C	
		Half	MC805G	MO	22	–	3	–	5	64	3	1.1	0.1	300	0 to 100	A	
		Half	MC905G	MO	22	–	3	–	5	64	3	1.1	0.1	300	–	A	
		Half w/o Inverter	MC906G	MO	22	–	3	–	4	43	3	1.1	0.1	300	–	A	
		Half	PL906	PH	22	1	–	–	4	36	3	0	0.8	–	–	–	
		Half w/o Inverter	MC806G	MO	23	–	3	–	4	43	3	1.1	0.1	300	0 to 100	A	
		–	SN1735	TI	70	–	–	–	3	15	3	–	–	150	–	A, D	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

Who makes what in DCTL/RTL

Manufacturer	Symbol	Adders	Binary Elements	Buffers	Counter Adapters	Gates NAND/NOR	Gates NOR	Gate Expanders	Inverters	Multivibrators	Shift Registers
Amelco	AL	●	●	●	●	●		●		●	●
CBS	CBS		●				●			●	
Fairchild	FA	●	●	●		●	●	●			●
Intellux	IN		●			●					
Motorola	MO	●	●	●	●	●		●	●		●
National Semiconductor	NA	●	●	●	●		●				●
Philco	PH	●	●	●	●	●	●	●			●
Raytheon	RA						●				●
Siliconix	SI	●									
Texas Instruments	TI	●		●		●		●			●
Westinghouse	WH						●				

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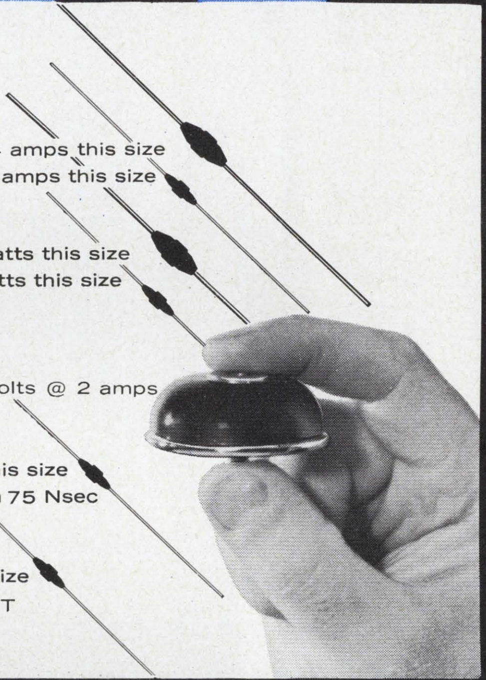
1ST



FIRST ***in power rectifiers:*** 4 amps this size
2 amps this size

FIRST ***in power zeners:*** 5 watts this size
3 watts this size

FIRST ***in high voltage assemblies:*** 7500 volts @ 2 amps

FIRST ***in fast recovery rectifiers:*** 2 amps this size
recovers in 75 Nsec

FIRST ***in radiation resistant diodes:*** 2 amps this size
@ 2 x 10^{14} NVT

ALL HAVE:

High surge capability: 100 amp or 250 watt this size

Stability: All parts meet initial specifications for each parameter after 2000 hours life test at 100°C at full rating

Controlled avalanche: Equal surge capability in both forward and reverse directions

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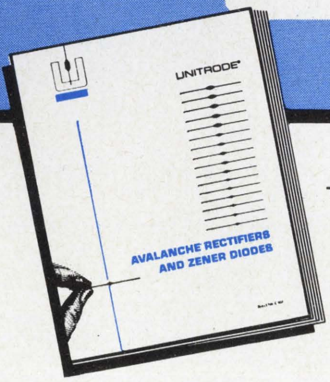

THIS NEW RECTIFIER AND ZENER CATALOG contains complete technical specifications, application data, etc. on all Unitrode diodes. To receive your copy, circle the reader service number below or contact your nearest Compar office.

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ON READER-SERVICE CARD CIRCLE 58

3. Transistor-Transistor Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
Adders A		Half	SG90,SG91, SG92,SG93	SY	12	–	–	6	20	15	–	–	–	1000	–	–	Differ in Temp & F.O.
		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		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	
		Dual	TFF 3011	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	
		Dual	SE826	SIG	20	–	–	–	5	50	+5	0.4	2.4	1000	–	F	
		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	
		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 M/S	SN5473	TI	35	–	–	–	10	50/	4.5-5.5	–	–	1000	–	D	
		Master/Slave	SN7472	TI	35	–	–	–	10	50	4.75- 5.25	–	–	100	0 to 70	D	
		Dual M/S	SN7473	TI	35	–	–	–	10	50/ff	4.75- 5.25	–	–	1000	0 to 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	–	
		J-K	SN5470	TI	40	–	–	–	10	60	4.5 to 5.5	–	–	1000	–	D	Single-phase
		Master/Slave	SN5472	TI	35	–	–	–	10	50	4.5-5.5	–	–	1000	–	D	
		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	
		Gated R-S FF	MC652	MO	80	–	6	–	4	200	10	10	.70	5V	0 to 75	A, C	
		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	–	
		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	–	
		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	–	
		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	
Drivers/Buffers C		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/ gate	4.5-5.5	–	–	1000	–	D	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

TTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
C		Dual 4-input	SN74932	TI	18	–	–	–	30	25/ gate	4.75-5.25	–	–	1000	0 to 70	D	
		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	
D	AND/OR/NOT 1	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	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	
	NAND 2	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	–	
		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	–	
		8-input	SWG263	SW	8	8	–	5	–	22	4.5-6	0.45	3	900	0 to +75	–	
		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	
		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	–	
		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	4.5 to 5.5	–	–	1000	–	D	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

TTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range (°C)[2]	Package Type	Remarks[3]
D	2	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	
		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	
		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	
		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
		Dual	SW402	SW	100	–	3	–	5	0.10	3.0	0.3	2.0	300	–	A	
	NAND/NOR 3	Quad 2-input	SG220,221	SY	6	–	–	–	12	22	–	0.25	3.5	1000	–	D, G	
		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	
		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	
		–	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	
		–	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	
		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.

