MOTOROLA
SEMICONDUCTORS
P.O. BOX 20912 • PHOENIX, ARIZONA 85036

| PNP | NPN |
|---|---|
| 2N6050 | 2N6057 |
| 2N6051 | 2N6058 |
| 2N6052 | 2N6059 |

## DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

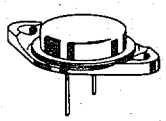
. . . designed for general-purpose amplifier and low-speed switching applications.

- High DC Current Gain — $h_{FE}$ = 3500 (Typ) @ $I_C$ = 5.0 Adc
- Collector-Emitter Sustaining Voltage — @ 100 mA
  $V_{CEO(sus)}$ = 60 Vdc (Min) — 2N6050, 2N6057
  80 Vdc (Min) — 2N6051, 2N6058
  100 Vdc (Min) — 2N6052, 2N6059
- Monolithic Construction with Built-In Base-Emitter Shunt Resistors

**DARLINGTON**
**12 AMPERE**

**COMPLEMENTARY SILICON POWER TRANSISTORS**

**60-80-100 VOLTS**
**150 WATTS**



### *MAXIMUM RATINGS

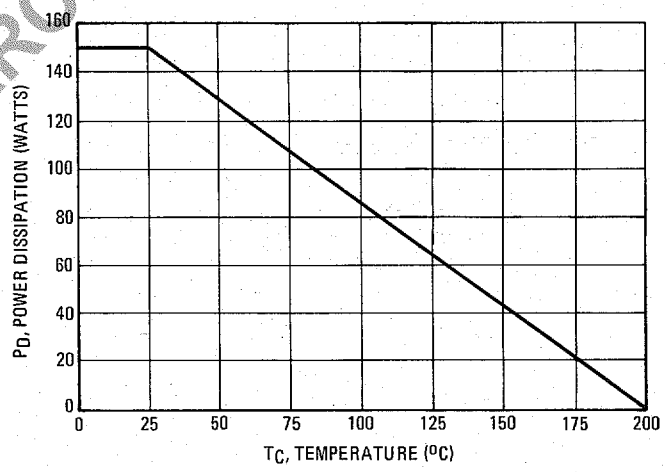
| Rating | Symbol | 2N6050 2N6057 | 2N6051 2N6058 | 2N6052 2N6059 | Unit |
|---|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 60 | 80 | 100 | Vdc |
| Collector-Base Voltage | $V_{CB}$ | 60 | 80 | 100 | Vdc |
| Emitter-Base Voltage | $V_{EB}$ | 5.0 | | | Vdc |
| Collector Current — Continuous<br>Peak | $I_C$ | 12<br>20 | | | Adc |
| Base Current | $I_B$ | 0.2 | | | Adc |
| Total Device Dissipation @$T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 150<br>0.857 | | | Watts<br>W/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | -65 to +200°C | | | °C |

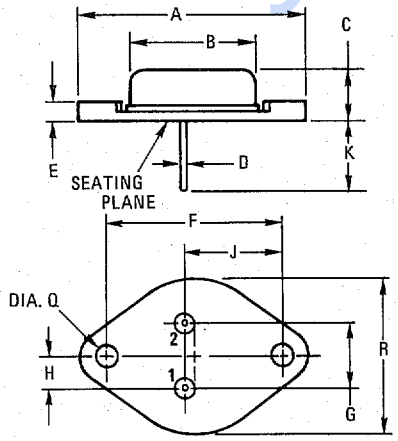
### THERMAL CHARACTERISTICS

| Characteristic | Symbol | Rating | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $\theta_{JC}$ | 1.17 | °C/W |

*Indicates JEDEC Registered Data

**FIGURE 1 — POWER DERATING**




STYLE 1:
PIN 1. BASE
2. EMITTER
CASE: COLLECTOR

| DIM | MILLIMETERS MIN | MILLIMETERS MAX | INCHES MIN | INCHES MAX |
|---|---|---|---|---|
| A | — | 39.37 | — | 1.550 |
| B | — | 22.23 | — | 0.875 |
| C | 6.35 | 11.43 | 0.250 | 0.450 |
| D | 0.97 | 1.09 | 0.038 | 0.043 |
| E | — | 3.43 | — | 0.135 |
| F | 29.90 | 30.40 | 1.177 | 1.197 |
| G | 10.67 | 11.18 | 0.420 | 0.440 |
| H | 5.21 | 5.72 | 0.205 | 0.225 |
| J | 16.64 | 17.15 | 0.655 | 0.675 |
| K | 11.18 | 12.19 | 0.440 | 0.480 |
| Q | 3.84 | 4.09 | 0.151 | 0.161 |
| R | — | 26.67 | — | 1.050 |

