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*Consult Motorola if a direct replacement is necessary.

## TABLE 5 — PLASTIC TO-220 (continued)

| $I_C$ Cont Amps Max | $V_{CEO(sus)}$ Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | @ $I_C$ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching @ $I_C$ Amp | $f_T$ MHz Min | $P_D$ (Case) Watts @ 25°C |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 45 | BD795 | BD796 | 25 min | 3 | | | | 3 | 65 |
| | 50 | 2N6290 | 2N6109 | 30/150 | 2.5 | 0.4 typ | 0.15 typ | 3 | 4 | 40 |
| | 60 | BD797 | BD798 | 25 min | 3 | | | | 3 | 65 |
| | 70 | 2N6292 | 2N6107 | 30/150 | 3 | 0.4 typ | 0.15 typ | 3 | 4 | 40 |
| | 80 | BD799 | BD800 | 15 min | 3 | | | | 3 | 65 |
| | 100 | BD801 | BD802 | 15 min | 3 | | | | 3 | 65 |
| | 150 | BU407,D | | 30 min | 1.5 | | 0.75 | 5 | 10 | 60 |
| | 200 | BU406,D | | 30 min | 1.5 | | 0.75 | 5 | 10 | 60 |
| | 375 | BU522## | | 250 min | 2.5 | | | | 7.5 | 75 |
| | 425 | BU522A## | | 250 min | 2.5 | | | | 7.5 | 75 |
| | 450 | BU522B## | | 250 min | 2.5 | | | | 7.5 | 75 |
| 8 | 40 | 2N6386## | | 1k/20k | 3 | | | | 20# | 65 |
| | 45 | BDX53## | BDX54## | 750 min | 3 | | | | 4# | 60 |
| | | BD895## | BD896## | 750 min | 3 | | | | 1# | 70 |
| | | BD895A## | BD896A## | 750 min | 4 | | | | 1# | 70 |
| | 60 | 2N6043## | 2N6040## | 1k/10k | 4 | 1.5 typ | 1.5 typ | 3 | 4# | 75 |
| | | BDX53A## | BDX54A## | 750 min | 3 | | | | 4# | 60 |
| | | BD897## | BD898## | 750 min | 3 | | | | 1# | 70 |
| | | BD897A## | BD898A## | 750 min | 4 | | | | 1# | 70 |
| | | TIP100## | TIP105## | 1k/20k | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 80 |
| | 80 | 2N6044## | 2N6041## | 1k/10k | 4 | 1.5 typ | 1.5 typ | 3 | 4# | 75 |
| | | BDX53B## | BDX54B## | 750 min | 3 | | | | 4# | 60 |
| | | BD899## | BD900## | 750 min | 3 | | | | 1# | 70 |
| | | BD899A## | BD900A## | 750 min | 4 | | | | 1# | 70 |
| | | TIP101## | TIP106## | 1k/20k | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 80 |
| | 100 | 2N6045## | 2N6042## | 1k/10k | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 75 |
| | | BDX53C## | BDX54C## | 750 min | 3 | | | | 4# | 60 |
| | | BD901## | BD902## | 750 min | 3 | | | | 1# | 70 |
| | | TIP102## | TIP107## | 1k/20k | 3 | 1.5 typ | 1.5 typ | 3 | 4# | 80 |
| | 120 | BDX53D## | BDX54D## | 750 min | 3 | | | | 4# | 60 |
| | | MJE15028 | MJE15029 | 20 min | 4 | | | | 30 | 50 |
| | 150 | MJE15030 | MJE15031 | 20 min | 4 | | | | 30 | 50 |
| | | BU807## | | 100 min | 5 | 0.55 typ | 0.2 typ | 5 | | 60 |
| | 200 | BU806## | | 100 min | 5 | 0.55 typ | 0.2 typ | 5 | | 60 |
| | 300 | MJE13006 | | 5/30 | 5 | 3 | 0.7 | 5 | 4 | 80 |
| | | MJE5740## | | 200 min | 4 | 8 typ | 2 typ | 6 | | 80 |
| | | | MJE5850 | 15 min | 2 | 2 | 0.5 | 4 | | 80 |
| | 350 | MJE5741## | | 200 min | 4 | 8 typ | 2 typ | 6 | | 80 |
| | | | MJE5851 | 15 min | 2 | 2 | 0.5 | 4 | | 80 |
| | 400 | MJE5742## | | 200 min | 4 | 8 typ | 2 typ | 6 | | 80 |
| | | MJE13007 | | 5/30 | 5 | 3 | 0.7 | 5 | 4 | 80 |
| | | | MJE5852 | 15 min | 2 | 2 | 0.5 | 4 | | 80 |
| | | MJE16080 | | 5 min | 8 | 2 | 0.5 | 5 | | 80 |
| | | MJE16106 | | 6/25 | 8 | 2 typ | 0.1 typ | 5 | | 100 |
| | 450 | MJE16081 | | 5 min | 8 | 2 | 0.5 | 5 | | 80 |
| 10 | 30 | | D45H1 | 20 min | 4 | | | | | 50 |
| | | | D45H2 | 40 min | 4 | | | | | 50 |
| | 40 | D44E1## | | 1000 min | 5 | 2 typ | 0.5 typ | 10 | | 50 |
| | 45 | BDX33## | BDX34## | 750 min | 4 | | | | 3 | 70 |
| | | BD805 | BD806 | 15 min | 4 | | | | 1.5 | 90 |
| | | | D45H4 | 20 min | 4 | | | | | 50 |
| | | D44H5 | D45H5 | 40 min | 4 | | | | | 50 |
| | 60 | BDX33A## | BDX34A## | 750 min | 4 | | | | 3 | 70 |
| | | BD807 | BD808 | 15 min | 4 | | | | 1.5 | 90 |

