

# Complementary Darlington Power Transistors

## DPAK For Surface Mount Applications

Designed for general purpose amplifier and low speed switching applications.

- Lead Formed for Surface Mount Applications in Plastic Sleeves (No Suffix)
- Straight Lead Version in Plastic Sleeves ("–1" Suffix)
- Lead Formed Version Available in 16 mm Tape and Reel ("T4" Suffix)
- Surface Mount Replacements for 2N6040–2N6045 Series, TIP120–TIP122 Series, and TIP125–TIP127 Series
- Monolithic Construction With Built-in Base–Emitter Shunt Resistors
- High DC Current Gain —  $h_{FE} = 2500$  (Typ) @  $I_C = 4.0$  Adc
- Complementary Pairs Simplifies Designs

### MAXIMUM RATINGS

| Rating                                                                                 | Symbol         | MJD122<br>MJD127 | Unit                         |
|----------------------------------------------------------------------------------------|----------------|------------------|------------------------------|
| Collector–Emitter Voltage                                                              | $V_{CEO}$      | 100              | Vdc                          |
| Collector–Base Voltage                                                                 | $V_{CB}$       | 100              | Vdc                          |
| Emitter–Base Voltage                                                                   | $V_{EB}$       | 5                | Vdc                          |
| Collector Current — Continuous<br>Peak                                                 | $I_C$          | 8<br>16          | Adc                          |
| Base Current                                                                           | $I_B$          | 120              | mAdc                         |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$  | $P_D$          | 20<br>0.16       | Watts<br>W/ $^\circ\text{C}$ |
| Total Power Dissipation* @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 1.75<br>0.014    | Watts<br>W/ $^\circ\text{C}$ |
| Operating and Storage Junction<br>Temperature Range                                    | $T_J, T_{stg}$ | –65 to +150      | $^\circ\text{C}$             |

### THERMAL CHARACTERISTICS

| Characteristic                           | Symbol          | Max  | Unit               |
|------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance, Junction to Case     | $R_{\theta JC}$ | 6.25 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction to Ambient* | $R_{\theta JA}$ | 71.4 | $^\circ\text{C/W}$ |

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

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                        |                |     |    |                 |
|------------------------------------------------------------------------|----------------|-----|----|-----------------|
| Collector–Emitter Sustaining Voltage<br>( $I_C = 30$ mAdc, $I_B = 0$ ) | $V_{CEO(sus)}$ | 100 | —  | Vdc             |
| Collector Cutoff Current<br>( $V_{CE} = 50$ Vdc, $I_B = 0$ )           | $I_{CEO}$      | —   | 10 | $\mu\text{Adc}$ |

\* These ratings are applicable when surface mounted on the minimum pad sizes recommended.  
(continued)

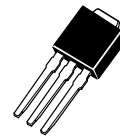
**NPN**  
**MJD122\***  
**PNP**  
**MJD127\***

