

TYPE	MATERIAL	POLARITY	REPLACE- MENT	PAGE NUMBER	USE	MAXIMUM RATINGS					ELECTRICAL CHARACTERISTICS									
						P _D	T _J	V _{CB}	V _{CE}	I _S	h _{FE} @ I _C		V _{CE(SAT)} @ I _C		f _T	I _S	f _T	I _S		
						@ 25°C	°C	(volts)	(volts)	Subscript	(min)	(max)	Units	(volts)	Units	Hz	Subscript	Units	Subscript	
2N489 2N494 2N495 2N496 2N497 2N497A 2N498 2N498A 2N499 2N499A 2N500	S S S S S S S S S S S	P P N N N N N N P P P	2N3498	8-232	RFA MSS AFA AFA AFA AFA RFA RFA RFA	150M 150M 4.0W 5.0W 4.0W 5.0W 30M 60M 50M	A C C C C C A A A	140 140 200 200 200 200 85 100 85	25 10 60 60 100 100 30 30 20	25 10 60 60 100 100 18 18 15	U U U U U U O O O	15 12 12 12 12 12 12 12 12	36 36 36 36 36 36 36 36 36	15M 200M 200M 200M 200M 200M 200M 200M 200M	0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15	5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M	15 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0	E E E E E E E E E	8.0M 7.2M 8.0M 7.2M 8.0M 7.2M 8.0M 7.2M 8.0M 7.2M	M T M T M T M T M T
2N501 2N511A 2N511B 2N512 2N512A 2N502B 2N503 2N504 2N506 2N507 2N508 2N508A 2N509	G G G G G G G G G G G G G	P P P P P P P P P N P P P	2N960 2N960 2N3283 2N3284 2N3284 2N3284 2N3284 2N3323 2N1189	8-74 8-74 9-51 9-51 9-51 9-51 9-71 6-7 6-28	HSS HSS RFA RFA RFC RFA RFA AFA AFC AFA RFA	60M 60M 60M 75M 75M 25M 30M 50M 50M 200M 0.2W 225M	A A A A A A A A A A A A A	100 100 85 100 100 85 85 200 100 100 100	15 15 20 30 30 20 35 18 18 30 30	12 12 20 20 20 20 25 18 18 30 30	S S S S S S S R S	20 30 30 30 30 30 20 200 200 100	10M 10M 10M 10M 10M 10M 10M 50M 50M 20M 20M 20M	0.2 0.2 0.2 0.2 0.2 0.2 0.6 0.6 0.6 0.6 0.6	10M 10M 10M 10M 10M 10M 50M 50M 50M 20M 20M 20M	9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0	E E E E E E E E E E E E	90M 90M 220M 220M 168M 50M 600K 600K 2.5M 2.5M 400M	T T T T T M B B B B B B T	
2N511 2N511A 2N511B 2N512 2N512A 2N512B 2N513 2N513A 2N513B 2N514 2N514A 2N514B	G G G G G G G G G G G G	P P P P P P P P P P P P	2N1554 2N1555 2N1556 2N1558 2N1559 2N1560 2N1163 2N1165 2N1167 2N1163 2N1165 2N1167	7-67 7-67 7-67 7-67 7-67 7-67 7-53 7-53 7-53 7-53 7-53 7-53	LPA LPA PMS LPA LPA PMS LPA LPA PMS PMS PMS PMS	150W 150W 150W 150W 150W 150W 150W 150W 150W 80W 80W 80W	C C C C C C C C C C C C	40 60 80 40 60 80 40 60 80 95 95 95	60 10 10 10 10 10 10 10 10 60 60 80	X X X X X X X X X X X	20 20 20 20 20 20 20 20 20 20 20 20	60 60 60 60 60 60 60 60 60 60 60 60	10A 10A 10A 15A 15A 15A 20A 20A 20A 20A 20A 20A	0.5 0.5 0.5 0.75 0.75 0.5 1.25 1.25 0.5 1.25 1.25 1.25	10A 10A 10A 15A 15A 10A 20A 20A 10A 25A 25A 25A	260K 260K 260K 260K 260K 260K 300K 300K 260K 260K 260K 260K	T T T T T T T T T T T T			
2N515 2N516 2N517 2N518 2N519 2N519A 2N520 2N520A 2N521 2N521A 2N522 2N522A	G G G G G G G G G G G G	N P P P P P P P P P P P			RFC RFC RFC MSS MSA MSA MSA MSA MSA MSA MSA MSA	50M 50M 50M 0.15W 100M 150M 100M 150M 100M 150M 100M 150M	A A A A A A A A A A A A	75 75 75 85 85 100 85 100 85 100 85 100	20 20 20 45 15 25 15 25 15 25 15 25	18 18 18 12 15 18 12 15 12 12 12 10	R R R O O O O O O O O O	60 60 60 60 20 50 40 170 60 250 80 320	10M 10M 10M 10M 20M 20M 20M 20M 20M 20M 20M 20M	0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15	10M 10M 10M 10M 10M 10M 10M 10M 10M 10M 10M 10M	4.0 4.0 4.0 4.0 15 15 20 40 35 70 60 100	E E E E E E E E E E E E	2.0M 2.0M 2.0M 10M 0.5M 0.5M 3.0M 2.0M 8.0M 8.0M 15M 15M	B B B B B B B B B B B B	