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2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

TTL *(continued)*

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range (°C)[2]	Package Type	Remarks[3]
D	3	Expandable	SG120,121 SG122,123	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	
		–	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	
		Dual 4-input	TTμL103	FA	25	–	4	–	15	25	5.0	0.33	4	750	–	A, C	
		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	–	–	
		Dual	WM701	WH	45	4	4	15	–	–	5.0	0.30	2.7	550	–	D, F, G	
		–	WM704	WH	45	8	8	15	–	–	5.0	0.30	2.7	500	–	D, F, G	
	Exclusive OR 4	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	
		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.
			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	
Gate Expanders E		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	
		Quad	SWG150	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Quad	SWG151	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Quad	SWG152	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Quad	SWG153	SW	–	10	–	–	–	5	4.5-6	–	–	–	–	–	
		Dual 4-input	SWG170	SW	–	8	–	–	–	5	4.5-6	–	–	–	–	-	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

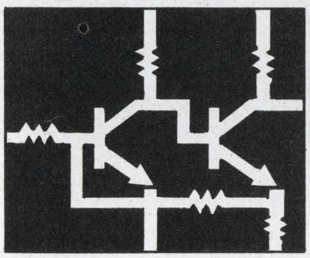
	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
E		Dual 4-input	SWG171	SW	–	8	–	–	–	5	4.5-6	–	–	–	–	–	
		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 F		Quad 2-input	SN5453	TI	15	–	–	–	10	25	4.5-5.5	–	–	1000	–	D	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

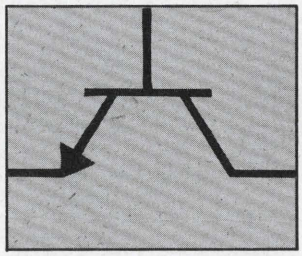
Who makes what in TTL

Manufacturer	Symbol	Adders	Binary Elements	Drivers/ Buffers	Gates: AND/OR/ NOT	Gates: NAND	Gates: NAND/ NOR	Gates: Exclusive-OR	Gate Expanders	Inverters
Fairchild	FA						•			
Motorola	MO		•							
Philco	PH						•			
Signetics	SIG		•	•		•		•	•	
Siliconix	SI						•			
Stewart-Warner	SW		•		•	•		•	•	
Sylvania	SY	•	•	•			•	•	•	
Texas Instruments	TI	•	•	•	•	•		•	•	•
Transitron	TR		•				•		•	
Westinghouse	WH						•			

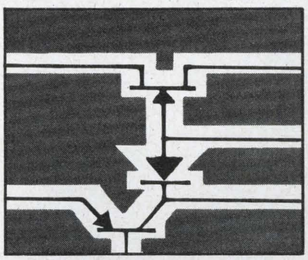
Amelco high-reliability silicon epitaxial devices



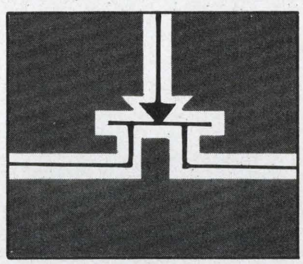
MONOLITHIC LINEAR INTEGRATED CIRCUITS
These high-performance differential amplifiers, operational amplifiers and video amplifiers are the result of advanced planar diffusion techniques. Precise photo-etching and diffusion processes result in closely matched diffused resistors and small geometry transistors for high performance.



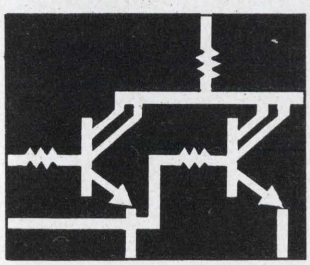
TRANSISTORS
Covering General Purpose, Small Signal Amplifiers and High Frequency types Amelco Transistors are of the passivated planar silicon diffused construction. Small Signal transistors provide excellent gain at low collector currents, and High Frequency devices benefit from precise control of small geometries.



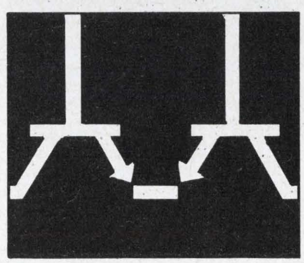
HYBRID LINEAR INTEGRATED CIRCUITS
Characterized by high reliability and low cost engineering, these circuits utilize thin-film deposition on ceramic substrates for passive components and interconnections, and die attached active components. Standard circuits include analog gates amplifiers, multivibrators and counters, with a variety of custom circuits readily available.



FIELD EFFECT TRANSISTORS
Amelco offers an extensive line of N channel silicon FET's, noted for high transconductance, low noise, low leakage and high reliability. These devices are made by passivated planar diffusion techniques and are specified in a wide range of Pinch-Off Voltage and other parameters. Available in metal cans or epoxy packages.