\*Motorola Preferred Device

**SILICON**  
**POWER TRANSISTORS**  
**8 AMPERES**  
**100 VOLTS**  
**20 WATTS**

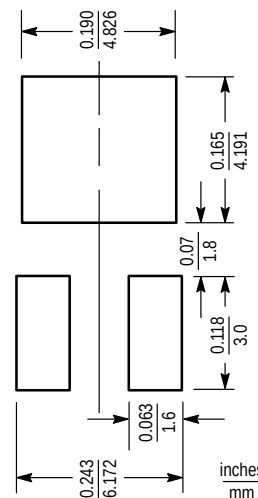


CASE 369A-13



CASE 369-07

### MINIMUM PAD SIZES RECOMMENDED FOR SURFACE MOUNTED APPLICATIONS



Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

**ELECTRICAL CHARACTERISTICS — continued** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic                                                                                                                                                                                         | Symbol    | Min    | Max       | Unit            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|-----------|-----------------|
| <b>OFF CHARACTERISTICS — continued</b>                                                                                                                                                                 |           |        |           |                 |
| Collector Cutoff Current<br>( $V_{CE} = 100\text{ Vdc}$ , $V_{BE(\text{off})} = 1.5\text{ Vdc}$ )<br>( $V_{CE} = 100\text{ Vdc}$ , $V_{BE(\text{off})} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ ) | $I_{CEX}$ | —<br>— | 10<br>500 | $\mu\text{Adc}$ |
| Collector Cutoff Current<br>( $V_{CB} = 100\text{ Vdc}$ , $I_E = 0$ )                                                                                                                                  | $I_{CBO}$ | —      | 10        | $\mu\text{Adc}$ |
| Emitter Cutoff Current<br>( $V_{BE} = 5\text{ Vdc}$ , $I_C = 0$ )                                                                                                                                      | $I_{EBO}$ | —      | 2         | $\text{mAdc}$   |

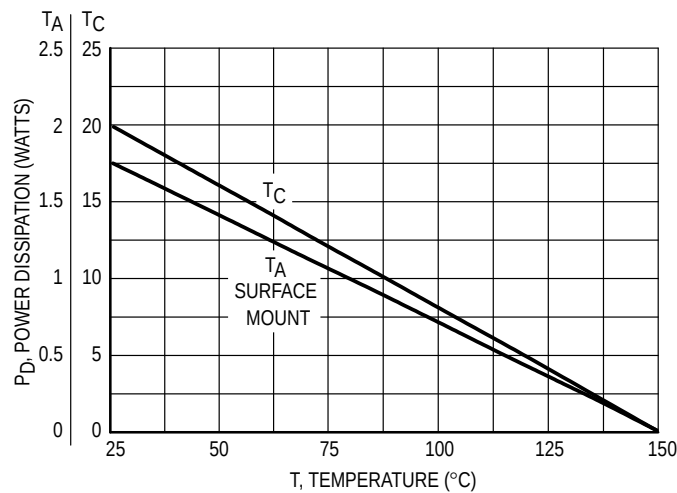
**ON CHARACTERISTICS**

|                                                                                                                                                |                      |             |             |              |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-------------|-------------|--------------|
| DC Current Gain<br>( $I_C = 4\text{ Adc}$ , $V_{CE} = 4\text{ Vdc}$ )<br>( $I_C = 8\text{ Adc}$ , $V_{CE} = 4\text{ Vdc}$ )                    | $h_{FE}$             | 1000<br>100 | 12,000<br>— | —            |
| Collector–Emitter Saturation Voltage<br>( $I_C = 4\text{ Adc}$ , $I_B = 16\text{ mAdc}$ )<br>( $I_C = 8\text{ Adc}$ , $I_B = 80\text{ mAdc}$ ) | $V_{CE(\text{sat})}$ | —<br>—      | 2<br>4      | $\text{Vdc}$ |
| Base–Emitter Saturation Voltage (1)<br>( $I_C = 8\text{ Adc}$ , $I_B = 80\text{ mAdc}$ )                                                       | $V_{BE(\text{sat})}$ | —           | 4.5         | $\text{Vdc}$ |
| Base–Emitter On Voltage<br>( $I_C = 4\text{ Adc}$ , $V_{CE} = 4\text{ Vdc}$ )                                                                  | $V_{BE(\text{on})}$  | —           | 2.8         | $\text{Vdc}$ |

**DYNAMIC CHARACTERISTICS**

|                                                                                                           |            |        |            |              |
|-----------------------------------------------------------------------------------------------------------|------------|--------|------------|--------------|
| Current–Gain–Bandwidth Product<br>( $I_C = 3\text{ Adc}$ , $V_{CE} = 4\text{ Vdc}$ , $f = 1\text{ MHz}$ ) | $ h_{fe} $ | 4      | —          | $\text{MHz}$ |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 0.1\text{ MHz}$ )                     | $C_{ob}$   | —<br>— | 300<br>200 | $\text{pF}$  |
| Small–Signal Current Gain<br>( $I_C = 3\text{ Adc}$ , $V_{CE} = 4\text{ Vdc}$ , $f = 1\text{ kHz}$ )      | $h_{fe}$   | 300    | —          | —            |

(1) Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .



**Figure 1. Power Derating**

# TYPICAL ELECTRICAL CHARACTERISTICS

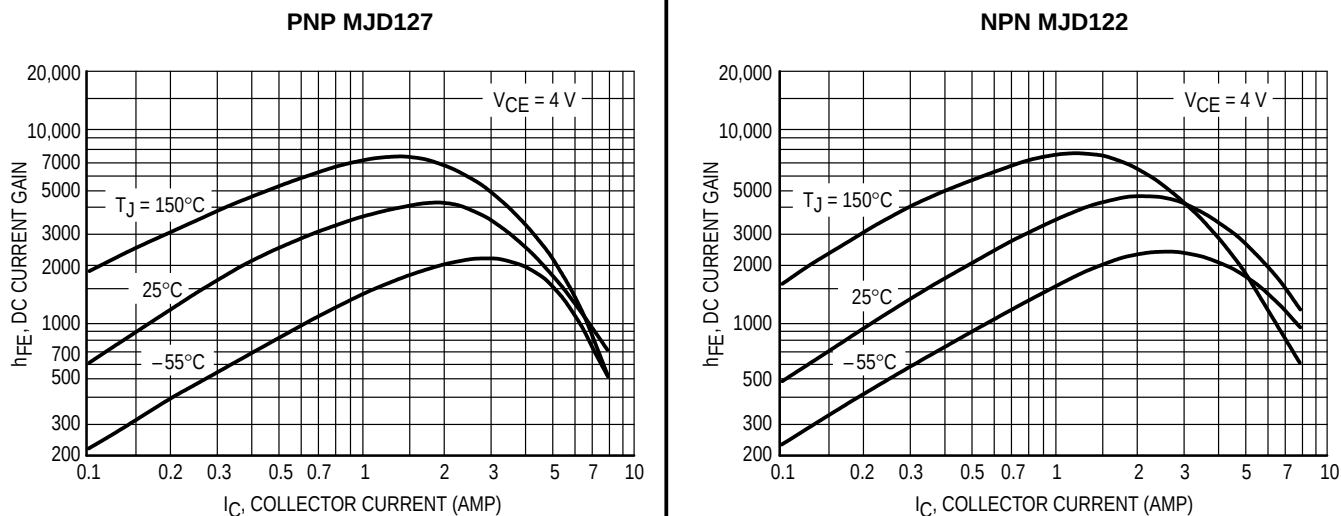


Figure 2. DC Current Gain

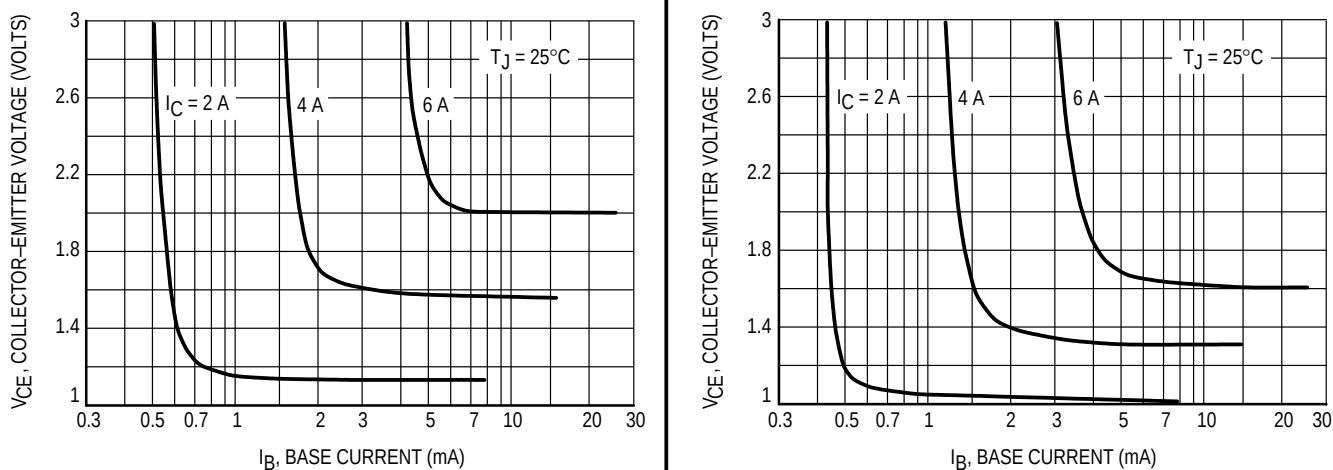