2N523 2N523A 2N524 2N524A 2N525 2N525A 2N526 2N526A 2N527 2N527A 2N528 2N529	G G G G G G G G G G G G	P P P P P P P P P P P P		6-17 6-17 6-17 6-17 6-17 6-17 6-17 6-17	MSA MSA AFA AFA AFA AFA AFA AFA AFA AFA AFA AFA	100M 150M 225M 225M 225M 225M 225M 225M 225M 225M 2.5W 100M	A A A A A A A A A A A A	85 100 100 100 100 100 100 100 100 100 100 85	15 20 45 45 45 45 45 45 45 45 40 15	6.0 6.0 30 30 30 30 30 30 30 30 40 15	O O R R R R R R R R R O	100 400 25 25 34 34 53 53 72 72 20	400 42 42 65 65 90 90 121 121 20M 20M	20M 20M 20M 20M 20M 20M 20M 20M 20M 20M 20M 0.5A	0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.5A	20M 20M 20M 20M 20M 20M 20M 20M 20M 20M 20M 20M	80 125 16 18 30 30 44 44 60 60 60	E E E E E E E E E E E E	21M 21M 800K 0.8M 1.0M 1.0M 1.3M 1.3M 1.5M 1.5M 1.5M 1.5M	B B B B B B B B B B B B
2N530 2N531 2N532 2N533 2N534 2N535 2N535A 2N535B 2N536 2N537 2N538 2N538A	G G G G G G G G G G G G	P P P P P P P P P P P P	2N1189 2N1192 2N1192 2N1193	6-28 6-30 6-30 6-30	AFA LNA LNA LNA MSS RFA	25M 50M 50M 50M 50M 30M	A A A A A A	85 85 85 85 85 100	15 15 15 15 20 20	15 15 15 15 20 20	O O O O U U U U U U	20 20 20 20 20 20 20 20 20 20	30M 30M 30M 30M 30M 30M 30M 30M 30M 30M	0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13	10M 10M 10M 10M 10M 10M 10M 10M 10M 10M	0.9 0.9 0.9 0.9	E E E E E E E E E E E E	1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M 1.0M	B B B B B B B B B B B B	
2N539 2N539A 2N540 2N540A 2N541 2N541A 2N542 2N542A 2N543 2N543A 2N544 2N545 2N546 2N547 2N548 2N549	G G G G G G G G G G G G G G G G	P P P P N N N N N N P P P P P P	2N2145 2N2145 2N1551 2N1551	7-78 7-78 7-67 7-67	PMS PMS PMS PMS VID AFA VID AFA VID AFA RFC RFA RFA RFA RFA	34W 11W 34W 34W 0.2W 0.2W 0.2W 0.2W 0.2W 0.2W 80M 5W 5W 5W 5W 5W	A A A A A A A A A A A A A A A A A	95 95 95 95 200 200 200 200 200 200 71 200 200 200 200 200	80 80 80 80 15 15 30 30 50 50 34 60 60 60 60 60	55 55 55 55 15 15 30 30 50 50 34 60 60 60 60 60	U U U U U U U U U U U O O O O O	30 30 45 45 15 15 20 20 20 20 20 15 15 20 20 20	75 75 113 113 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 0.5A 0.5A 0.5A 0.5A 0.5A	2.0A 2.0A 2.0A 2.0A 1.5 1.0 1.5 1.0 1.5 1.0 1.0 5.0 5.0 5.0 5.0 5.0	2.0A 2.0A 2.0A 2.0A 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 5.0M 0.5A 0.5A 0.5A 0.5A 0.5A	80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80	E E E E E E E E E E E E E E E E	10M 8.0M 10M 10M 10M 10M 10M 10M 10M 10M 10M 4.0M 4.0M 4.0M 4.0M	T T T T T T T T T T T T T T T T	

GERMANIUM MILLIWATT TRANSISTORS

This line of low-frequency, low-power transistors consists of a wide selection of highly reliable germanium PNP devices designed for general purpose switching, amplifier, and control applications.