**CASE 11-03**
**TO-3**

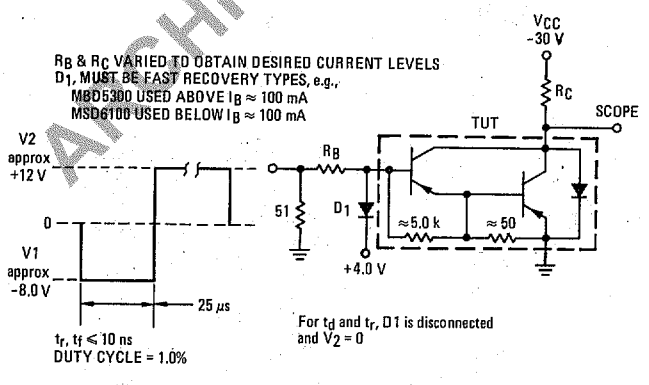
## *ELECTRICAL CHARACTERISTICS ($T_C$ = 25°C unless otherwise noted)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Sustaining Voltage (1) ($I_C$ = 100 mAdc, $I_B$ = 0) | 2N6050, 2N6057 | $V_{CEO(sus)}$ | 60 | – | Vdc |
| | 2N6051, 2N6058 | | 80 | – | |
| | 2N6052, 2N6059 | | 100 | – | |
| Collector Cutoff Current | | $I_{CEO}$ | | | mAdc |
| ($V_{CE}$ = 30 Vdc, $I_B$ = 0) | 2N6050, 2N6057 | | – | 1.0 | |
| ($V_{CE}$ = 40 Vdc, $I_B$ = 0) | 2N6051, 2N6058 | | – | 1.0 | |
| ($V_{CE}$ = 50 Vdc, $I_B$ = 0) | 2N6052, 2N6059 | | – | 1.0 | |
| Collector Cutoff Current | | $I_{CEX}$ | | | mAdc |
| ($V_{CE}$ = Rated $V_{CEO}$, $V_{BE(off)}$ = 1.5 Vdc) | | | – | 0.5 | |
| ($V_{CE}$ = Rated $V_{CEO}$, $V_{BE(off)}$ = 1.5 Vdc, $T_C$ = 150°C) | | | | 5.0 | |
| Emitter Cutoff Current ($V_{BE}$ = 5.0 Vdc, $I_C$ = 0) | | $I_{EBO}$ | – | 2.0 | mAdc |
| **ON CHARACTERISTICS (1)** | | | | | |
| DC Current Gain | | $h_{FE}$ | | | – |
| ($I_C$ = 6.0 Adc, $V_{CE}$ = 3.0 Vdc) | | | 750 | 18,000 | |
| ($I_C$ = 12 Adc, $V_{CE}$ = 3.0 Vdc) | | | 100 | – | |
| Collector-Emitter Saturation Volatage | | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 6.0 Adc, $I_B$ = 24 mAdc) | | | – | 2.0 | |
| ($I_C$ = 12 Adc, $I_B$ = 120 mAdc) | | | – | 3.0 | |
| Base-Emitter Saturation Voltage ($I_C$ = 12 Adc, $I_B$ = 120 mAdc) | | $V_{BE(sat)}$ | – | 4.0 | Vdc |
| Base-Emitter On Voltage ($I_C$ = 6.0 Adc, $V_{CE}$ = 3.0 Vdc) | | $V_{BE(on)}$ | – | 2.8 | Vdc |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Magnitude of Common Emitter Small-Signal Short Circuit Forward Current Transfer Ratio ($I_C$ = 5.0 Adc, $V_{CE}$ = 3.0 Vdc, f = 1.0 MHz) | | $\|h_{fe}\|$ | 4.0 | – | MHz |
| Output Capacitance | 2N6050/2N6052 | $C_{ob}$ | – | 500 | pF |
| ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 0.1 MHz) | 2N6057/2N6059 | | – | 300 | |
| Small-Signal Current Gain ($I_C$ = 5.0 Adc, $V_{CE}$ = 3.0 Vdc, f = 1.0 kHz) | | $h_{fe}$ | 300 | – | – |

*Indicates JEDEC Registered Data
(1) Pulse test: Pulse Width = 300 μs, Duty Cycle = 2.0%.



