

**MJH10012**  
(See MJ10012)

# Complementary Darlington Silicon Power Transistors

... designed for use as general purpose amplifiers, low frequency switching and motor control applications.

- High DC Current Gain @ 10 Adc —  $h_{FE} = 400$  Min (All Types)
- Collector–Emitter Sustaining Voltage
  - $V_{CE(sus)} = 150$  Vdc (Min) — MJH11018, 17
  - $= 200$  Vdc (Min) — MJH11020, 19
  - $= 250$  Vdc (Min) — MJH11022, 21
- Low Collector–Emitter Saturation Voltage
  - $V_{CE(sat)} = 1.2$  V (Typ) @  $I_C = 5.0$  A
  - $= 1.8$  V (Typ) @  $I_C = 10$  A
- Monolithic Construction

**PNP**  
**MJH11017\***  
**MJH11019\***  
**MJH11021\***  
**NPN**  
**MJH11018\***  
**MJH11020\***  
**MJH11022\***

\*Motorola Preferred Device

**15 AMPERE  
DARLINGTON  
COMPLEMENTARY SILICON  
POWER TRANSISTORS  
150, 200, 250 VOLTS  
150 WATTS**

## MAXIMUM RATINGS

| Rating   | Symbol         | MJH            |                |                | Unit                         |
|--|----------------|----------------|----------------|----------------|------------------------------|
|  |                | 11018<br>11017 | 11020<br>11019 | 11022<br>11021 |                              |
| Collector–Emitter Voltage  | $V_{CEO}$      | 150            | 200            | 250            | Vdc                          |
| Collector–Base Voltage   | $V_{CB}$       | 150            | 200            | 250            | Vdc                          |
| Emitter–Base Voltage   | $V_{EB}$       | 5.0            |                |                | Vdc                          |
| Collector Current — Continuous<br>— Peak (1)   | $I_C$          | 15<br>30       |                |                | Adc                          |
| Base Current   | $I_B$          | 0.5            |                |                | Adc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate Above $25^\circ\text{C}$ | $P_D$          | 150<br>1.2     |                |                | 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 | $R_{\theta JC}$ | 0.83 | $^\circ\text{C}/\text{W}$ |

(1) Pulse Test: Pulse Width = 5.0 ms, Duty Cycle  $\leq 10\%$ .

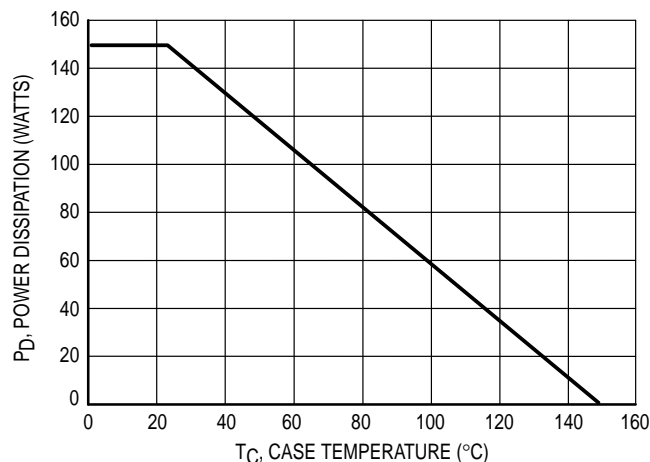
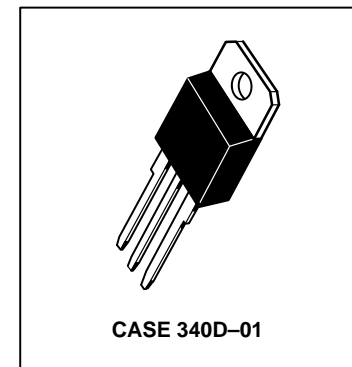