The line is generally characterized by devices having a power rating to 225 mW, a maximum operating temperature range from -65°C to $+100^{\circ}\text{C}$, and a typical cutoff frequency ($f_{\alpha b}$) to 8 MHz.

QUICK SELECTION GUIDE — FOR AMPLIFIER / OSCILLATOR AND SWITCHING APPLICATIONS TO 20 KILOCYCLES

The following transistors merit first consideration within the specified gain-voltage groups. All of the specified devices have collector power dissipation ratings (P_D) of 150-225 mW, and a maximum operating junction temperature of 100°C .

MINIMUM DC CURRENT GAIN (h_{FE})	TRANSISTOR VOLTAGE RATING; V_{CE} (R = 10 k)			
	12-24	25-39	40-49	50-60
20	—	2N524	MA910 ③	2N2042
30	2N322	2N525 2N1191 ①	2N1924 2N1186	—
40	2N323 2N1008 ① ②	2N526 2N1192 ①	2N1008A ① ② 2N1925	2N1008B ① ② 2N2043
60	2N324 2N1705	2N527 2N1175	2N1926	—
90	2N467 2N508 MA1706	2N1193 ① 2N2171 2N3427	2N1188	—
130	MA1707	2N3428	—	—
180	MA1708	2N1194 ① MA1702	—	—

① Small Signal Current Gain h_{fe} ② V_{CEO} ③ V_{CES}

COMPLETE NUMERICAL-ALPHABETICAL LISTING

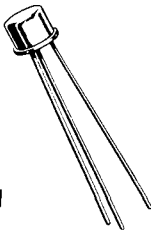
Type	MAXIMUM RATINGS					ELECTRICAL CHARACTERISTICS					MILITARY and Hi-Rel Type
	P _D mW	T _J °C	V _{CSO} volts	V _{CEB} (R = 10 k) volts	I _C mA	h _{FE} @ V _{CE} & I _C				f _{αB} typ MHz	
						min	max	volts	mA		
2N319	225	100	—	20	500	25	42	1	20	1.0 ⑤	
2N320	225	100	—	20	500	34	65	1	20	1.5 ⑤	
2N321	225	100	—	20	500	53	121	1	20	2.0 ⑤	
2N322	225	100	—	18	500	34	65	1	20	1.0 ⑤	
2N323	225	100	—	18	500	53	121	1	20	1.5 ⑤	
2N324	225	100	—	18	500	72	198	1	20	2.0 ⑤	
2N331	200	100	30	V _{EB} = 12	200	30	70	6	1	1.5	JAN 2N331
2N381	225	100	50	25	400	35	65	1	20	3	
2N382	225	100	50	25	400	60	95	1	20	4	
2N383	225	100	50	25	400	75	120	1	20	5	
2N398	50	85	105	V _{pt} = 105	100	20	—	0.35	5	1.0	USN 2N398
2N398A	150	100	105	V _{pt} = 105	200	20	—	0.35	5	1.0	
2N460	225	100	45	35 ⑦	400	31	200	6	1 ②	4	
2N461	225	100	45	35 ⑦	400	0.94 h _b	0.972	6	1 ②	1.2	USAF 2N461
2N464	200	100	45	40	100	14	—	6	1	1.0	
2N465	200	100	45	30	100	27	—	6	1	1.5	USA 2N465
2N466	200	100	35	20	100	56	—	6	1	2.0	JAN 2N466
2N467	200	100	35	15	100	112	—	6	1	2.5	USA 2N467
2N508	225	100	—	18	500	99	198	1	20	2.5 ⑤	
2N524	225	100	—	30	500	25	42	1	20	0.8 ⑤	2N524A ①
2N525	225	100	—	30	500	34	65	1	20	1.0 ⑤	2N525A ①
2N526	225	100	—	30	500	53	90	1	20	1.3 ⑤	JAN 2N526
2N527	225	100	—	30	500	72	121	1	20	1.5 ⑤	2N526A ①
2N650	200	100	45	30	500	30	70	6	1	1.5	2N527A ①
											2N650A ①
2N651	200	100	45	30	500	50	120	6	1	2.0	USN 2N650A
											2N651A ①
2N652	200	100	45	30	500	100	225	6	1	2.5	USN 2N651A
											2N652A ①
											USN 2N652A
2N653	200	100	30	25	250	30	70	6	1	1.5	
2N654	200	100	30	25	250	50	125	6	1	2.0	
2N655	200	100	30	25	250	100	250	6	1	2.5	
2N1008	200	100	20	20 ⑥	300	40 h _{FE}	150	5	10	—	
2N1008A	200	100	40	40 ⑥	300	40 h _{FE}	150	5	10	—	
2N1008B	200	100	60	60 ⑥	300	40 h _{FE}	150	5	10	—	
2N1175	225	100	—	25	500	70	140	1	20	1.5 ⑤	
2N1185	200	100	45	30	500	190	400	6	1	3.0	
2N1186	200	100	60	45	500	30	70	6	1	1.5	
2N1187	200	100	60	45	500	50	120	6	1	2.0	
2N1188	200	100	60	45	500	100	225	6	1	2.5	
2N1189	200	100	45	30	500	60	—	1	10 ②	3.5	
2N1190	200	100	45	30	500	100	—	1	10 ②	4.5	
2N1191	200	100	40	25	200	30	70	6	1	1.5	
2N1192	200	100	40	25	200	50	125	6	1	2.0	