# $|h_{fe}|$ @ 1 MHz, ## Darlington

(continued)

## TABLE 12 — POWER DARLINGTONS (continued)

| $I_C$ Cont Amps Max | $V_{CEO(sus)}$ Volts Min | Device Type NPN | Device Type PNP | $h_{FE}$ Min/Max | @ $I_C$ Amp | Resistive Switching $t_s$ μs Max | Resistive Switching $t_f$ μs Max | Resistive Switching @ $I_C$ Amp | $\|h_{fe}\|$ @ 1 MHz Min | $P_D$ (Case) Watts @ 25°C | Case JEDEC/MOT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 40 | MJE3300 | MJE3310 | 1k min | 1 | | | | 20 | 15 | TO-225AA/77R |
| | | 2N6037 | 2N6034 | 750/1k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-225AA/77 |
| | 45 | BD675 | BD676 | 750 min | 1.5 | | | | | 40 | TO-225AA/77 |
| | | BD675A | BD676A | 750 min | 2 | | | | | 40 | TO-225AA/77 |
| | | | BD776 | 750 min | 2 | | | | 20 | 15 | TO-225AA/77 |
| | 60 | BD677 | BD678 | 750 min | 1.5 | | | | | 15 | TO-225AA/77 |
| | | BD677A | BD678A | 750 min | 2 | | | | | 40 | TO-225AA/77 |
| | | BD777 | BD778 | 750 min | 2 | | | | 20 | 40 | TO-225AA/77 |
| | | MJE3301 | | 1k min | 1 | | | | 20 | 15 | TO-225AA/77R |
| | | MJE800 | MJE700 | 750 min | 1.5 | | | | 1 | 40 | TO-225AA/77 |
| | | MJE800T | MJE700T | 750 min | 1.5 | | | | 1 | 40 | TO-220/221A |
| | | MJE801 | MJE701 | 750 min | 2 | | | | 1 | 40 | TO-225AA/77 |
| | | 2N6038 | 2N6035 | 750/18k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-225AA/77 |
| | | 2N6294 | 2N6296 | 750/18k | 2 | 0.9 typ | 0.7 typ | 2 | 4 | 50 | TO-213AA/80 |
| | 80 | BD679 | BD680 | 750 min | 1.5 | | | | | 40 | TO-225AA/77 |
| | | BD679A | BD680A | 750 min | 2 | | | | | 40 | TO-225AA/77 |
| | | BD779 | BD780 | 750 min | 2 | | | | 20 | 15 | TO-225AA/77 |
| | | MJD6039 | MJD6036 | 1k/12k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 20 | TO-252/369A-04 |
| | | MJE802 | MJE702 | 750 min | 1.5 | | | | | 40 | TO-225AA/77 |
| | | MJE803 | MJE703 | 750 min | 2 | | | | | 40 | TO-225AA/77 |
| | | 2N6039 | 2N6036 | 750/18k | 2 | 1.7 typ | 1.2 typ | 2 | 25 | 40 | TO-225AA/77 |
| | | 2N6295 | 2N6297 | 750/18k | 2 | 0.9 typ | 0.7 typ | 2 | 4 | 50 | TO-213AA/80 |
| | 100 | BD681 | BD682 | 750 min | 1.5 | | | | | 40 | TO-225AA/77 |