### FIGURE 2 – SWITCHING TIMES TEST CIRCUIT




For NPN test circuit reverse diode and voltage polarities.

### FIGURE 3 – SWITCHING TIMES

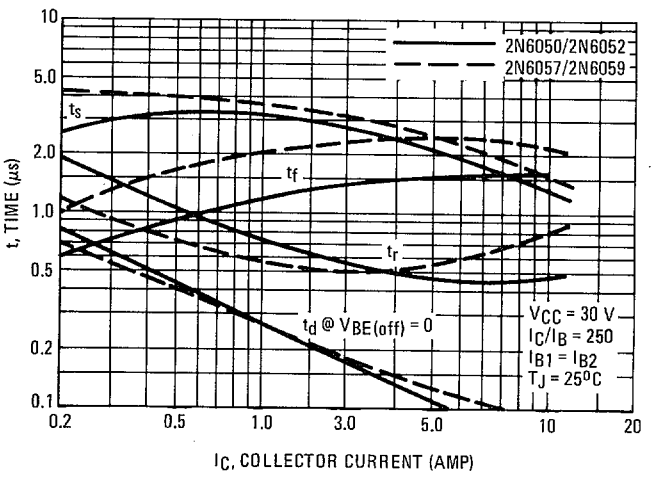
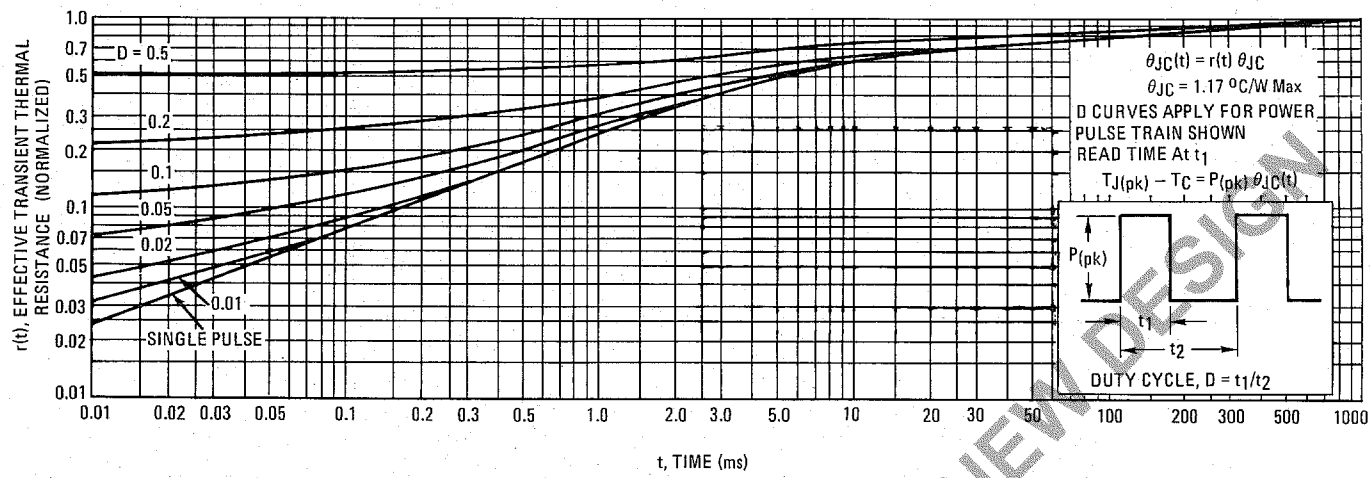