Figure 3. Collector Saturation Region

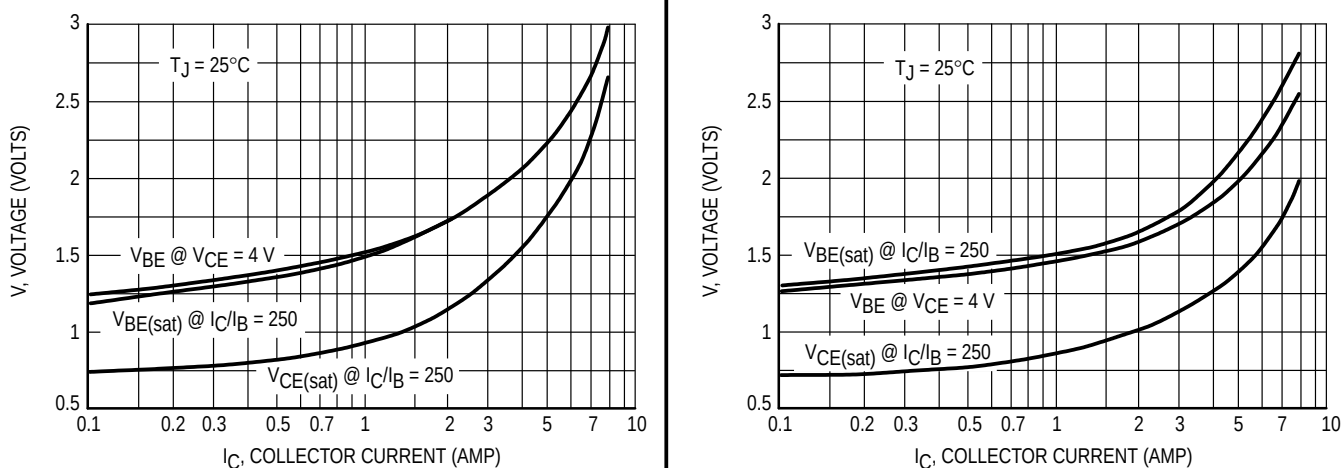


Figure 4. "On" Voltages

TYPICAL ELECTRICAL CHARACTERISTICS

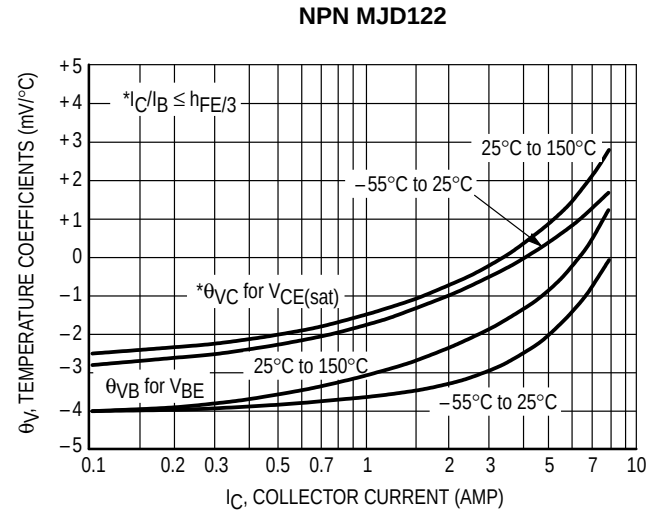