2N508

FOR SPECIFICATIONS, SEE 2N322 DATA SHEET

2N524 thru 2N527
2N524A thru 2N527A, Hi-Rel
2N526 JAN

$V_{CB} = 45 \text{ V}$
 h_{FE} - to 72-121 (min-max)
 f_{α_b} - to 7.0 MHz (max)



CASE 31
(TO-5)

PNP germanium transistor for switching and amplifier applications in the audio-frequency range. Available for military and high-reliability industrial purposes.

Base connected to case

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CB}	45	Vdc
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Emitter-Base Voltage	V_{EB}	15	Vdc
Collector Current	I_C	500	mAdc
Storage and Operating Temperature	T_{stg}, T_j	-65 to +100	$^{\circ}\text{C}$
Collector Dissipation in Free Air @ 25 $^{\circ}\text{C}$ Ambient	P_D	225	mW
Thermal Resistance (Junction to Air)	θ_{JA}	0.333	$^{\circ}\text{C}/\text{mW}$
Thermal Resistance (infinite heat sink)	θ_{JC}	0.15	$^{\circ}\text{C}/\text{mW}$

MM2894 (SILICON)

$V_{CE0} = 12\text{ V}$
 $I_C = 100\text{ mA}$
 $h_{FE} = 70\text{ Typ}$
 $t_{OFF} = 60\text{ ns}$



CASE 22
(TO-18)

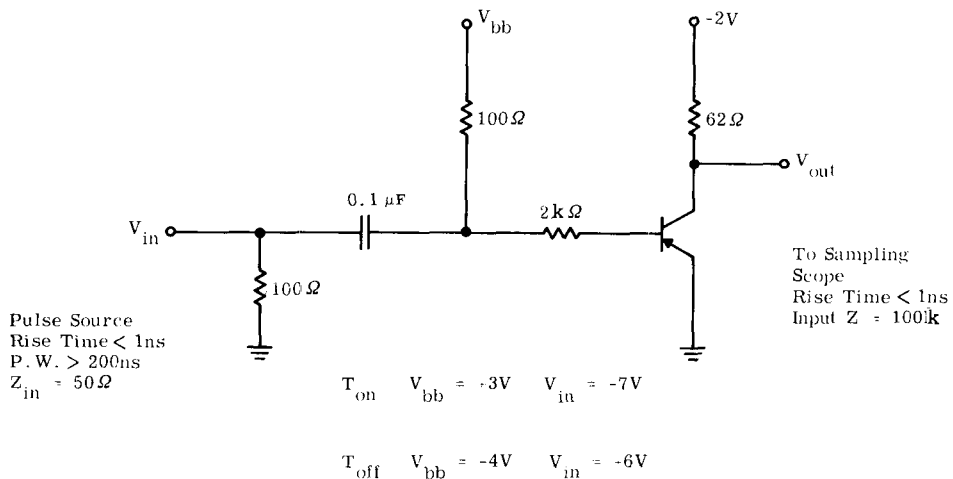
PNP silicon annular transistors for low-level, high-speed switching applications.