**FIGURE 4 – THERMAL RESPONSE**




## ACTIVE-REGION SAFE OPERATING AREA

**FIGURE 5 – 2N6050, 2N6057**

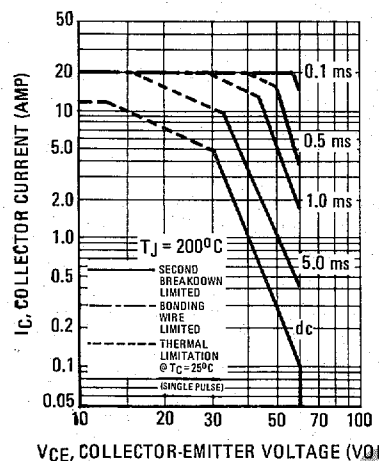



**FIGURE 6 – 2N6051, 2N6058**

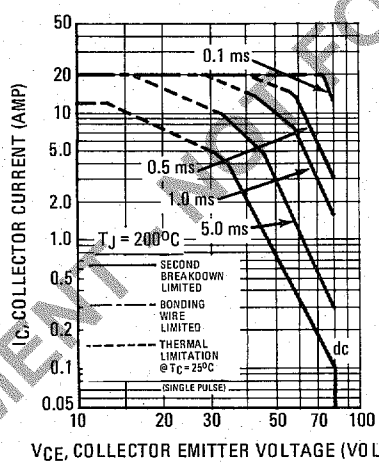
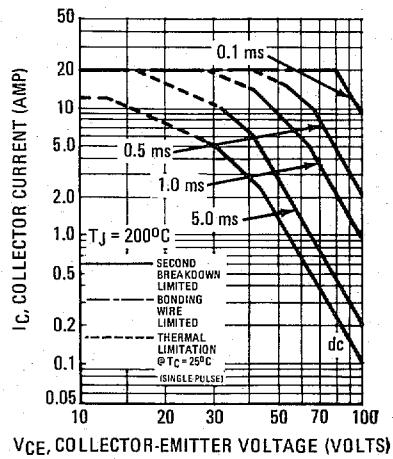



**FIGURE 7 – 2N6052, 2N6059**




There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figures 5, 6 and 7 is based on $T_{J(pk)} = 200^oC$; $T_C$ is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 200^oC$ $T_{J(pk)}$ may be calculated from the data in Figure 4. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415).

**FIGURE 8 – SMALL-SIGNAL CURRENT GAIN**

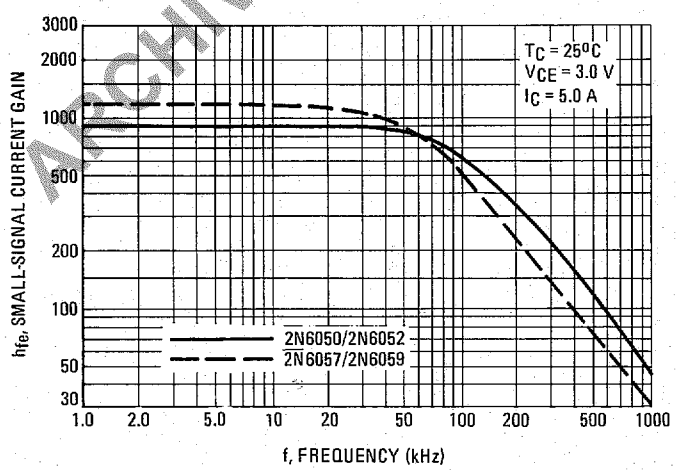
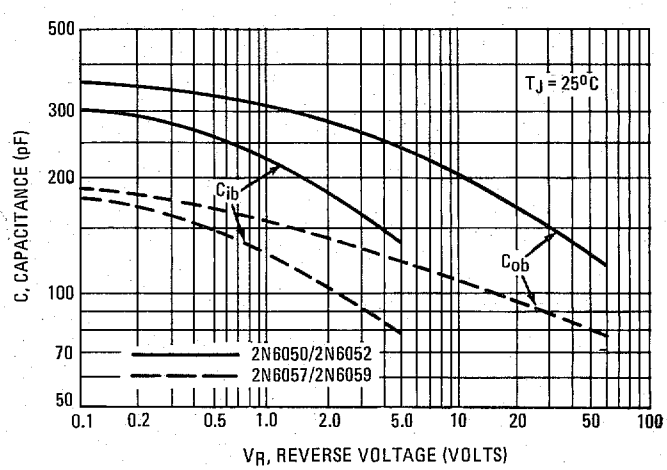