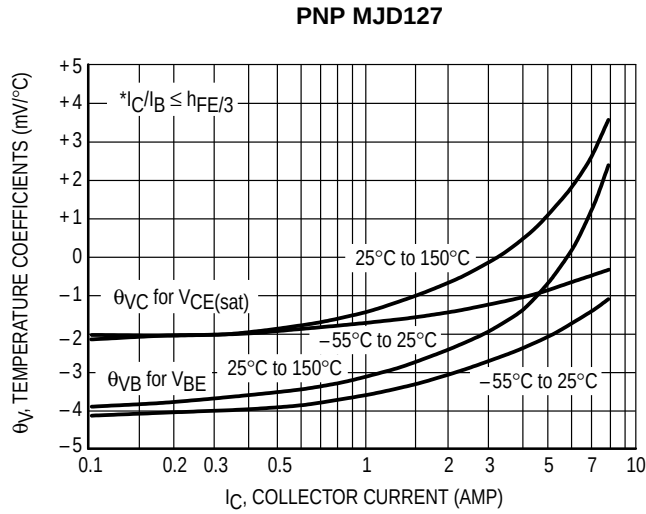


Figure 5. Temperature Coefficients

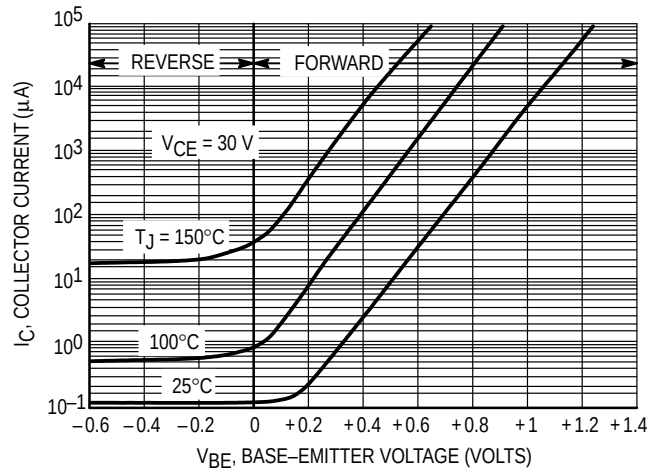
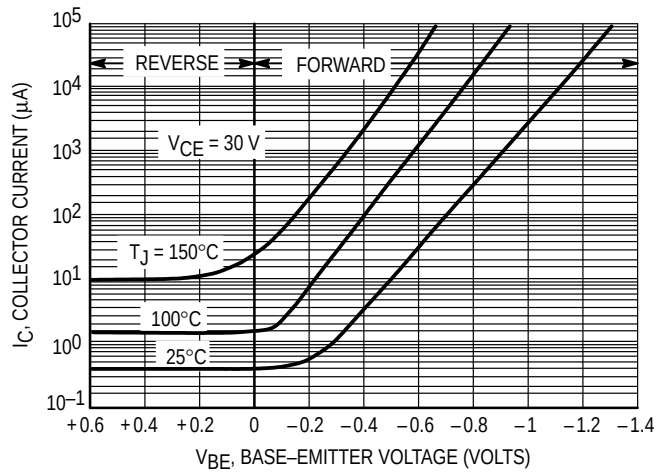


