

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_{CER} (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 | — | — |

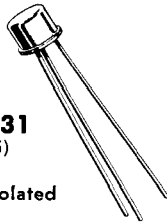
① Small Signal Current Gain h_{fe} ② V_{CEO} ③ V_{CES}

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 | |

2N1191 thru 2N1194

$V_{CB} = 40 \text{ V}$
 $h_{FE} - \text{to } 125\text{-}600 \text{ (min-max)}$
 $f_{\alpha_b} - \text{to } 3.0 \text{ MHz (typ)}$



CASE 31
(TO-5)

All leads isolated

PNP germanium transistors for high-gain audio amplifier and switching applications.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------|-------------|-------|
| Collector-Base Voltage | V_{CB} | 40 | Vdc |
| Collector-Emitter Voltage | V_{CER} | 25 | Vdc |
| Emitter-Base Voltage | V_{EB} | 25 | Vdc |
| Collector Current (Continuous) | I_C | 200 | mAdc |
| Storage and Operating Temperature | T_{stg}, T_J | -65 to +100 | °C |
| Collector Dissipation in Free Air (Derate 2.67 mW/°C above 25°C) | P_D | 200 | mW |
| Thermal Resistance (Junction to Air) | θ_{JA} | 0.375 | °C/mW |
| Thermal Resistance (Junction to Case) | θ_{JC} | 0.250 | °C/mW |

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

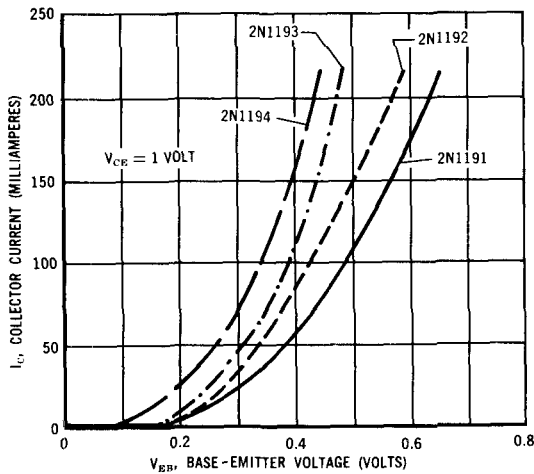
| Characteristic | Symbol | Min | Typ | Max | Unit | |
|---|------------------------|--------|-----|-----|-----------------|-----|
| Collector-Base Cutoff Current ($V_{CB} = 25 \text{ V}, I_E = 0$) ($V_{CB} = 1.0 \text{ V}, I_E = 0$) | All Types I_{CBO} | - | - | 15 | μAdc | |
| | | - | 2.0 | - | μAdc | |
| Emitter-Base Cutoff Current ($V_{EB} = 25 \text{ V}, I_C = 0$) | All Types I_{EBO} | - | - | 15 | μAdc | |
| Collector-Emitter Leakage Current ($V_{CB} = 25 \text{ V}, R_{BE} = 10 \text{ K}$) | All Types I_{CER} | - | - | 600 | μAdc | |
| Output Capacitance ($V_{CE} = 6 \text{ V}, I_E = 1.0 \text{ mA}$) | All Types C_{ob} | - | 20 | - | pF | |
| Noise Figure ($V_{CE} = 4.5 \text{ V}, I_E = 0.5 \text{ mA}$, $f = 1 \text{ kHz}, R_S = 100 \text{ ohms}$) | All Types NF | - | 10 | - | dB | |
| Small Signal Current Gain Cutoff Frequency ($V_{CB} = 6 \text{ V}, I_E = 1.0 \text{ mA}$) | f_{ob} | 2N1191 | - | 1.5 | - | MHz |
| | | 2N1192 | - | 2.0 | - | |
| | | 2N1193 | - | 2.5 | - | |
| | | 2N1194 | - | 3.0 | - | |

2N1191 thru 2N1194 (continued)

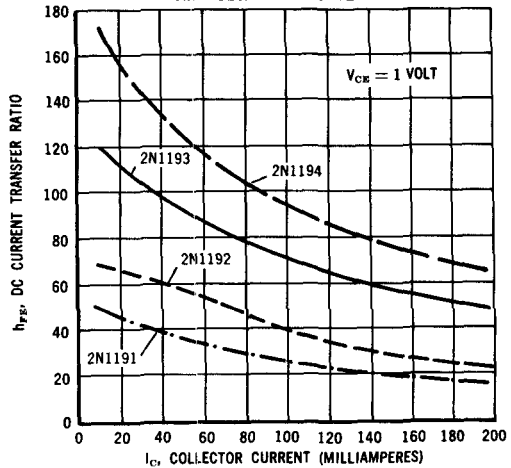
ELECTRICAL CHARACTERISTICS (continued)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|--|-----------|----------|-----|-----|-----|------|
| Small Signal Current Gain ($V_{CE} = 6 \text{ V}$, $I_E = 1.0 \text{ mA}$, $f = 1 \text{ kHz}$) | 2N1191 | h_{fe} | 30 | 40 | 70 | — |
| | 2N1192 | | 50 | 75 | 125 | |
| | 2N1193 | | 100 | 160 | 250 | |
| | 2N1194 | | 190 | 280 | 500 | |
| DC Current Gain ($V_{CE} = 1 \text{ V}$, $I_C = 10 \text{ mA}$) | 2N1191 | h_{FE} | 20 | — | 80 | — |
| | 2N1192 | | 40 | — | 135 | |
| | 2N1193 | | 70 | — | 300 | |
| | 2N1194 | | 125 | — | 600 | |
| Small Signal Power Gain ($V_{CE} = 6 \text{ V}$, $I_E = 1.0 \text{ mA}$, $f = 1 \text{ kHz}$, matched) | 2N1191 | G_e | — | 42 | — | dB |
| | 2N1192 | | — | 44 | — | |
| | 2N1193 | | — | 46 | — | |
| | 2N1194 | | — | 48 | — | |
| Base-Emitter Input Voltage ($V_{CE} = 6 \text{ V}$, $I_C = 1.0 \text{ mA}$) | All Types | V_{BE} | — | — | 0.3 | Vdc |

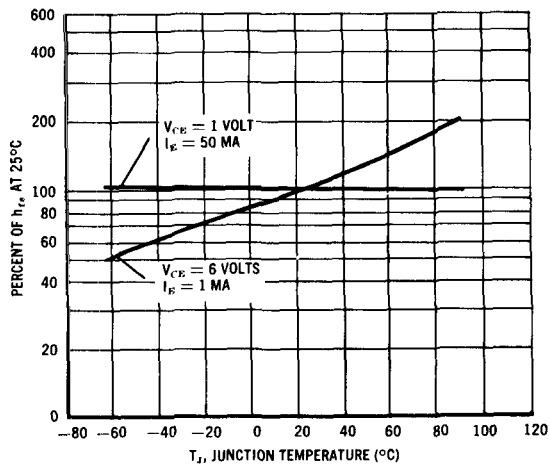
OUTPUT CURRENT versus BASE DRIVE VOLTAGE



DC CURRENT TRANSFER RATIO versus CURRENT COLLECTOR



SMALL SIGNAL CURRENT GAIN (h_{fe}) versus TEMPERATURE
(For All Types)



POWER-TEMPERATURE DERATING CURVE
(For All Types)