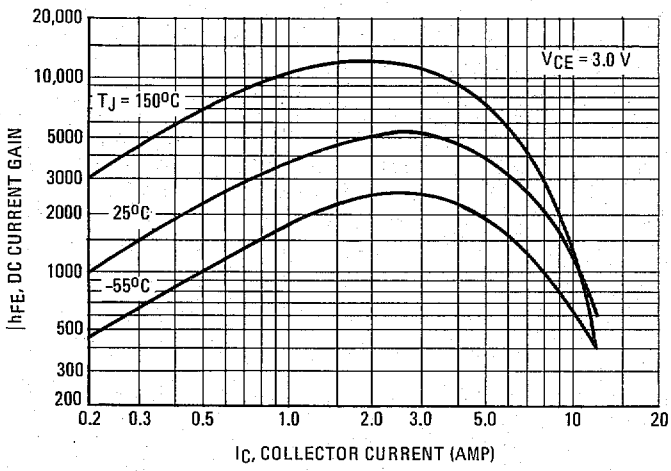

**FIGURE 9 – CAPACITANCE**



**PNP**
**2N6050, 2N6051, 2N6052**

**NPN**
**2N6057, 2N6058, 2N6059**

**FIGURE 10 – DC CURRENT GAIN**



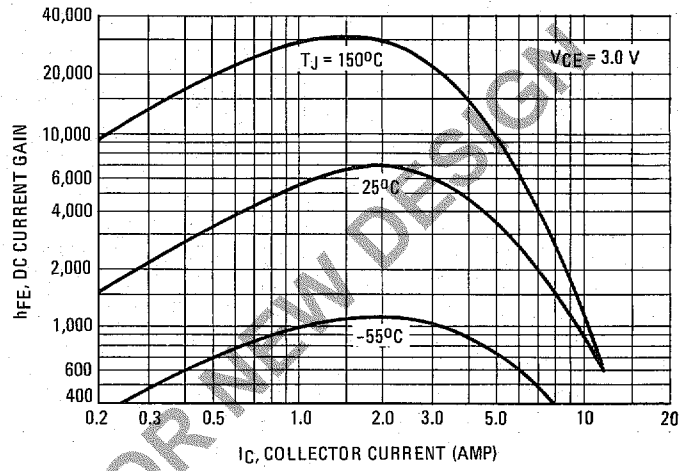
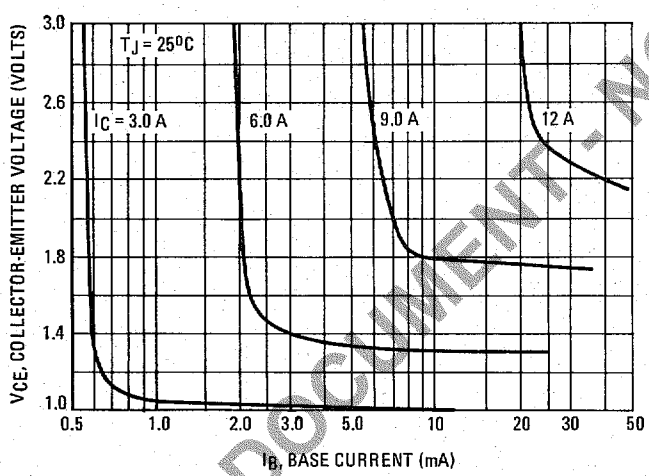