Figure 1. Power Derating



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

**MJH11017 MJH11019 MJH11021 MJH11018 MJH11020 MJH11022**

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

| Characteristic   | Symbol         | Min               | Max               | Unit |
|--|----------------|-------------------|-------------------|------|
| <b>OFF CHARACTERISTICS</b>   |                |                   |                   |      |
| Collector–Emitter Sustaining Voltage (1)<br>( $I_C = 0.1\text{ A dc}$ , $I_B = 0$ )  | $V_{CEO(sus)}$ | 150<br>200<br>250 | —                 | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = 75\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 100\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 125\text{ Vdc}$ , $I_B = 0$ )                                       | $I_{CEO}$      | —<br>—<br>—       | 1.0<br>1.0<br>1.0 | mAdc |
| Collector Cutoff Current<br>( $V_{CE} = \text{Rated } V_{CB}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ )<br>( $V_{CE} = \text{Rated } V_{CB}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ , $T_J = 150^\circ\text{C}$ ) | $I_{CEV}$      | —<br>—            | 0.5<br>5.0        | mAdc |
| Emitter Cutoff Current ( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )   | $I_{EBO}$      | —                 | 2.0               | mAdc |

**ON CHARACTERISTICS (1)**

|   |               |            |             |     |
|---|---------------|------------|-------------|-----|
| DC Current Gain ( $I_C = 10\text{ A dc}$ , $V_{CE} = 5.0\text{ Vdc}$ )<br>( $I_C = 15\text{ A dc}$ , $V_{CE} = 5.0\text{ Vdc}$ )              | $h_{FE}$      | 400<br>100 | 15,000<br>— | —   |
| Collector–Emitter Saturation Voltage ( $I_C = 10\text{ A dc}$ , $I_B = 100\text{ mA}$ )<br>( $I_C = 15\text{ A dc}$ , $I_B = 150\text{ mA}$ ) | $V_{CE(sat)}$ | —<br>—     | 2.5<br>4.0  | Vdc |
| Base–Emitter On Voltage ( $I_C = 10\text{ A}$ , $V_{CE} = 5.0\text{ Vdc}$ )   | $V_{BE(on)}$  | —          | 2.8         | Vdc |
| Base–Emitter Saturation Voltage ( $I_C = 15\text{ A dc}$ , $I_B = 150\text{ mA}$ )  | $V_{BE(sat)}$ | —          | 3.8         | Vdc |

**DYNAMIC CHARACTERISTICS**

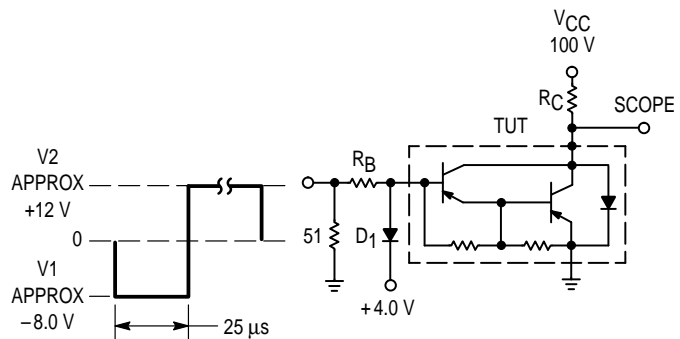
|   |          |        |            |    |
|---|----------|--------|------------|----|
| Current–Gain Bandwidth Product<br>( $I_C = 10\text{ A dc}$ , $V_{CE} = 3.0\text{ Vdc}$ , $f = 1.0\text{ MHz}$ ) | $f_T$    | 3.0    | —          | —  |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 0.1\text{ MHz}$ )                           | $C_{ob}$ | —<br>— | 400<br>600 | pF |
| Small–Signal Current Gain ( $I_C = 10\text{ A dc}$ , $V_{CE} = 3.0\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )         | $h_{fe}$ | 75     | —          | —  |

**SWITCHING CHARACTERISTICS**

| Characteristic | Symbol | Typical |     | Unit          |
|----------------|--------|---------|-----|---------------|
|                |        | NPN     | PNP |               |
| Delay Time     | $t_d$  | 150     | 75  | ns            |
| Rise Time      | $t_r$  | 1.2     | 0.5 | $\mu\text{s}$ |
| Storage Time   | $t_s$  | 4.4     | 2.7 | $\mu\text{s}$ |
| Fall Time      | $t_f$  | 2.5     | 2.5 | $\mu\text{s}$ |

(1) Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

$R_B$  &  $R_C$  varied to obtain desired current levels  
 $D_1$ , must be fast recovery types, e.g.:  
 1N5825 used above  $I_B \approx 100\text{ mA}$   
 MSD6100 used below  $I_B \approx 100\text{ mA}$



$t_r, t_f \leq 10\text{ ns}$   
 Duty Cycle = 1.0%

For  $t_d$  and  $t_r$ ,  $D_1$  is disconnected and  $V_2 = 0$

For NPN test circuit, reverse diode and voltage polarities.