Figure 6. Collector Cut-Off Region

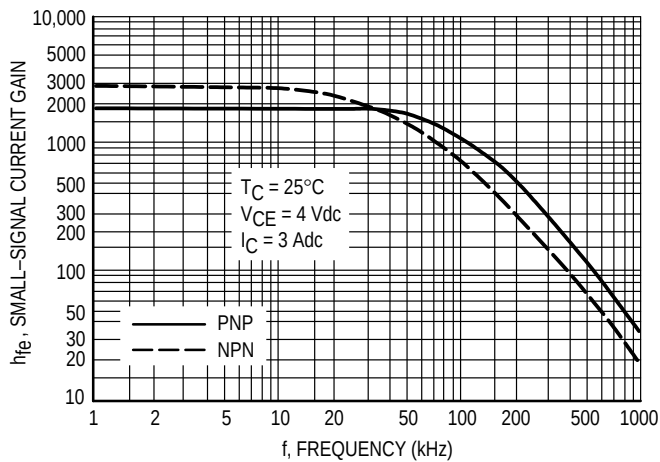


Figure 7. Small-Signal Current Gain

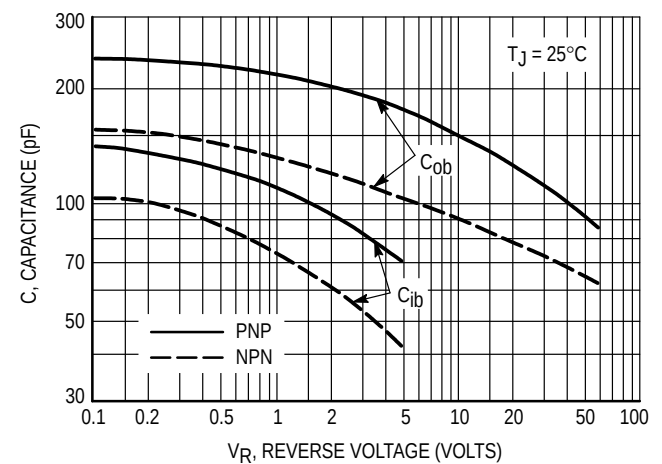


Figure 8. Capacitance

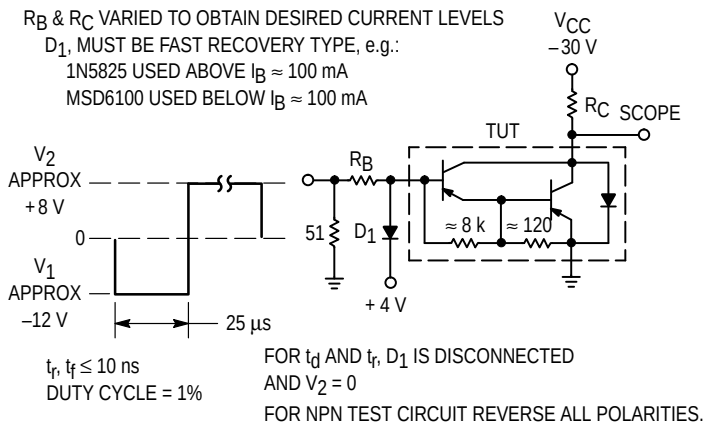


Figure 9. Switching Times Test Circuit