**FIGURE 11 – COLLECTOR SATURATION REGION**



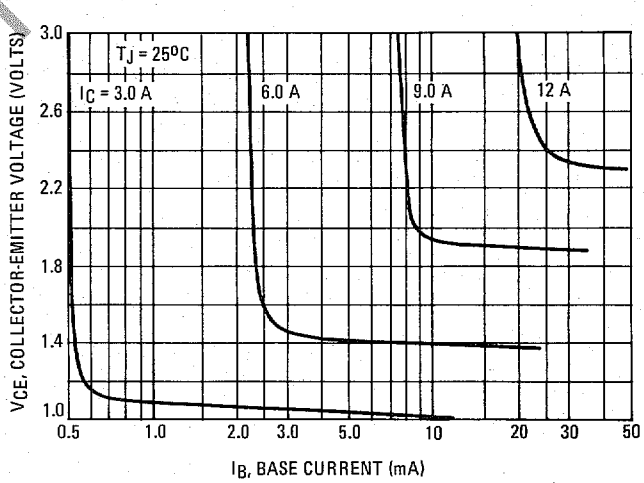
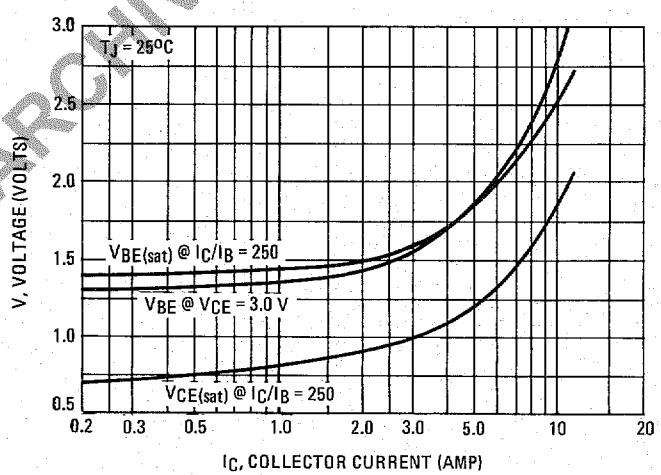
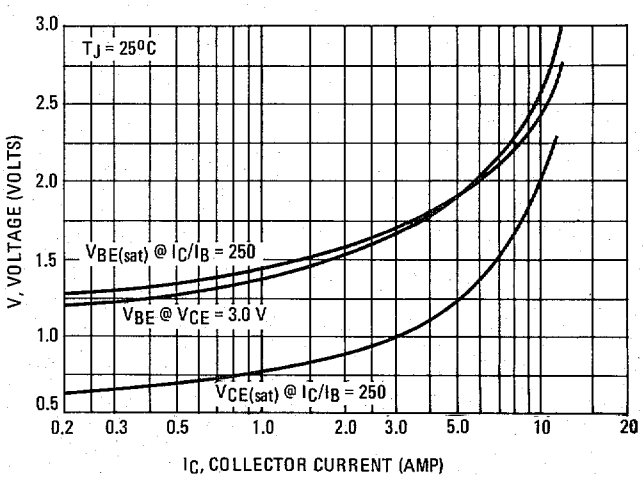