MONOLITHIC INTEGRATED LOGIC CIRCUITS
Amelco digital circuits encompass Direct Coupled Transistor Logic (DCTL) and Transistor-Transistor Logic (T^2L). DCTL, called OMIC for Optimized Micro-circuits, include transistors with dual collectors for improved performance. Available in 3 grades and over 14 circuits. T^2L circuits are designed for high packaging density and low power dissipation to meet the requirements of airborne systems.



DIFFERENTIAL AMPLIFIERS
Amelco 'Diff Amps' consist of two silicon transistors in a single package. The transistors are matched to close tolerances for use in many critical applications. Both conventional and field effect transistors are used.

Amelco's superior reliability and performance are in large part due to proprietary methods of ultra-precision photomasking and mask alignment combined with total quality control over the entire production process. Prompt attention is given to all inquiries through the home office or through Amelco Field Sales Offices, Representatives, and Distributors throughout the free World.

AMELCO SEMICONDUCTOR
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ON READER-SERVICE CARD CIRCLE 59

4. Emitter-Coupled Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
Adders A		Half	MC303	MO	6	–	–	–	25	60	10	1.55	0.75	–	–	A, C	
		Half	MC353	MO	6	–	–	–	25	60	10	1.55	0.75	–	0 to 75	A, C	
Binary Elements B		Set-Reset	MC302	MO	10	–	–	–	25	35	10	1.55	0.75	–	–	A, C	
		J-K	MC308	MO	10	–	–	–	–	52	10	1.55	0.75	–	–	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	
Drivers C		Line & Capacity	MC315	MO	10	3	25	–	25	–	–5.2	1.55	0.75	–	–	A, C	
		Line & Capacity	MC365	MO	10	3	25	–	25	–	–5.2	1.55	0.75	–	0 to 75	A, C	
		–	MC304	MO	–	–	–	5	25	18	10	–	–	–	–	A, C	
		–	MC354	MO	–	–	–	5	25	18	10	–	–	–	0 to 75	A, C	
		–	SW304	SW	–	–	–	5	25	18	-5.2	–	–	–	–	A, C	
Gates D	NOR 1	Dual 2-input	MC309 MC310 MC311	MO	6	–	–	–	26	49	10	1.55	0.75	–	–	A, C	Units differ in output configuration
		Dual 2-input	MC359 MC360 MC361	MO	6	–	–	–	26	49	10	1.55	0.75	–	0 to 75	A, C	Units differ in output configuration
		Dual	SW309 SW310 SW311	SW	6	–	2	–	26	49	-5.2	-1.5	-0.75	–	–	A, C	Units differ in output configuration
		Dual	MC312	MO	6.5	–	3	–	25	68	5.2	–.75	–1.6	400	–	A, C	
		Dual	MC362	MO	6.5	–	3	–	25	68	5.2	–.75	–1.6	400	0 to 75	A, C	
		Dual	WS371	WH	10	4	4	25	–	220	-5.0	-1.6	-0.8	250	0 to 75	C	
	OR/NOR 2	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
		–	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
	OR/NOR/AND NAND 3	5-input	MC301	MO	6	3	25	–	26	35	10	1.55	0.75	–	–	A, C	
		3-input	MC306 MC307	MO	6	3	25	–	26	35	10	1.55	0.75	–	–	A, C	
		5-input	MC351	MO	6	3	5	–	26	35	10	1.55	0.75	–	0 to 75	A, C	
		3-input	MC356 MC357	MO	6	3	25	–	26	35	10	1.55	0.75	–	0 to 75	A, C	
Gate Expanders E		–	MC305	MO	6	–	–	–	–	–	10	–	–	–	–	A, C	
		–	MC355	MO	6	–	–	–	–	–	10	–	–	–	0 to 75	A, C	
		–	SW305	SW	6	–	–	–	–	–	-5.2	–	–	–	–	A, C	
Level Translators F		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	

1) See pages 4-9 for manufacturer's name.
2) $-55°$ to $+125°C$ unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

Report from

BELL LABORATORIES

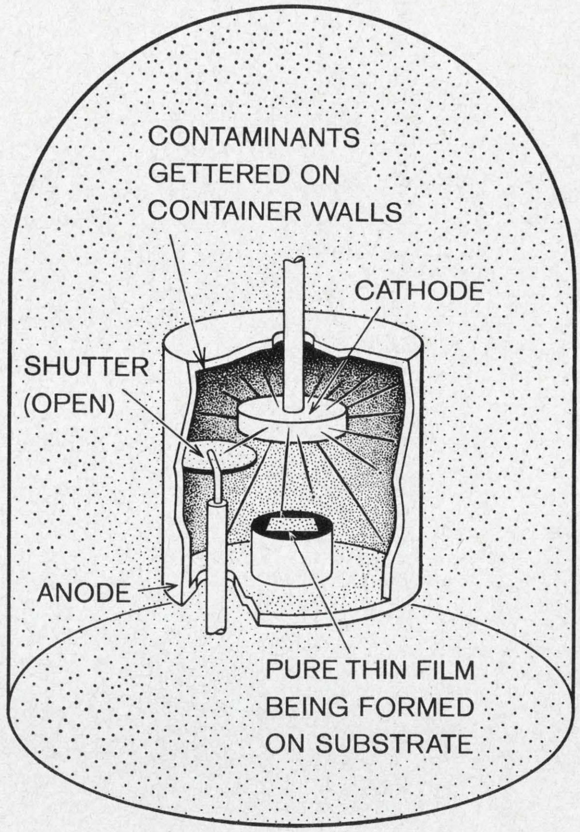
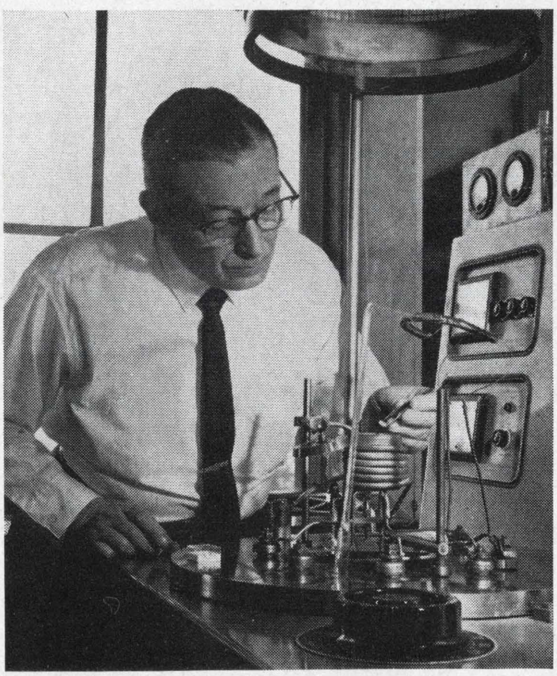