**Figure 2. Switching Times Test Circuit**

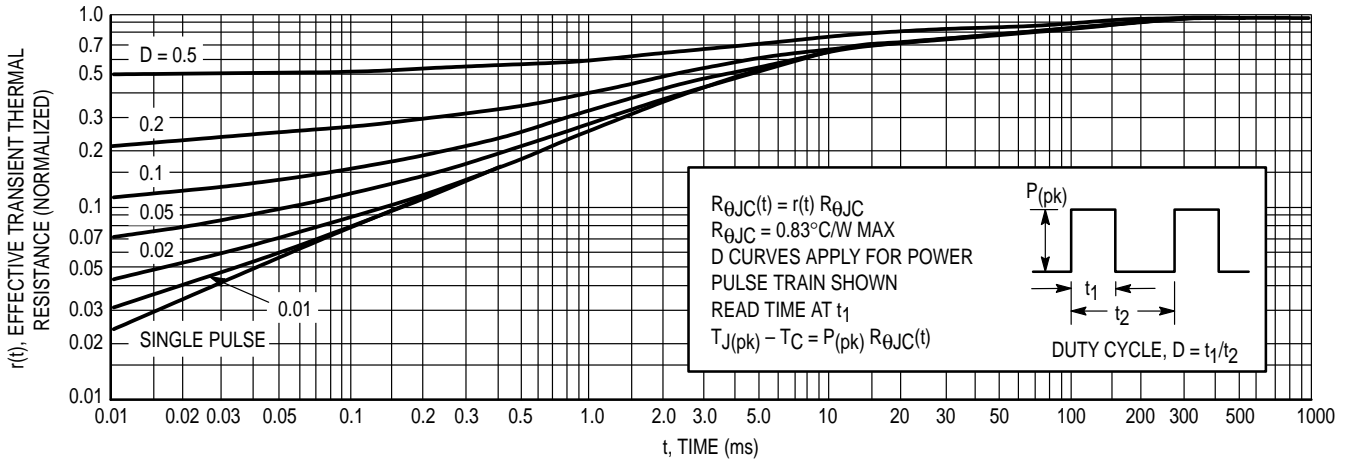


Figure 3. Thermal Response

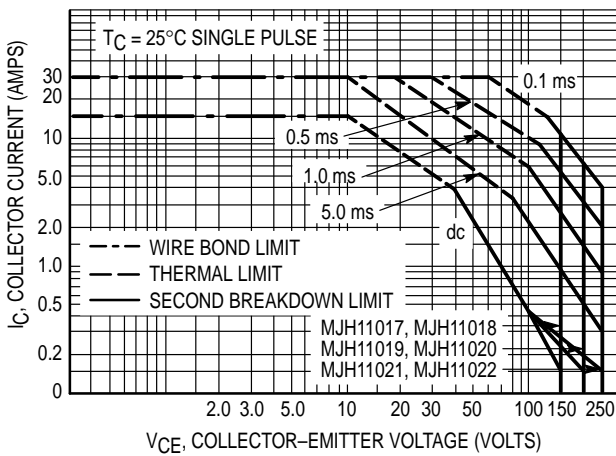


Figure 4. Maximum Rated Forward Bias Safe Operating Area (FBSOA)