**FIGURE 12 – "ON" VOLTAGES**

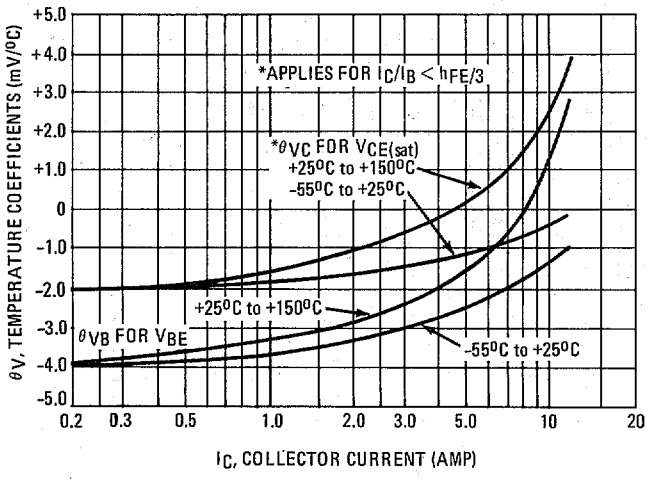


**PNP**
**2N6050, 2N6051, 2N6052**

**NPN**
**2N6057, 2N6058, 2N6059**

**FIGURE 13 – TEMPERATURE COEFFICIENTS**



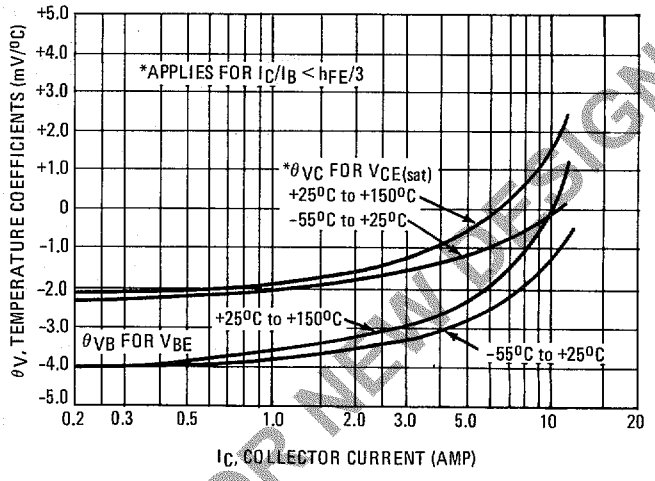
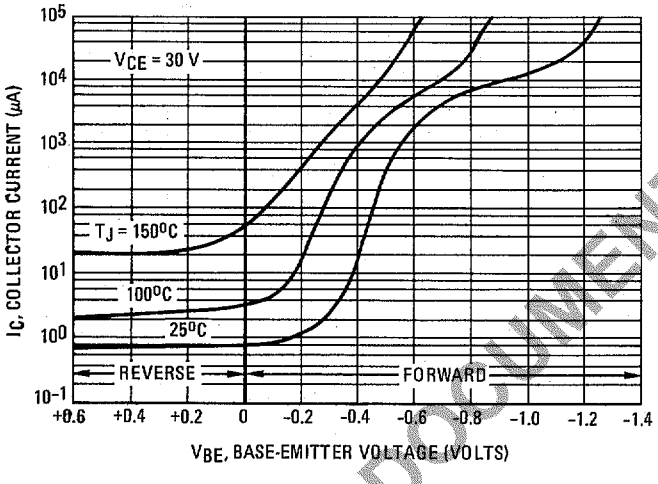




**FIGURE 14 – COLLECTOR CUT-OFF REGION**



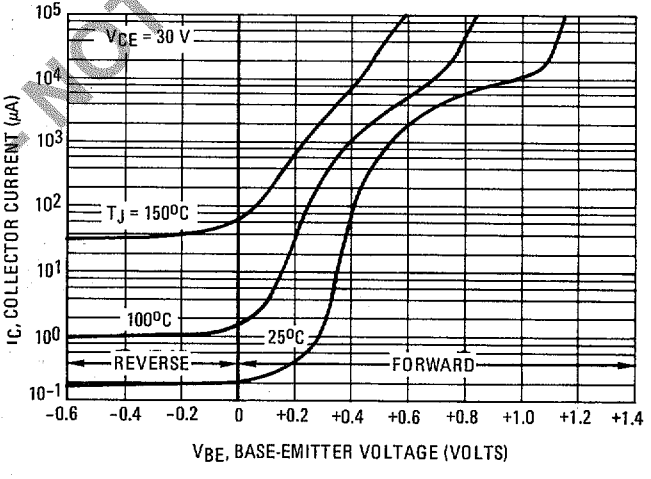
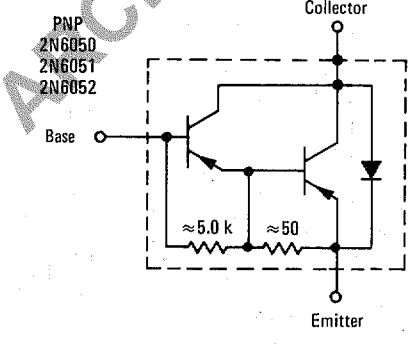
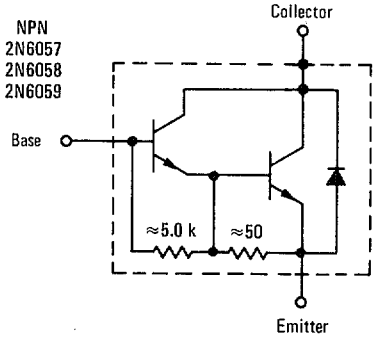




**FIGURE 15 – DARLINGTON SCHEMATICS**



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