Diagram illustrating formation of high-purity thin film at ordinary vacuum level: **Cathode consists of reactive metal which, transferred to substrate, forms thin film. Anode is shaped into enclosing cylinder. Surrounding atmosphere consists of argon and unwanted contaminants. When 1500-volt potential is applied, ionized argon "sputters" metal from cathode. During sputtering, metal atoms "getter" the contaminants—i.e., remove them from surroundings and hold them at the container walls. Then a protective shutter is swung aside (as shown here) and pure, uncontaminated metal travels from the cathode to the substrate to form the film.**

High-purity thin films



H. C. Theuerer of Bell Laboratories prepares to place a thin-film substrate in getter sputtering equipment.

Very thin films of metal offer many opportunities for achieving small high-performance, high-reliability electronic circuits. And the technology has now reached the point where numerous problems related to thin films are being solved.

One of these problems was contamination of the films during preparation. At ordinary levels of vacuum, enough contaminants remained in the surrounding atmosphere to harm the characteristics of the film. Yet establishing an ultrahigh vacuum is expensive and time-consuming.

A solution was found by H. C. Theuerer at Bell Telephone Laboratories. It consists of letting reactive metals do double duty. As shown in the drawing, the same metal that forms the film also removes the contaminants from the atmosphere. With the new process, known as "getter sputtering," film purities that formerly required a 10^{-12} Torr vacuum can now be achieved with 10^{-6} Torr equipment.

5. Resistor-Capacitor Transistor Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
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
		–	TMC40003	MEP	10	–	–	5	5	48	+6, -3	0	6	1000	–	G	TFH
		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@3V	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@4V	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
		–	TMC40001	MEP	10	–	4	5	5	48	+6, -3	0	6	1000	–	G	
		Inverter	TMC40004	MEP	10	–	–	5	5	48	+6, -3	0	6	500	–	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@6V	–	–	–	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		One-Shot	TMC40002	MEP	10	–	–	5	5	48	+6, -3	0	6	500	–	G	
		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	

1) See pages 4-9 for manufacturer's name.
2) −55° to +125°C unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

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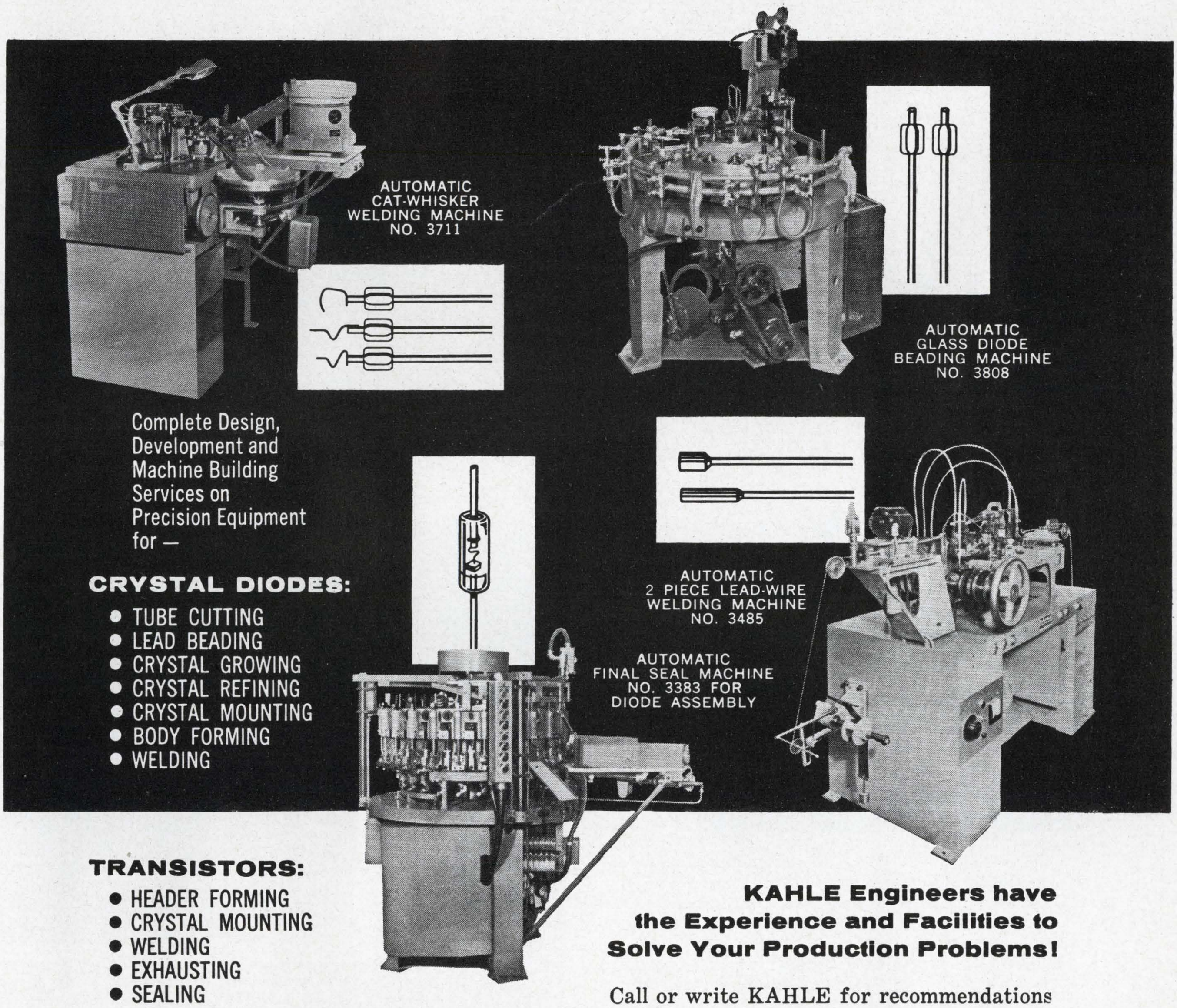

