

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

## THERMAL CHARACTERISTICS

| Characteristic                          | Symbol          | Max   | Unit                        |
|---|-----------------|-------|-----------------------------|
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 62.5  | $^{\circ}\text{C}/\text{W}$ |
| Thermal Resistance, Junction-to-Case    | $R_{\theta JC}$ | 3.125 | $^{\circ}\text{C}/\text{W}$ |

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

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

## OFF CHARACTERISTICS

|   |  |               |                       |                          |                 |
|---|--|---------------|-----------------------|--------------------------|-----------------|
| Collector-Emitter Sustaining Voltage (Note 2)<br>( $I_C = 30 \text{ mAdc}$ , $I_B = 0$ )  | TIP31, TIP32<br>TIP31A, TIP32A<br>TIP31B, TIP32B<br>TIP31C, TIP32C | $V_{CE(sus)}$ | 40<br>60<br>80<br>100 | -<br>-<br>-<br>-         | Vdc             |
| Collector Cutoff Current ( $V_{CE} = 30 \text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 60 \text{ Vdc}$ , $I_B = 0$ )   | TIP31, TIP32, TIP31A, TIP32A<br>TIP31B, TIP31C, TIP32B, TIP32C     | $I_{CEO}$     | -<br>-                | 0.3<br>0.3               | mAdc            |
| Collector Cutoff Current<br>( $V_{CE} = 40 \text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 80 \text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 100 \text{ Vdc}$ , $V_{EB} = 0$ ) | TIP31, TIP32<br>TIP31A, TIP32A<br>TIP31B, TIP32B<br>TIP31C, TIP32C | $I_{CES}$     | -<br>-<br>-<br>-      | 200<br>200<br>200<br>200 | $\mu\text{Adc}$ |
| Emitter Cutoff Current ( $V_{BE} = 5.0 \text{ Vdc}$ , $I_C = 0$ )   |  | $I_{EBO}$     | -                     | 1.0                      | mAdc            |

## ON CHARACTERISTICS (Note 2)

|  |  |               |          |         |     |
|--|--|---------------|----------|---------|-----|
| DC Current Gain ( $I_C = 1.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ )<br>( $I_C = 3.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ ) |  | $h_{FE}$      | 25<br>10 | -<br>50 | -   |
| Collector-Emitter Saturation Voltage ( $I_C = 3.0 \text{ Adc}$ , $I_B = 375 \text{ mAdc}$ )  |  | $V_{CE(sat)}$ | -        | 1.2     | Vdc |
| Base-Emitter On Voltage ( $I_C = 3.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ )   |  | $V_{BE(on)}$  | -        | 1.8     | Vdc |

## DYNAMIC CHARACTERISTICS

|  |  |          |     |   |     |
|--|--|----------|-----|---|-----|
| Current-Gain - Bandwidth Product ( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f_{test} = 1.0 \text{ MHz}$ ) |  | $f_T$    | 3.0 | - | MHz |
| Small-Signal Current Gain ( $I_C = 0.5 \text{ Adc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )                |  | $h_{fe}$ | 20  | - | -   |

2. Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

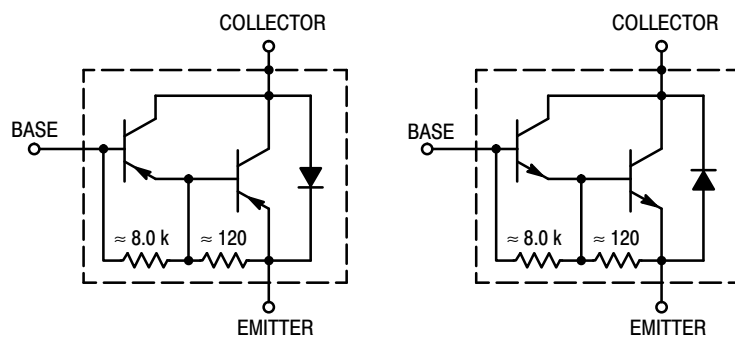


Figure 1. Darlington Circuit Schematic

## ORDERING INFORMATION

| Device  | Package             | Shipping        |
|---------|---------------------|-----------------|
| TIP31   | TO-220              | 50 Units / Rail |
| TIP31G  | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31A  | TO-220              | 50 Units / Rail |
| TIP31AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31B  | TO-220              | 50 Units / Rail |
| TIP31BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31C  | TO-220              | 50 Units / Rail |
| TIP31CG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32   | TO-220              | 50 Units / Rail |
| TIP32G  | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32A  | TO-220              | 50 Units / Rail |
| TIP32AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32B  | TO-220              | 50 Units / Rail |
| TIP32BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32C  | TO-220              | 50 Units / Rail |
| TIP32CG | TO-220<br>(Pb-Free) | 50 Units / Rail |

TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

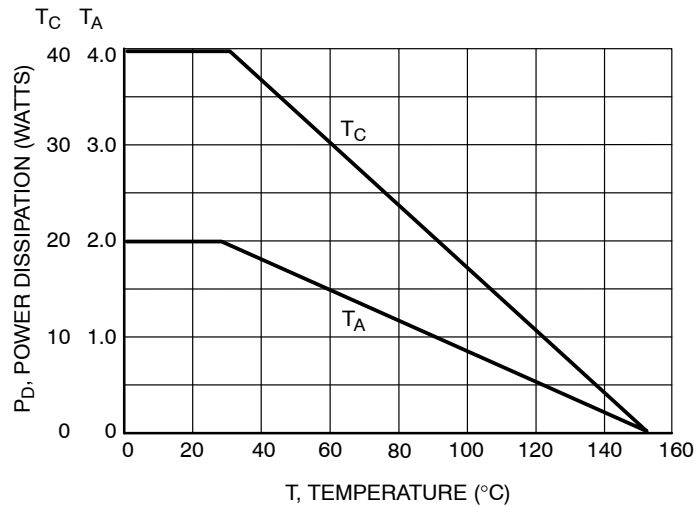
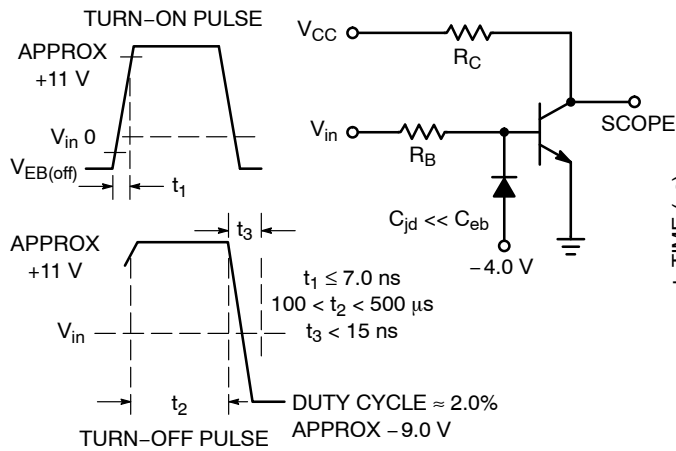


Figure 2. Power Derating



$R_B$  and  $R_C$  VARIED TO OBTAIN DESIRED CURRENT LEVELS.