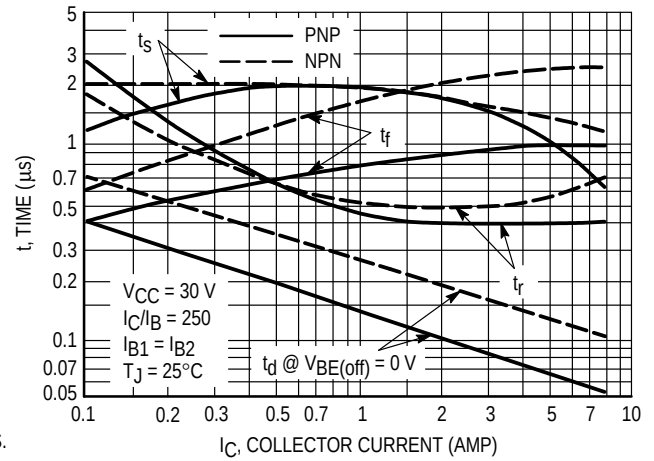


Figure 10. Switching Times

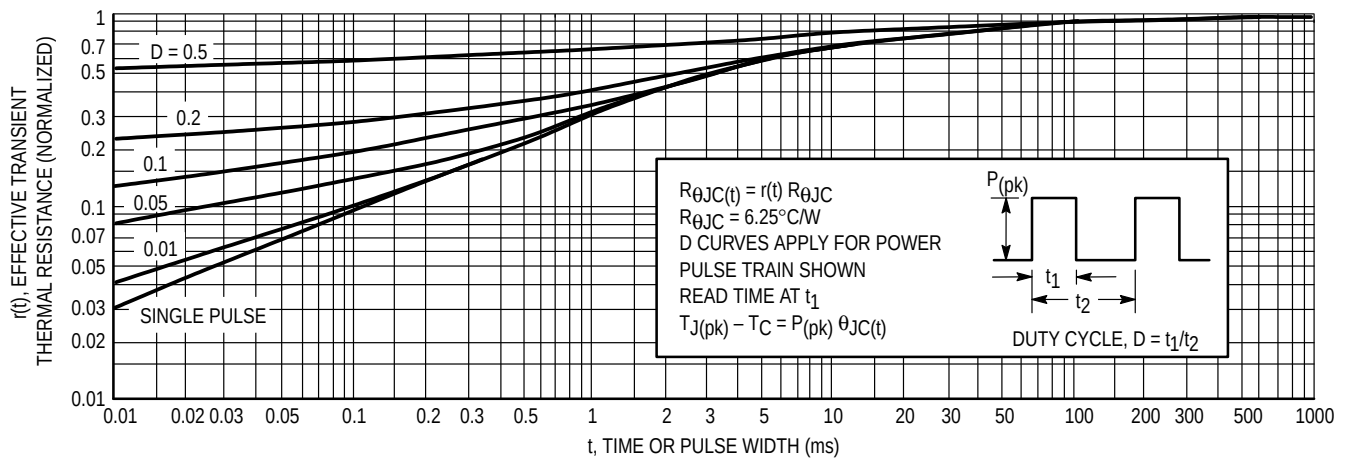


Figure 11. Thermal Response

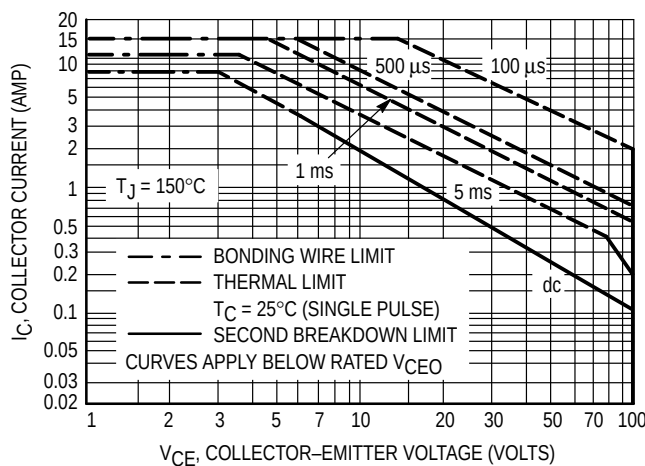
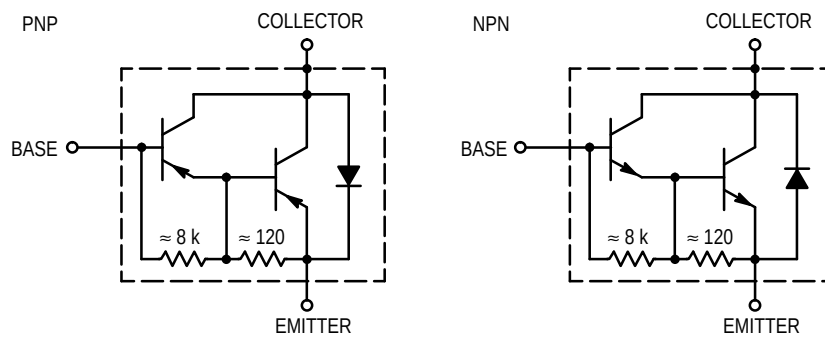