| 5 | 60 | MJE1100 | MJE1090 | 750 min | 3A | | | | 1 | 70 | TO-225AB/90 |
| | | MJE1101 | MJE1091 | 750 min | 4A | | | | 1 | 70 | TO-225AB/90 |
| | | TIP120 | TIP125 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| | 80 | MJE1102 | MJE1092 | 750 min | 3A | | | | 1 | 70 | TO-225AB/90 |
| | | MJE1103 | MJE1102 | 750 min | 4A | | | | 1 | 70 | TO-225AB/90 |
| | | TIP121 | TIP126 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| | 100 | MJF122 | MJF127 | 2k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 28 | —/221C-02 |
| | | TIP122 | TIP127 | 1k min | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 65 | TO-220/221A |
| 7 | 300 | MJ3041 | | 250 min | 2.5 | | | | | 100 | TO-204/1 |
| | 350 | MJ3042 | | 250 min | 2.5 | | | | | 100 | TO-204/1 |
| | 375 | BU522 | | 250 min | 2.5 | | | | 7.5 | 75 | TO-220/221A |
| | 425 | BU522A | | 250 min | 2.5 | | | | 7.5 | 75 | TO-220/221A |
| | 450 | BU522B | | 250 min | 2.5 | | | | 7.5 | 75 | TO-220/221A |
| 8 | 40 | 2N6386 | | 1k/20k | 3 | | | | 20 | 65 | TO-220/221A |
| | 45 | BDX53 | BDX54 | 750 min | 3 | | | | 4 | 60 | TO-220/221A |
| | | BD895 | BD896 | 750 min | 3 | | | | 1 | 70 | TO-220/221A |
| | | BD895A | BD896A | 750 min | 4 | | | | 1 | 70 | TO-220/221A |
| | 60 | BDX53A | BDX54A | 750 min | 3 | | | | 4 | 60 | TO-220/221A |
| | | BD897 | BD898 | 750 min | 3 | | | | 1 | 70 | TO-220/221A |
| | | BD897A | BD898A | 750 min | 4 | | | | 1 | 70 | TO-220/221A |
| | | MJ1000 | MJ900 | 1k min | 3 | | | | | 90 | TO-204/1 |
| | | TIP100 | TIP105 | 1k/20k | 3 | 1.5 typ | 1.5 typ | 3 | 4 | 80 | TO-220/221A |
| | | 2N6043 | 2N6040 | 1k/10k | 4 | 1.5 typ | 1.5 typ | 3 | 4 | 75 | TO-220/221A |
| | | 2N6300 | 2N6298 | 750k/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 75 | TO-213AA/80 |
| | | 2N6055 | 2N6053 | 750k/18k | 4 | 1.5 typ | 1.5 typ | 4 | 4 | 100 | TO-204/1 |
| | | MJE6043 | MJE6040 | 1k/20k | 4 | 1.5 typ | 1.5 typ | 4 | 2 | 75 | TO-225AB/90 |
| | 80 | BDX53B | BDX54B | 750 min | 3 | | | | 4 | 60 | TO-220/221A |
| | | BD899 | BD900 | 750 min | 3 | | | | 1 | 70 | TO-220/221A |
| | | BD899A | BD900A | 750 min | 4 | | | | 1 | 70 | TO-220/221A |

(continued)