Figure 3. Switching Time Equivalent Circuit

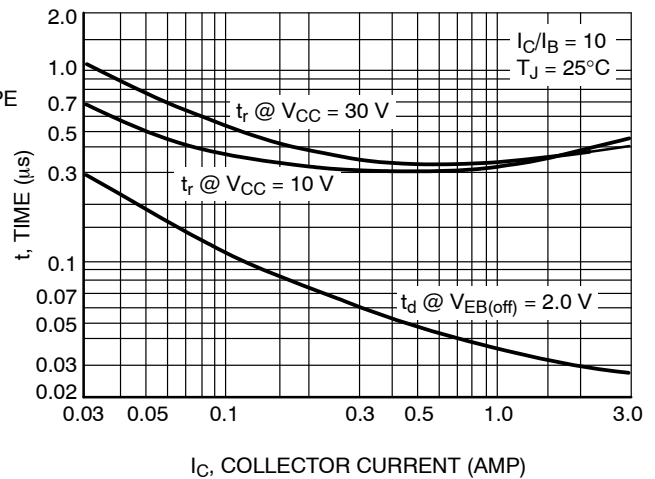


Figure 4. Turn-On Time

TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

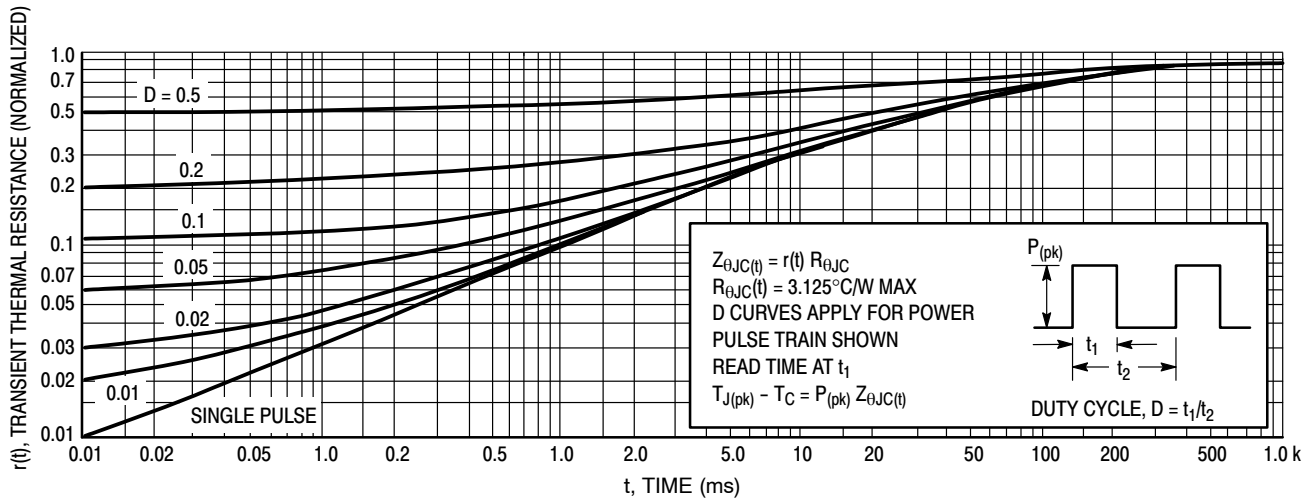


Figure 5. Thermal Response

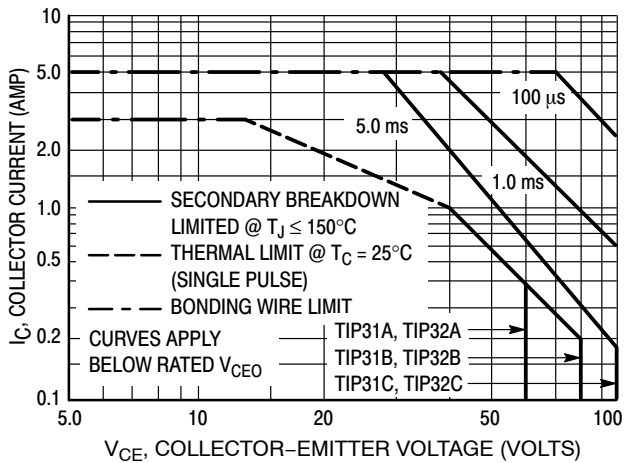


Figure 6. Active Region Safe Operating Area

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 6 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  $T_{J(pk)} \leq 150^{\circ}\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 5. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