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6. Complementary Transistor Logic

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
Binary Element A		Dual-rank	CTμL951	FA	15-20	–	–	15	–	150	4.5,-2	0.36	2.25	400	15 to 55	G	
Buffers B		–	CTμL956	FA	12	–	–	–	25	125	4.5,-2	0.36	2.25	400	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	

1) See pages 4-9 for manufacturer's name.
2) $-55°$ to $+125°C$ unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

7. Miscellaneous Digital Circuits

	Logic Function	Type	Model	Mfr.[1]	Propagation Delay (ns)	Fan-in Typ.	Fan-in Max.	Fan-out Typ.	Fan-out Max.	Power Diss. (mW)	Supply Voltage (Volts)	Logic Levels (Volts) "0"	Logic Levels (Volts) "1"	Noise Margin (mV)	Temp Range[2] (°C)	Package Type	Remarks[3]
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.
Diode Matrix B		–	*	RAD	†10	–	–	–	–	450	40	–	–	–	–	D, G	†Reverse Recovery Time
			*Nine matrix sizes avail. from 5 x 5 to 15 x 15 in RM-50,60,70 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	
Level Detector C		–	WM208T	WH	1 MHz	–	–	–	–	–	6	–	–	–	–	A, C, D	
Level Shifter D		–	WS150Q	WH	–	–	–	–	–	100	10, 6.4 -10, -64	0-1.5	2.5- 9.0	–	–	C	
Memory E		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	
MOS F	Adder	Dual-Full	MEM1000	GI	500	–	–	–	5	25	–26, -12	–2	–10	1 V	-55 to +85	F	
	Analog Switch	4-channel	PL4S01	GME	–	–	–	–	–	150	-15-30+10	10	0	1000	–	G	
	Converter	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	BCD Decade	PL4C01	GME	2500	–	–	–	–	75	-12, -24	–3	–9	1000	–	G	
	Flip-Flop	RST	MEM1005	GI	0-1MHz	–	–	–	5	80	–28	–2	–10	1 V	-55 to +85	A	
	J-K Flip Flop	Dual	PL4M01	GME	2500	–	–	–	–	100	-12, -24	–3		1000	–	G	
	Multiplexer	6-Channel	MEM2001	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	F	
		5-Channel	MEM2002	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	F	
		4-Channel	MEM2003	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
		4-Channel	MEM2004	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
		4-Channel	MEM2004A	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
		4-Channel	MEM2005	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
		3-Channel	MEM2006	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
		3-Channel	MEM2007	GI	–	–	–	–	–	–	-30	–	–	–	-55 to +85	G	
	NAND/NOR	Dual 4-input	PL4G01	GME	1000	–	–	–	–	20	-12, -24	–3	–9	1000	–	G	–24v clock
	NOR-Gate	Dual 3-input	MEM1002	GI	500	–	–	–	5	30	–26	-2	–10	1 V	-55 to +85	A	
	Shift Reg.	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	
	Shift Reg.	20-bit	MEM3020	GI	0-1MHz	–	–	–	5	200	–26	–2	–10	1 V	-55 to +85	A	
		21-bit	MEM3021	GI	0-500MHz	–	–	–	5	200	-28	–2	–10	1 V	-55 to +85	A	
Pulse Source G			NM4002	NOR	25	–	–	–	–	590	+20	0	+3	–	–	A, B	Apollo pre-core driver
Schmitt Trigger H		–	NC/PC17	GI	8	–	1	–	5	200	12, 4.2, -3	0	5	–	–	A, E	MC RCT
Shift Register I		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 5.25	–	–	1000	0-70	D	† Shift freq.
Steering Gate J		–	NC/PC9	GI	–	–	–	–	–	–	–	–	–	–	–	A, E	MC RCDT
Utilogic K	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	

1) See pages 4-9 for manufacturer's name.
2) $-55°$ to $+125°C$ unless otherwise indicated.
3) MC= Multiple Chip; TF= Thin-film hybrid.