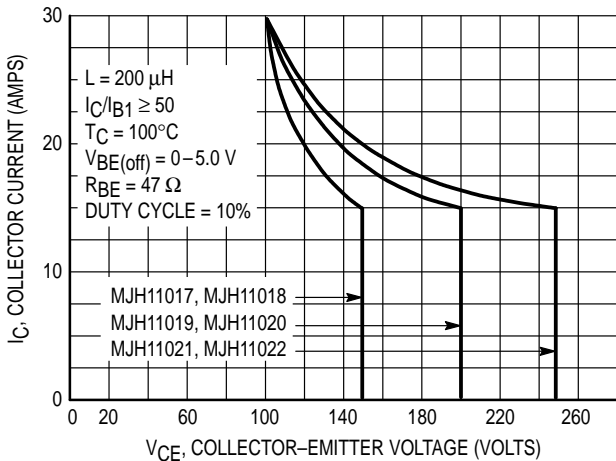


Figure 5. Maximum Rated Reverse Bias Safe Operating Area (RBSOA)

**FORWARD BIAS**

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 4 is based on  $T_J(\text{pk}) = 150^{\circ}\text{C}$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_J(\text{pk}) \leq 150^{\circ}\text{C}$ .  $T_J(\text{pk})$  may be calculated from the data in Figure 3. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

**REVERSE BIAS**

For inductive loads, high voltage and high current must be sustained simultaneously during turn-off, in most cases, with the base to emitter junction reverse biased. Under these conditions the collector voltage must be held to a safe level at or below a specific value of collector current. This can be accomplished by several means such as active clamping, RC snubbing, load line shaping, etc. The safe level for these devices is specified as Reverse Bias Safe Operating Area and represents the voltage-current conditions during reverse biased turn-off. This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode. Figure 5 gives RBSOA characteristics.

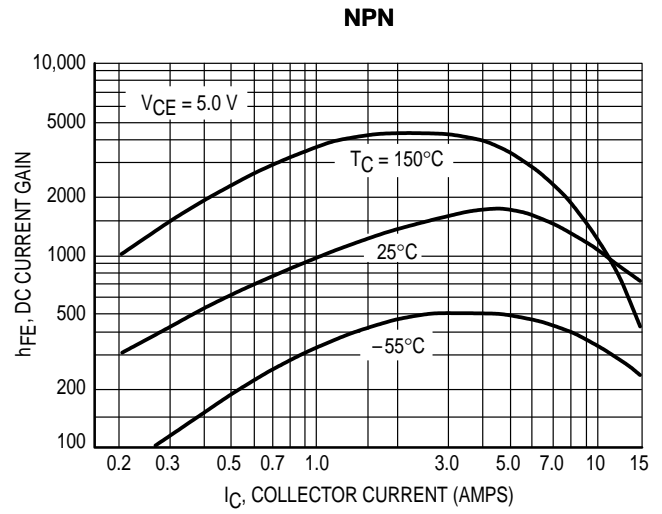
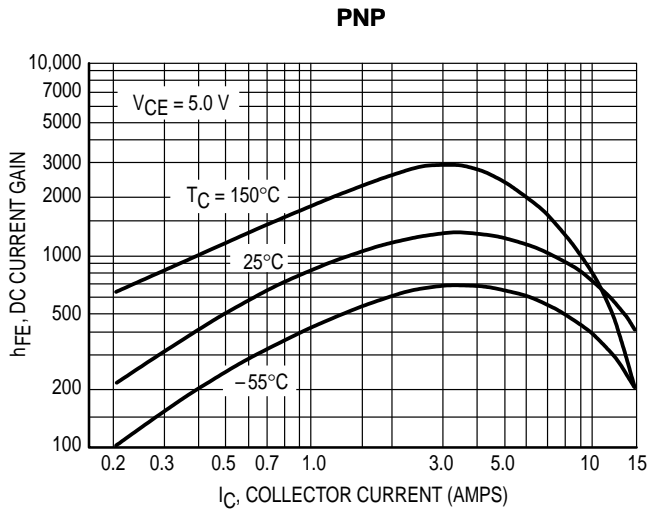