Figure 12. Maximum Forward Bias Safe Operating Area

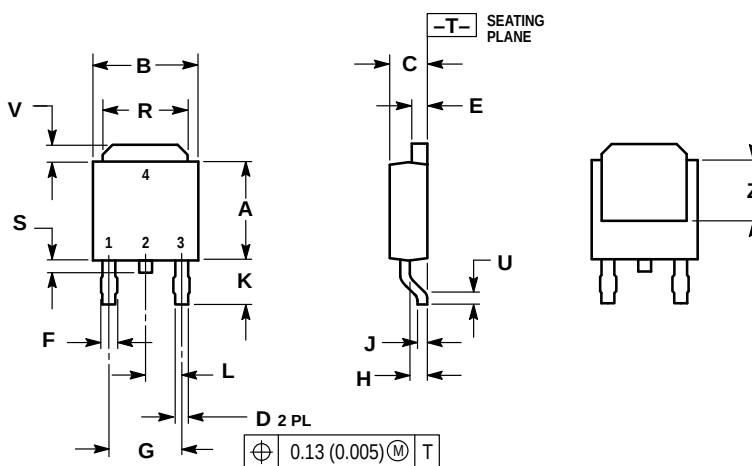
There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate  $I_C - V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater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

The data of Figure 12 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} < 150^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 11. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.



**Figure 13. Darlington Schematic**

## PACKAGE DIMENSIONS



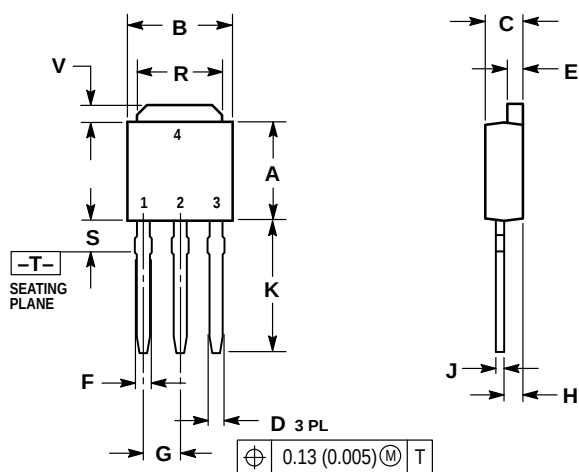
## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.250 | 5.97        | 6.35 |
| B   | 0.250     | 0.265 | 6.35        | 6.73 |
| C   | 0.086     | 0.094 | 2.19        | 2.38 |
| D   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.033     | 0.040 | 0.84        | 1.01 |
| F   | 0.037     | 0.047 | 0.94        | 1.19 |
| G   | 0.180 BSC |       | 4.58 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.102     | 0.114 | 2.60        | 2.89 |
| L   | 0.090 BSC |       | 2.29 BSC    |      |
| R   | 0.175     | 0.215 | 4.45        | 5.46 |
| S   | 0.020     | 0.050 | 0.51        | 1.27 |
| U   | 0.020     | —     | 0.51        | —    |
| V   | 0.030     | 0.050 | 0.77        | 1.27 |
| Z   | 0.138     | —     | 3.51        | —    |

## STYLE 1:

- PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

CASE 369A-13  
ISSUE W

## NOTES:

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|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.250 | 5.97        | 6.35 |
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| D   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.033     | 0.040 | 0.84        | 1.01 |
| F   | 0.037     | 0.047 | 0.94        | 1.19 |
| G   | 0.090 BSC |       | 2.29 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.350     | 0.380 | 8.89        | 9.65 |
| R   | 0.175     | 0.215 | 4.45        | 5.46 |
| S   | 0.050     | 0.090 | 1.27        | 2.28 |
| V   | 0.030     | 0.050 | 0.77        | 1.27 |

## STYLE 1:

- PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

CASE 369-07  
ISSUE K

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