8. Linear Circuits

Function	Model	Mfr.[1]	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[2]
Amplifier Demodulator A	MCM602	KE	DC-2 kHz	–	*2.6	–	35 k ±10%	4300 ± 10%	±15VDC ±12 VDC	–	G	
Analog switch B	E16-501	AL	Ton <500 ns Toff <600 ns	±5	†40	–	–	–	40	–	A	†hFE
	45P912	GE	100 MHz	0.0006	–	–	–	–	20	–	A	
	4JP913	GE	100 MHz	0.0006	–	–	–	–	20	–	A	
	PC402	GI	200 kHz	3	–	–	10 k/3.9 k	–	+45, +28	–	E	
	PC401	GI	200 kHz	3	–	–	10 k/3.9 k	–	+45, +28	–	E	
	NM2017	NOR	200 kHz	5	–	–	10 k	–	10	–	D	
Audio Amp. C	AMC101	AMP	dc–20 KHz	–	80	.002	–	–	5	6	G	
	8502	VAR	10 Hz – 100 KHz	0-20	46	10	10 k	1000	10 to 20	10	–	
	WC183G	WH	.5-10 KHz	–	94	45	40 k	–	4.5	*3	D	
Bit Driver D	WS151	WH	Ton = 100 ns Toff = 350 ns	–	–	–	5 k	–	10	–	C	
Broadband Amp. E	4JP108	GE	6 MHz	–	*20	–	50	1	15	–	A	
	PA7600	PH	0-200 MHz	–	†43	2.5	–	–	6	5	A	†MHz Video Bandwidth
	SE501	SIG	40 MHz	–	28	–	1.3 k	–	6.0	4 dB	A, C	
	WM1146Q	WH	dc-100 MHz	–	16	–	–	–	12	4	C	
D/A Switch F	4JP380	GE	250 MHz	–	–	–	–	20	5	–	A	
Demodulator Chopper G	NM2024	NOR	5 kHz	26	–	–	–	–	28	–	D	
Differential Amp. H	D13-000	AL	400 kHz	–	45	6-V	20 k	5 k	±12	–	A, C	
	D13-001	AL	400 kHz	–	45	6 V	10 k	5.5 k	±12	–	A, C	
	D13-002	AL	400 kHz	–	45	5 V	5 k	5.5 k	±12	–	A, C	
	μA711	FA	40 ns	† 1 mV	63	*+4.5,–0.5		200	+12,–6	–	A	dual input †offset voltage
	PC200	GI	0-20 kHz	–	73	–	100 k Diff.	200	±2 to ±22	5μV	E	
	PC201	GI	0-20 kHz	–	73	–	200 k Diff.	200	±6 to ±22	5μV	F	
	TMC40005	MEP	100 kHz	±0.040	20	–	2 M	1 k	±12	–	F	
	MC1519	MO	1 MHz	±5	73/45†	–	2.6 k/1.2 k†	2.7 k/48†	±14	–	A	†CE/CC
	MC1525	MO	1400 kHz	±5	140	–	2 k	11 k	±14	–	A	
	MC1526	MO	500 kHz	±5	65	–	60 k	11 k	±14	–	A	Darington (npn)
	MC1527	MO	1400 kHz	±5	140	–	2 k	11 k	±14	–	A	(pnp)
	MC1528	MO	300 kHz	±5	65	–	80 k	11 k	±14	–	A	Darlington (pnp)
	NM1005	NOR	300 kHz	†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 kHz	–	*1500 Open Loop	–	4 k	–	+6,–3	–	A, C	
	203	SSD	500 kHz	±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	
	SN5510	TI	dc–300 MHz	±4	40	0.4	3.5 k	35	±6	–	D	
	WS115	WH	0-150 kHz	–	34	–	1 M	8 k	12, -6	–	D	
	WS123	WH	0-100 kHz	–	50	–	150 k	0.5 k	12, -6	–	D	
	WS141G	WH	0-50 kHz	–	43	–	50 k	–	-12, 6	–	D	
	WS142	WH	0-100 kHz	–	43	–	20 k	–	6, -12	–	D	
	WS143G	WH	0-50 kHz	–	60	–	10 k	–	-12, 12, 6	–	D	
	WS144	WH	0-100 kHz	–	63	18	2 k	–	6, 12, -12	–	D	
	WS153	WH	Ton = 150 ns Toff=150 ns	–	hfe = 500	–	–	–	20	–	C	Dual Darlington
Differential Comparator I	μA710	FA	40 ns	†2 mV	63	*+3.2,–0.5		200	+12,–6	–	A, C	† offset voltage
	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 kHz	±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	
Driver Switch J	NM1038	NOR	50 kHz	±10	–	–	11 k	–	34, 6, -6	–	D	
Emitter Coupled K	MC1110	MO	DC – 300	0.114	26	10	2 k	5 k	±12	6	A	
General Purpose Amp. L	12X207	GE	10-100 kHz	0.0001	*600	–	10 k	1 M	30	10 mv rms	A	
	12X218	GE	10-100 kHz	–	–	–	50 M	250	25	B	E	
	4JPA113	GE	100 kHz	–	85	50	20 k	50	15	–	A	
	4JP114	GE	1 MHz	–	†3,000	45	1.5	10	6	–	A	†Current gain
	MCM601	KE	3-100 kHz	–	26	0.8	4 M	500	+15 VDC	–	–	
	NM1032	NOR	dc – 190 kHz	–	45	–	34 k	2 k	6, -12	–	D	

1) See pages 4-9 for manufacturer's names.
2) MC= Multiple Chip; TF= Thin-film hybrid.