MOTOROLA
# SEMICONDUCTOR
TECHNICAL DATA

| NPN | PNP |
|---|---|
| TIP100 | TIP105 |
| TIP101 | TIP106 |
| TIP102 | TIP107 |

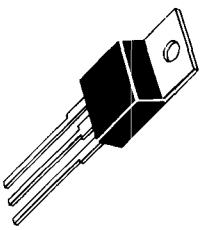
## PLASTIC MEDIUM-POWER COMPLEMENTARY SILICON TRANSISTORS

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

- High DC Current Gain –
  $h_{FE}$ = 2500 (Typ) @ $I_C$ = 4.0 Adc
- Collector-Emitter Sustaining Voltage – @ 30 mAdc
  $V_{CEO(sus)}$ = 60 Vdc (Min) – TIP100, TIP105
  = 80 Vdc (Min) – TIP101, TIP106
  = 100 Vdc (Min) – TIP102, TIP107
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 2.0 Vdc (Max) @ $I_C$ = 3.0 Adc
  = 2.5 Vdc (Max) @ $I_C$ = 8.0 Adc
- Monolithic Construction with Built-In Base-Emitter Shunt Resistors
- TO-220AB Compact Package
- TO-66 Leadform Also Available

## DARLINGTON 8 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS

60-80-100 VOLTS
80 WATTS



***MAXIMUM RATINGS**

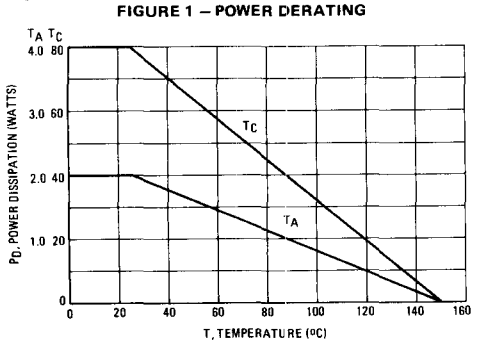
| Rating | Symbol | TIP100, TIP105 | TIP101, TIP106 | TIP102, TIP107 | Unit |
|---|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 60 | 80 | 100 | Vdc |
| Collector-Base Voltage | $V_{CB}$ | 60 | 80 | 100 | Vdc |
| Emitter-Base Voltage | $V_{EB}$ | 5.0 | | | Vdc |
| Collector Current – Continuous | $I_C$ | 8.0 | | | Adc |
| Peak | | 15 | | | |
| Base Current | $I_B$ | 1.0 | | | Adc |
| Total Power Dissipation @ $T_C$ = 25°C | $P_D$ | 80 | | | Watts |
| Derate above 25°C | | 0.64 | | | W/°C |
| Unclamped Inductive Load Energy (1) | E | 30 | | | mJ |
| Total Power Dissipation @ $T_A$ = 25°C | $P_D$ | 2.0 | | | Watts |
| Derate above 25°C | | 0.016 | | | W/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | -65 to +150 | | | °C |

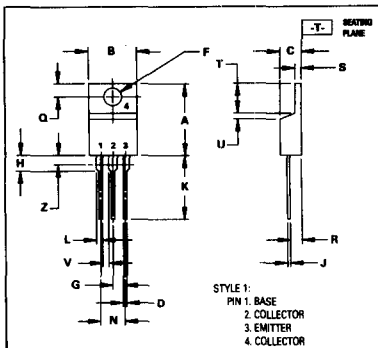
**THERMAL CHARACTERISTICS**

| Characteristics | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.56 | °C/W |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 62.5 | °C/W |

(1) $I_C$ = 1.1 A, L = 50 mH, P.R.F. = 10 Hz, $V_{CC}$ = 20 V, $R_{BE}$ = 100 Ω.