Figure 6. DC Current Gain

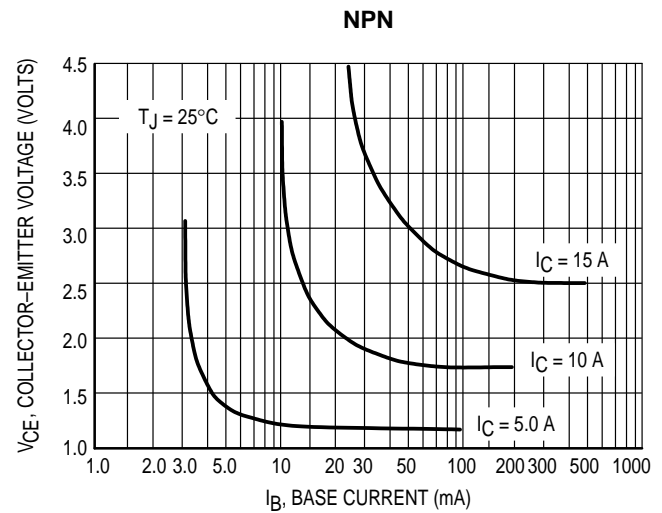
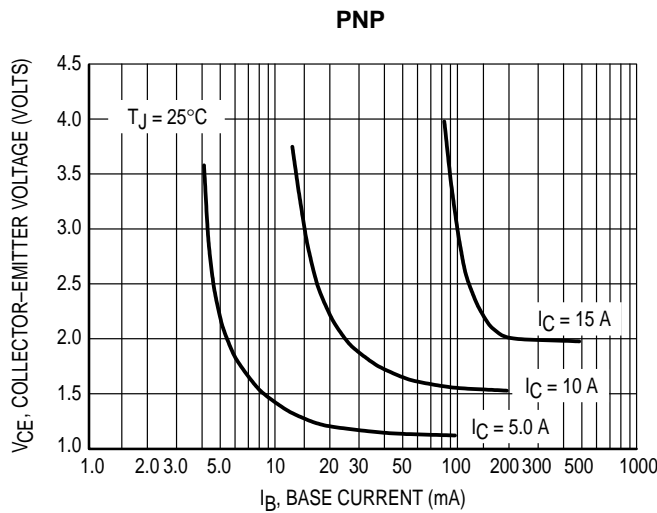


Figure 7. Collector Saturation Region

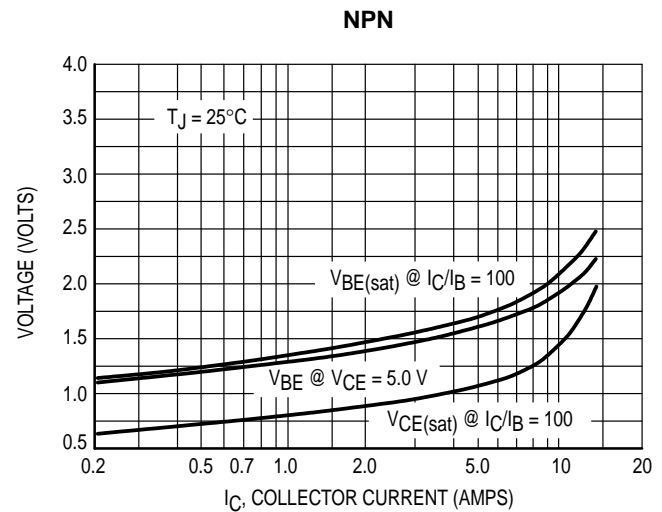
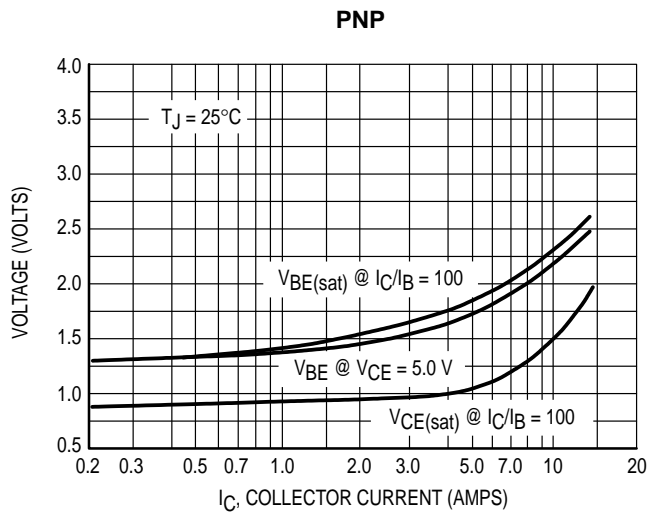