Linear Circuits *(continued)*

Function	Model	Mfr.[1]	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[2]
L	NM1033	NOR	dc – 190 kHz	–	66	–	3.4 k	2 k	12, 6, -12	–	D	
	UC1501A	SPR	3 – 250 kHz	–	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	–	–	
	PA7602	PH	0-100 Hz	–	76	*6	†>25 k	†<50	12	–	A	†Gain of 40dB
	WM108	WH	0-100 kHz	–	†20,000	–	10 M	–	12	–	C	†gm
Limiter M	UC1508A	SPR	50 Hz – 12 kHz	2	40	16	40 k	15	15	–	–	
Mixer Osc. N	WM1102	WH	30 MHz	–	10	–	100	200	12	–	C	
Operational Amp. O	A13-251	AL	10 MHz	–	86	10 V	250 k	1 k	±12	–	A	
	μA702A	FA	dc-30MHz	†2 mV	68	*±53	25 k	200	+12,–6	–	A, C	†offset voltage
	μA702C	FA	dc-30 MHz	†5 mV	68	*±5.3	20 k	200	+12,–6	–	A, C	†offset voltage
	μA709	FA	dc-500 kHz	†1 mV	93	±14	400 k	150	±15	–	A	†offset voltage
	μA709C	FA	dc-500 kHz	†2 mV	93	±14	250 k	150	±15	–	A	†offset voltage
	4JPA107	GE	200 kHz	–	70	±10	750 k	100	±12	–	A	
	4JPA135	GE	200 kHz	–	70	*±4	1 M	100	±6	–	A	
	TMC40006	MEP	100 kHz	–	60	–	100 k	5 k	±12	–	G	
	MC1530	MO	1.2 MHz	±5	74	10	10 k	25	±9	–	A	
	MC1531	MO	400 kHz	±5	71	10	1 M	25	±9	–	A	Darlington Input
	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 kHz	±10	86-116	24	10^{12}	100 k	±15	0.5	G	FETs
	Q85AH	PR	0–2000 kHz	±11	86-116	24	10^{8}	100 k	±15	2	G	
	SE506	SIG	300 kHz	–	*13,000 Open Loop	–	200 k	–	+15,–15	–	A, C	
	SN521A	TI	dc – 50 kHz	±4	62	–	12 k - 100 k	10 k	10, 6, -9	–	D	
	SN522A	TI	dc – 50 kHz	±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	
	WS161Q	WH	500 kHz	†10	*2000	–	300 k	40	12	–	C	†Offset voltage
	PL-210	GI	1.5MHz	±8	70	±15 V	30k	50	±18	4μV	E	
	PL-212	GI	1.2MHz	±8	64	±10 V	100k	50	±12	4μV	E	
	PL-250	GI	30KHz	±20	50	–	10^{14}	150	±12	–	E	
	PL-251	GI	30KHz	±20	50	–	10^{14}	150	±12	–	E	Short-circuit proof
Phase Splitter Amp. P	UC1502A	SPR	3 – 250 kHz	–	84	160	2 k	100	15	–	–	
	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. Q	MCM611	KE	dc – 4 kHz	–	–	5000	–	2	±15	–	–	
	MC1524	MO	300 kHz	±5	*10/20/40	1000	8.5 k	0.58	±12	–	A	
	NM1003	NOR	dc – 20 kHz	0-60	54	8000	10 k	500	36	–	G	Modified To-53
	NM1008	NOR	dc – 20 kHz	0-60	46	8000	10 k	300	36	–	G	Modified To-53
	WS140y	WH	Ton < 0.45 μsec Toff < 1.8 μsec	–	hfe > 1000	–	–	–	40	–	stud	
	WS1454	WH	Ton<0.45 μsec Toff < 1.8 μsec	–	hfe > 1000	–	–	–	70	–	stud	
Pulse Amp. R	UC1509A	SPR	–	5	22	–	20 k	100, 10	15	–	–	
	UC1510A	SPR	–	6.7	0	–	40 k	100, 10	15	–	–	
	12X264	GE	10 MHz	–	25	–	–	–	15	–	A	
RF/IF Amp. S	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
	WM1101	WH	0-3 MHz	–	30 @ 60 MHz	–	100	200	12	5	–	
Read Amp. T	WS934	WH	0-1 MHz	–	*4-32 V/V	–	180	100	±9	4	D	
Sense Amp. U	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 kHz	–	30	–	–	–	13	–	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
Summing Amp. V	4JP116	GE	100 MHz	–	1 x 10^{5}	–	1	1	±25	–	A	
Video Amp. W	E13-511	AL	50 MHz	0.26	22	–	520	520	+12	–	A	
	NC/PC101	GI	40 MHz	0.2	20	4.5	1 k	500	6	3	A, E	
	SA20	SY	up to 100 MHz	–	45	–	2.6 k	>5	24	15	A	
	WS112y	WH	0-5 MHz	–	25	–	1 k	1 k	12	6	A, C, F, G	
	WM1106	WH	0-6 MHz	–	20	–	100	1.3 k	12	–	C	
	WM1116	WH	0-8 MHz	–	20	–	100	1.3 k	12	–	C	
	WM1126	WH	0-10 MHz	–	20	–	100	1.3 k	12	–	C	
	WM1136	WH	0-12 MHz	–	20	–	100	1.3k	12	–	C	
	WM1146	WH	0-35 MHz	–	20	–	100	2 k	12	4	C	

1) See pages 4-9 for manufacturer's names.
2) MC= Multiple Chip; TF= Thin-film hybrid.