**FIGURE 1 – POWER DERATING**




STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

| DIM | MILLIMETERS MIN | MILLIMETERS MAX | INCHES MIN | INCHES MAX |
|---|---|---|---|---|
| A | 14.48 | 15.75 | 0.570 | 0.620 |
| B | 9.66 | 10.28 | 0.380 | 0.405 |
| C | 4.07 | 4.82 | 0.160 | 0.190 |
| D | 0.64 | 0.88 | 0.025 | 0.035 |
| F | 3.61 | 3.73 | 0.142 | 0.147 |
| G | 2.42 | 2.66 | 0.095 | 0.105 |
| H | 2.80 | 3.93 | 0.110 | 0.155 |
| J | 0.46 | 0.71 | 0.018 | 0.028 |
| K | 12.70 | 14.27 | 0.500 | 0.562 |
| L | 1.15 | 1.39 | 0.045 | 0.055 |
| N | 4.83 | 5.33 | 0.190 | 0.210 |
| Q | 2.54 | 3.04 | 0.100 | 0.120 |
| R | 2.04 | 2.79 | 0.080 | 0.110 |
| S | 1.15 | 1.39 | 0.045 | 0.055 |
| T | 5.97 | 6.47 | 0.235 | 0.255 |
| U | 0.00 | 1.27 | 0.000 | 0.050 |
| V | 1.15 | — | 0.045 | — |
| Z | — | 2.04 | — | 0.080 |

**CASE 221A-04**
**TO-220AB**

3

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Sustaining Voltage (1) | | $V_{CEO(sus)}$ | | | Vdc |
| ($I_C$ = 30 mAdc, $I_B$ = 0) | TIP100, TIP105 | | 60 | – | |
| | TIP101, TIP106 | | 80 | – | |
| | TIP102, TIP107 | | 100 | – | |
| Collector Cutoff Current | | $I_{CEO}$ | | | μAdc |
| ($V_{CE}$ = 30 Vdc, $I_B$ = 0) | TIP100, TIP105 | | – | 50 | |
| ($V_{CE}$ = 40 Vdc, $I_B$ = 0) | TIP101, TIP106 | | – | 50 | |
| ($V_{CE}$ = 50 Vdc, $I_B$ = 0) | TIP102, TIP107 | | – | 50 | |
| Collector Cuttoff Current | | $I_{CBO}$ | | | μAdc |
| ($V_{CB}$ = 60 Vdc, $I_E$ = 0) | TIP100, TIP105 | | – | 50 | |
| ($V_{CB}$ = 80 Vdc, $I_E$ = 0) | TIP101, TIP106 | | – | 50 | |
| ($V_{CB}$ = 100 Vdc, $I_E$ = 0) | TIP102, TIP107 | | – | 50 | |
| Emitter Cutoff Current | | $I_{EBO}$ | – | 8.0 | mAdc |
| ($V_{BE}$ = 5.0 Vdc, $I_C$ = 0) | | | | | |
| **ON-CHARACTERISTICS (1)** | | | | | |
| DC Current Gain | | $h_{FE}$ | | | – |
| ($I_C$ = 3.0 Adc, $V_{CE}$ = 4.0 Vdc) | | | 1000 | 20,000 | |
| ($I_C$ = 8.0 Adc, $V_{CE}$ = 4.0 Vdc) | | | 200 | – | |
| Collector-Emitter Saturation Voltage | | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 3.0 Adc, $I_B$ = 6.0 mAdc) | | | – | 2.0 | |
| ($I_C$ = 8.0 Adc, $I_B$ = 80 mAdc) | | | – | 2.5 | |
| Base-Emitter On Voltage | | $V_{BE(on)}$ | | | Vdc |
| ($I_C$ = 8.0 Adc, $V_{CE}$ = 4.0 Vdc) | | | – | 2.8 | |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Small-Signal Current Gain | | $\|h_{fe}\|$ | | | – |
| ($I_C$ = 3.0 Adc, $V_{CE}$ = 4.0 Vdc, f = 1.0 MHz) | | | 4.0 | – | |
| Output Capacitance | | $C_{ob}$ | | | pF |
| ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 0.1 MHz) | TIP105, TIP106, TIP107 | | – | 300 | |
| | TIP100, TIP101, TIP102 | | – | 200 | |