Collector connected to case

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CB}	15	Vdc
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Total Device Dissipation @ 25° C Ambient Temperature Derate above 25° C	P_D	0.36 2.06	Watt mW/° C
Total Device Dissipation @ 25° C Case Temperature Derate above 25° C	P_D	1.2 6.9	Watts mW/° C
Operating Junction Temperature	T_J	200	° C
Storage Temperature	T_{stg}	-65 to 200	° C

SWITCHING TIME TEST CIRCUIT



2N524 THRU 2N527 (continued)

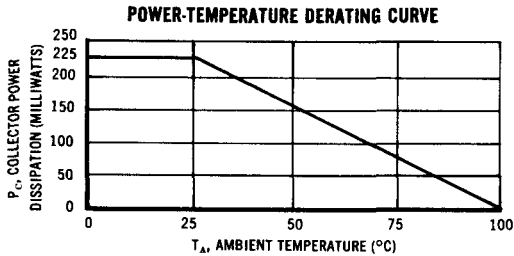
ELECTRICAL CHARACTERISTICS ($T_c = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
Collector Cutoff Current ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	-	10	μAdc
Emitter Cutoff Current ($V_{EB} = 15 \text{ Vdc}$, $I_C = 0$)	I_{EBO}	-	10	μAdc
Collector-Emitter Breakdown Voltage ($I_C = 0.6 \text{ mAdc}$, $R_{BE} = 10\text{K}$)	BV_{CER}	30	-	μVdc
Collector-Emitter Reach Through (Punch-Thru) Voltage ($V_{EB} = 1 \text{ Vdc}$, $V_{TVM Z} \geq 1 \text{ Megohm}$)	V_{RT}	30	-	μVdc
Static Forward-Current Transfer Ratio ($V_{CE} = 1 \text{ Vdc}$, $I_C = 20 \text{ mAdc}$)	h_{FE}			
		25	42	-
		34	65	-
		53	90	-
		72	121	-
Small-Signal Short-Circuit Forward Current Transfer Ratio Frequency Cutoff ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$)	$f_{\alpha b}$			MHz
		0.8	5.0	
		1.0	5.5	
		1.3	6.5	
		1.5	7.0	
Output Capacitance ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ MHz}$)	C_{ob}	5	40	pF
Small-Signal Open Circuit Output Admittance ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ kHz}$)	h_{ob}			μmho
		0.10	1.3	
		0.10	1.2	
		0.10	1.0	
		0.10	0.9	
Small-Signal Open Circuit Reverse Transfer Voltage Ratio ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ kHz}$)	h_{rb}			$\times 10^{-4}$
		1.0	10	
		1.0	11	
		1.0	12	
		1.0	14	
Small-Signal Short Circuit Input Impedance ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ kHz}$)	h_{ib}			ohms
		26	36	
		26	35	
		26	33	
		26	31	
Collector-Emitter Saturation Voltage ($I_B = 2 \text{ mAdc}$, $I_C = 20 \text{ mAdc}$)	$V_{CE}(\text{sat})$			mVdc
		-	130	
		-	130	
		-	130	
		-	130	
Base Input Voltage ($V_{CE} = 1 \text{ Vdc}$, $I_C = 20 \text{ mAdc}$)	V_{BE}			mVdc
		220	320	
		200	300	
		190	280	
		180	260	

2N524 thru 2N527 (continued)

ELECTRICAL CHARACTERISTICS (continued)

Characteristics	Symbol	Min	Max	Unit
Noise Figure ($V_{CB} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ kHz}$, $BW = 1 \text{ Hz}$)	NF	-	15	dB
Small-Signal Short-Circuit Forward-Current Transfer Ratio ($V_{CE} = 5 \text{ Vdc}$, $I_E = 1 \text{ mAdc}$, $f = 1 \text{ kHz}$)	h_{fe}			
2N524		18	41	-
2N525		30	64	
2N526		44	88	
2N527		60	120	



The maximum continuous power is related to maximum junction temperature by the thermal resistance factor.
This curve has a value of 225mW at case temperatures of 25°C and is 0 mW at 100°C with a linear relation between the two temperatures such that:

$$\text{allowable } P_D = \frac{100^\circ - T_A}{0.333}$$