Linear Circuits *(continued)*

Function	Model	Mfr.[1]	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[2]
Voltage Regulators X	PC501	GI	100 kHz	+16 to +24	–	150mA	–	0.2	+12	0.4 mV	E	
	PC502	GI	100 kHz	-16 to -24	–	150mA	–	0.2	-12	0.4 mV	E	
	PC503	GI	100 kHz	+28 to +36	–	140mA	–	0.4	+24	1 mV	E	
	PC504	GI	100 kHz	-28 to -36	–	140 mA	–	0.4	-24	1 mV	E	
	NC/PC511	GI	100 kHz	+15 to +24	–	150mA	–	0.1	+12	0.4 mV	A or E	
	PC512	GI	100 kHz	+27 to +36	–	140mA	–	0.2	+24	1 mV	E	
	NC/PC513	GI	100 kHz	-15 to -24	–	150mA	–	0.1	-12	0.4 mV	A or E	
	PC514	GI	100 kHz	-27 to -36	–	140mA	–	0.2	-24	1 mV	E	
	PL-521	GI	100KHz	+28	–	+6V	–	0.05	–	–	E	Imax=200 mA
	PL-523	GI	–	–28	–	-6 V	–	0.05	–	–	E	Imax=200 mA
	NCS-675A	GI	–	+28	–	+5V	–	0.1	–	–	A	Imax=200mA
	NM1004	NOR	–	>20, >30		†1.25mA	-	–	715	1 mV		†Drive Current

1) See pages 4-9 for manufacturer's names.
2) MC= Multiple Chip; TF= Thin-film hybrid.

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with TI semiconductor instrumentation

MODEL 553 *DYNAMIC* TEST SYSTEM (upper right)

for single-socket d-c *and* dynamic testing of IC's, thin films, modules, discrete semiconductors. The 553 makes digitally-programmed automatic measurements with an accuracy of 1% of reading. Operators can easily learn to program tests using simple mnemonic language.

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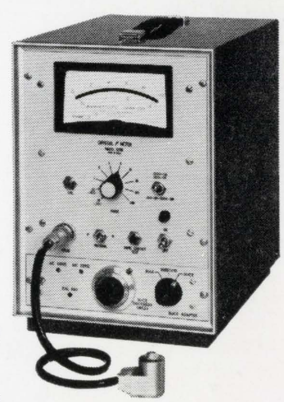
A portable a-c test instrument for measuring bulk, slice and sheet resistivity of semiconductor material. A 5-point probe gives high accuracy. Range is from .001 to 300 ohm-cm fs; 0.1 to 3000 ohms/sq.



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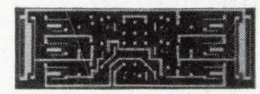
ON READER-SERVICE CARD CIRCLE 76

802

Did you know Sprague makes...?

UNICIRCUIT® RCTL INTEGRATED CIRCUITS



(8X actual size)

Sprague Series US-0100 . . . a complete line of monolithic digital building blocks featuring low power consumption (2 mW typ.)

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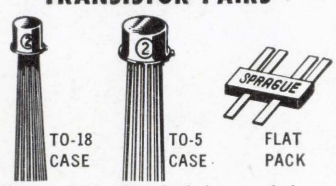
UNICIRCUIT® mW RTL INTEGRATED CIRCUITS

TO-5 CASE

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 CIRCLE 102

DIFFERENTIAL AMPLIFIER TRANSISTOR PAIRS

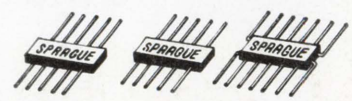


TO-18 CASE · TO-5 CASE · FLAT PACK

NPN or PNP • Matched characteristics. h_{FE} = 10-20%. $\triangle V_{BE}$ = 5-20 mV. $\triangle V_{BE}$/Temp = 5-20μV/°C.

ON READER-SERVICE CIRCLE 103

MULTIPLE TRANSISTORS (NPN-PNP PAIRS/QUADS)

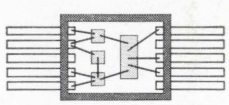


AMPLIFIERS · SWITCHES · CHOPPERS

Pairs	Quads
2 NPN	4 NPN
2 PNP	4 PNP
1 NPN—1 PNP	2 NPN—2 PNP

ON READER-SERVICE CIRCLE 104

UNICIRCUIT® CUSTOM HYBRID CIRCUITS



Combine monolithic silicon circuits with tantalum or Ni-Cr alloy resistors. Close resistance tolerances, low temperature coefficient. Resistor matching, ±½%.

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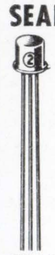
LOW-COST HERMETICALLY-SEALED PLANAR TRANSISTORS



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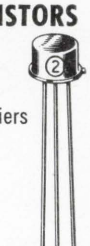
High Voltage Switches
Low Level Amplifiers
High Speed Switch/Amplifiers
Choppers
Power Amplifiers
Core Drivers

TQ SERIES (PNP)
Low Level Amplifiers
High Gain Switch/Amplifiers
High Speed Switches



TO-18 CASE · TO-5 CASE

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SILICON ALLOY REPLACEMENT TRANSISTORS

FULL PLANAR RELIABILITY

2N327A	2N945	2N1026
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2N329A	2N1025	2N1917

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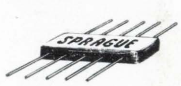
DIGITAL-TO-ANALOG CONVERSION CIRCUITS



UT-1000—Four-bit ladder network

UT-4001—Ladder switch for driving resistor ladder networks

UT-4024—Buffer amplifier

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Fastest switching transistor available in the 1 to 100μA range

C_{ib} = 0.7 pF typ., 1.5 pF max.

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TO-18 CASE

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For complete technical data on any of these products, write to:
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Sprague Electric Company
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