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

**FIGURE 2 – SWITCHING TIMES TEST CIRCUIT**

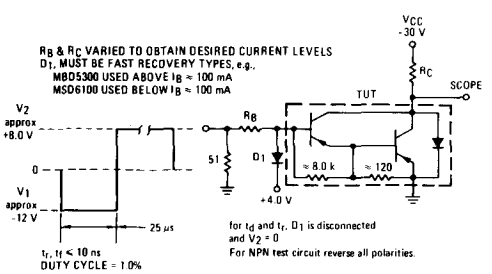



**FIGURE 3 – SWITCHING TIMES**

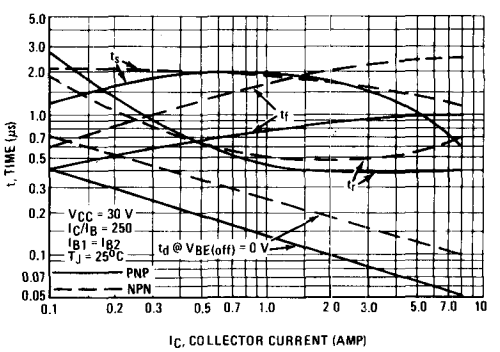


FIGURE 4 – THERMAL RESPONSE

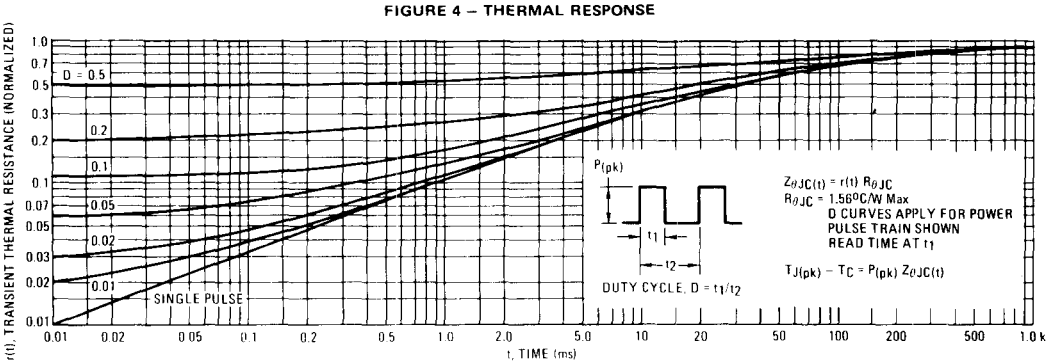
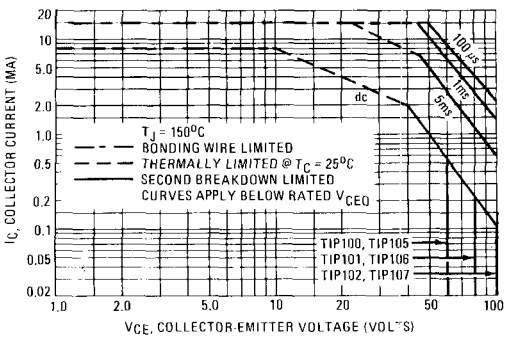



FIGURE 5 – ACTIVE-REGION SAFE OPERATING AREA




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 Figure 5 is based on* $T_{J(pk)} = 150^{o}C$; $T_C$ is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} < 150^{o}C$. $T_{J(pk)}$ 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

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FIGURE 6 – SMALL-SIGNAL CURRENT GAIN

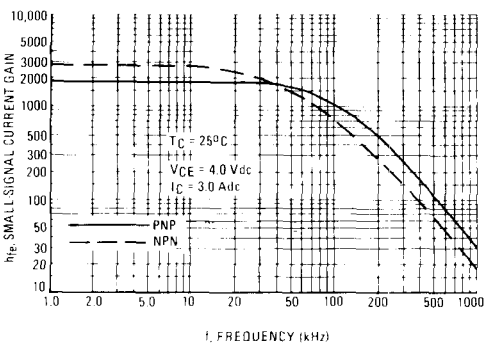
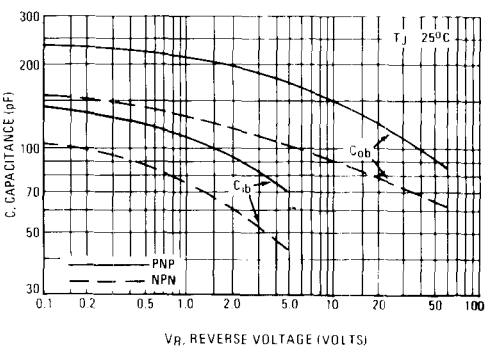