Figure 8. "On" Voltages

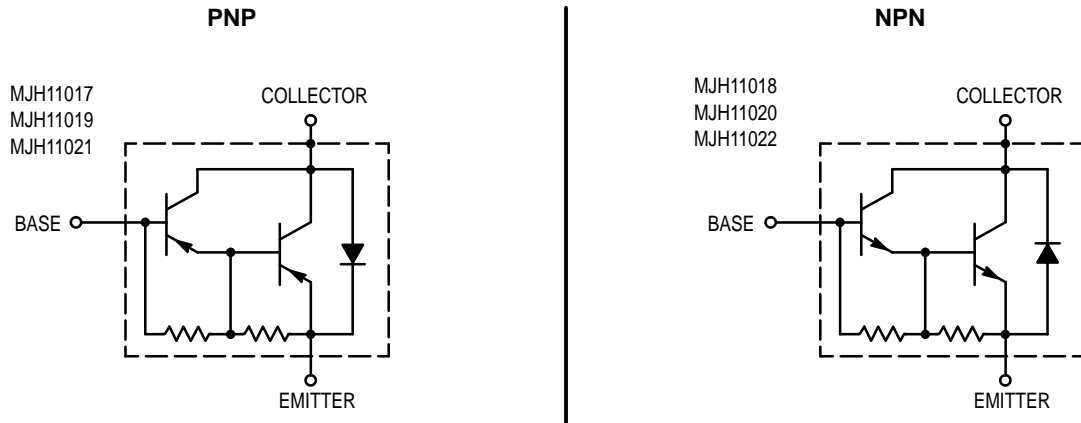
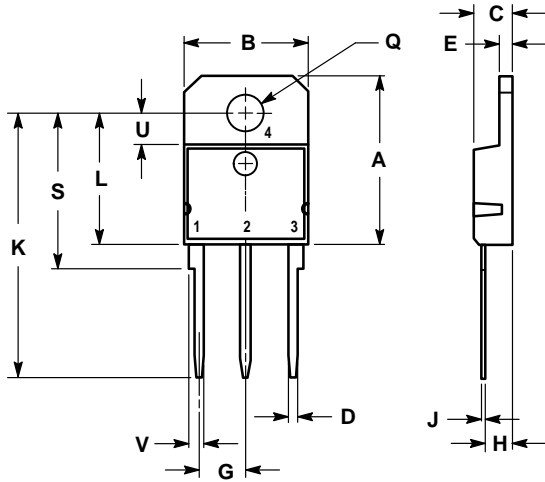


Figure 9. Darlington Schematic

PACKAGE DIMENSIONS



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

| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 19.00       | 19.60 | 0.749  | 0.771 |
| B   | 14.00       | 14.50 | 0.551  | 0.570 |
| C   | 4.20        | 4.70  | 0.165  | 0.185 |
| D   | 1.00        | 1.30  | 0.040  | 0.051 |
| E   | 1.45        | 1.65  | 0.058  | 0.064 |
| G   | 5.21        | 5.72  | 0.206  | 0.225 |
| H   | 2.60        | 3.00  | 0.103  | 0.118 |
| J   | 0.40        | 0.60  | 0.016  | 0.023 |
| K   | 28.50       | 32.00 | 1.123  | 1.259 |
| L   | 14.70       | 15.30 | 0.579  | 0.602 |
| Q   | 4.00        | 4.25  | 0.158  | 0.167 |
| S   | 17.50       | 18.10 | 0.689  | 0.712 |
| U   | 3.40        | 3.80  | 0.134  | 0.149 |
| V   | 1.50        | 2.00  | 0.060  | 0.078 |

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

**CASE 340D-01**  
**SOT 93, TO-218 TYPE**  
**ISSUE A**

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