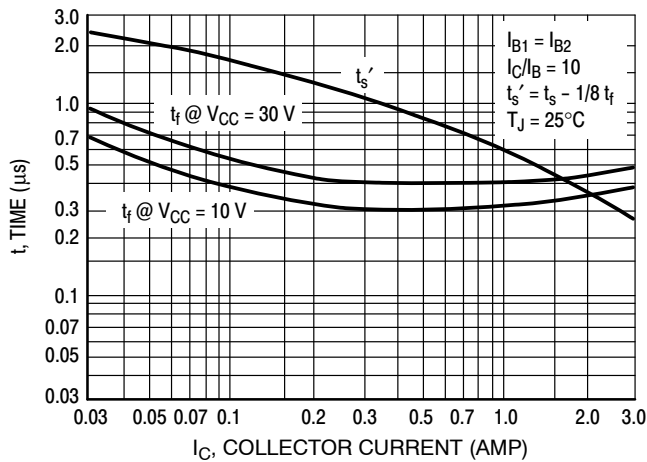


Figure 7. Turn-Off Time

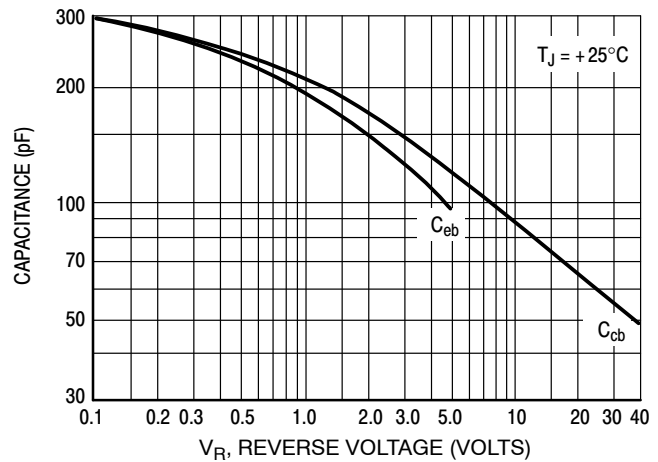


Figure 8. Capacitance

TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

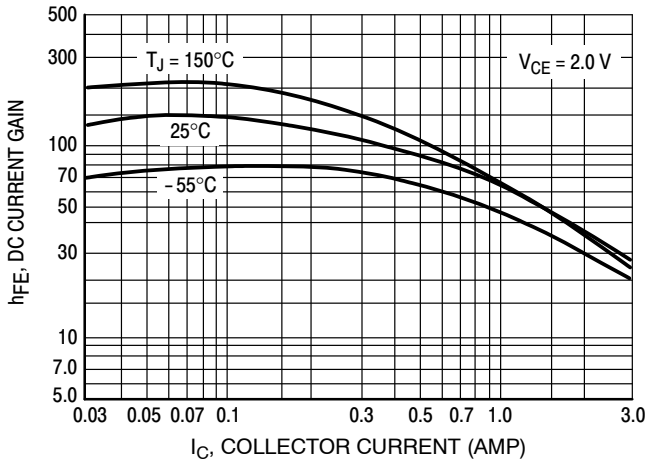


Figure 9. DC Current Gain

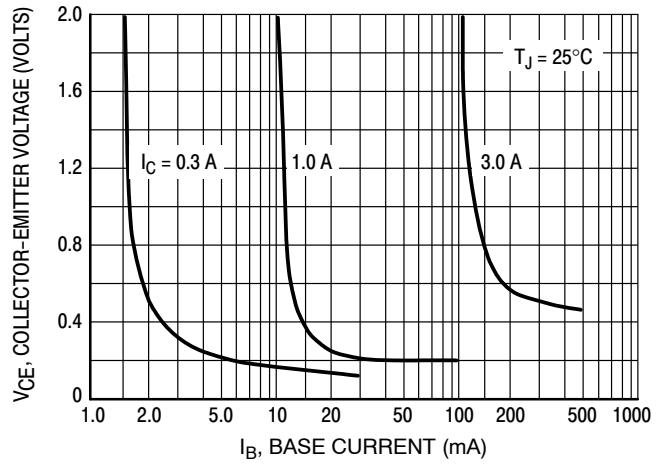


Figure 10. Collector Saturation Region

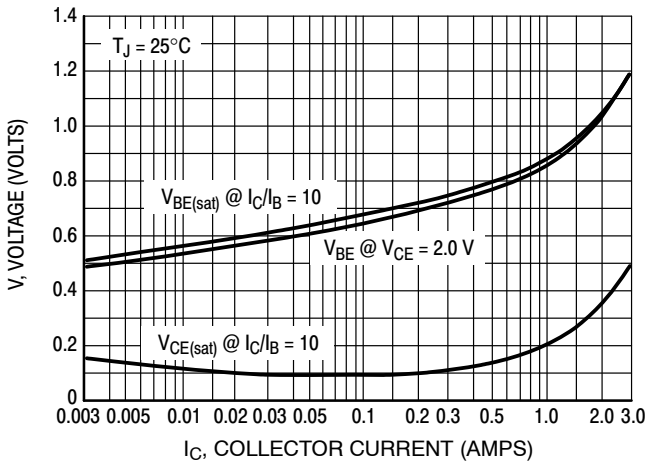


Figure 11. "On" Voltages

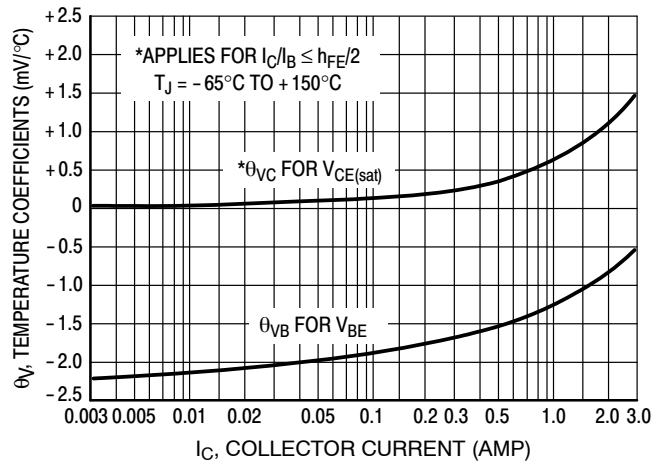


Figure 12. Temperature Coefficients

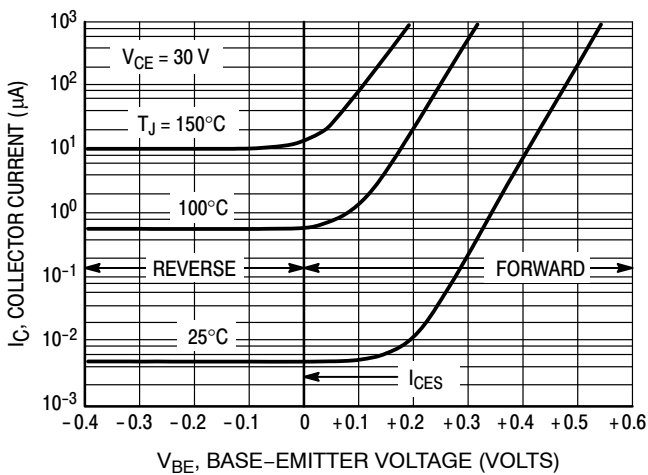


Figure 13. Collector Cut-Off Region

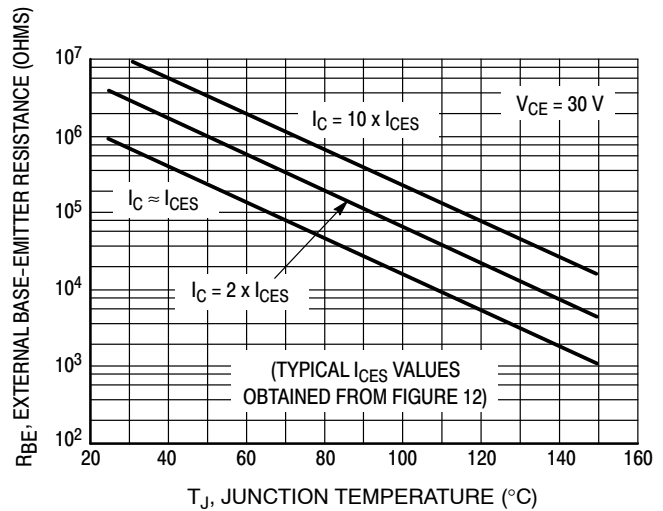
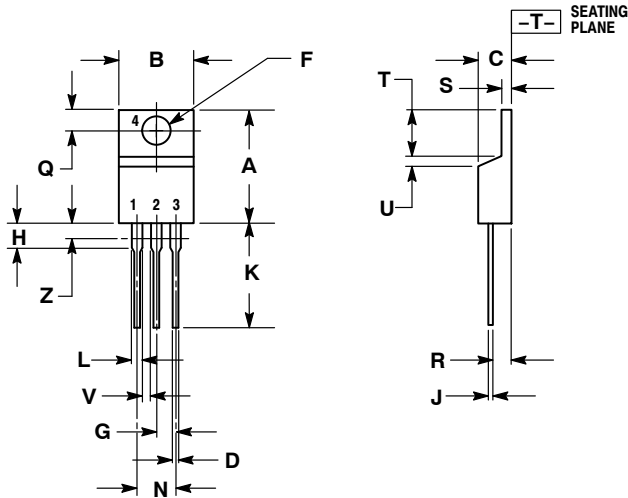


Figure 14. Effects of Base-Emitter Resistance

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

## PACKAGE DIMENSIONS

### TO-220 CASE 221A-09 ISSUE AG



#### NOTES:

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

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.570  | 0.620 | 14.48       | 15.75 |
| B   | 0.380  | 0.405 | 9.66        | 10.28 |
| C   | 0.160  | 0.190 | 4.07        | 4.82  |
| D   | 0.025  | 0.036 | 0.64        | 0.91  |
| F   | 0.142  | 0.161 | 3.61        | 4.09  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.161 | 2.80        | 4.10  |
| J   | 0.014  | 0.025 | 0.36        | 0.64  |
| K   | 0.500  | 0.562 | 12.70       | 14.27 |
| L   | 0.045  | 0.060 | 1.15        | 1.52  |
| N   | 0.190  | 0.210 | 4.83        | 5.33  |
| Q   | 0.100  | 0.120 | 2.54        | 3.04  |
| R   | 0.080  | 0.110 | 2.04        | 2.79  |
| S   | 0.045  | 0.055 | 1.15        | 1.39  |
| T   | 0.235  | 0.255 | 5.97        | 6.47  |
| U   | 0.000  | 0.050 | 0.00        | 1.27  |
| V   | 0.045  | ---   | 1.15        | ---   |
| Z   | ---    | 0.080 | ---         | 2.04  |

#### STYLE 1:

- PIN 1. BASE
- COLLECTOR
- EMITTER
- COLLECTOR

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