FIGURE 7 – CAPACITANCE



**NPN**
**TIP100, TIP101, TIP102**

**PNP**
**TIP105, TIP106, TIP107**

**FIGURE 8 – DC CURRENT GAIN**

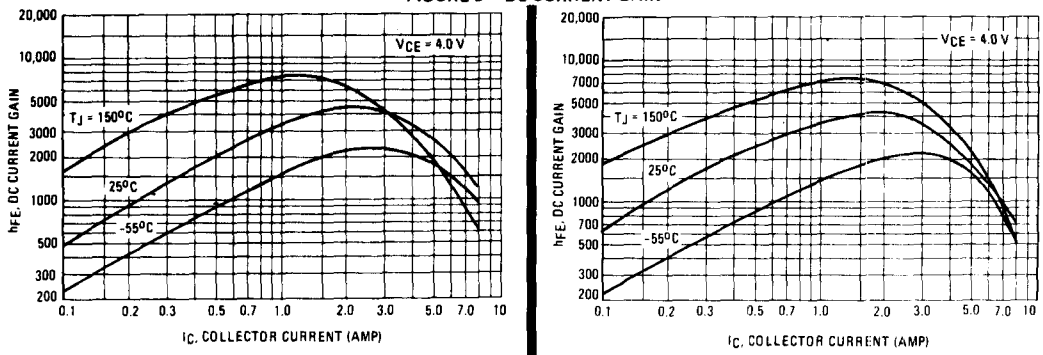



**FIGURE 9 – COLLECTOR SATURATION REGION**

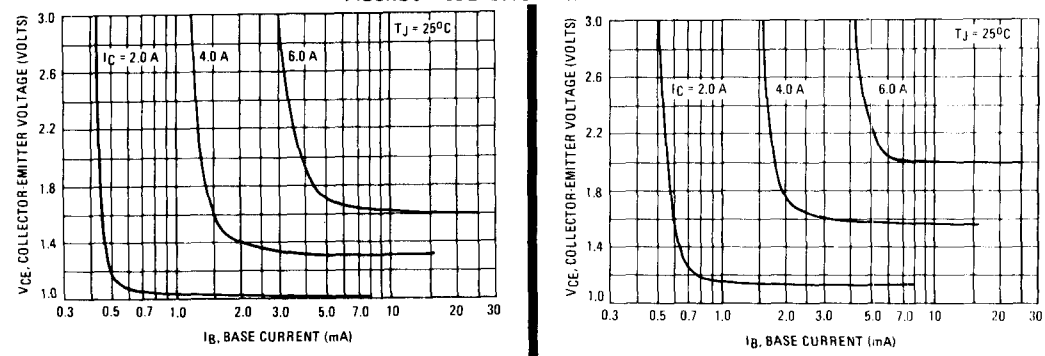
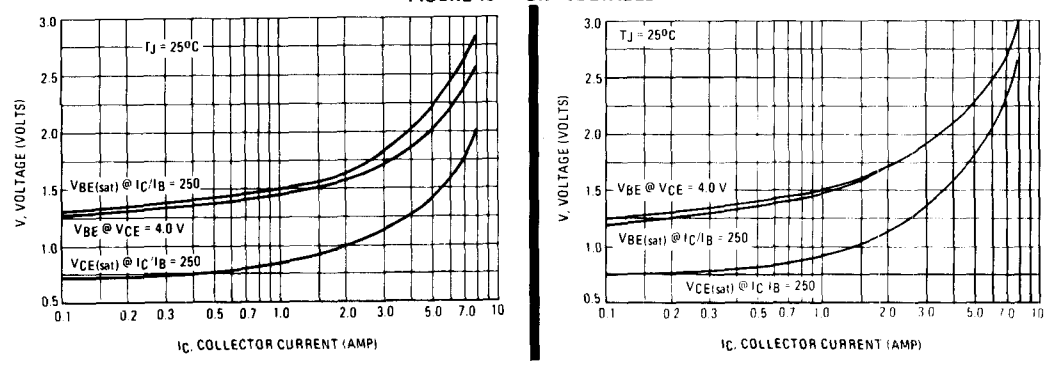



**FIGURE 10 – "ON" VOLTAGES**

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