

# Complementary Darlington Silicon Power Transistors

## MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)

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

### Features

- 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
- These are Pb–Free Devices

### MAXIMUM RATINGS

| Rating                                                                                      | Symbol         | Max               | Unit      |
|---------------------------------------------------------------------------------------------|----------------|-------------------|-----------|
| Collector–Emitter Voltage<br>MJH11018, MJH11017<br>MJH11020, MJH11019<br>MJH11022, MJH11021 | $V_{CEO}$      | 150<br>200<br>250 | Vdc       |
| Collector–Base Voltage<br>MJH11018, MJH11017<br>MJH11020, MJH11019<br>MJH11022, MJH11021    | $V_{CB}$       | 150<br>200<br>250 | Vdc       |
| Emitter–Base Voltage                                                                        | $V_{EB}$       | 5.0               | Vdc       |
| Collector Current – Continuous<br>– Peak (Note 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        | W<br>W/°C |
| Operating and Storage Junction Temperature Range                                            | $T_J, T_{stg}$ | –65 to<br>+150    | °C        |

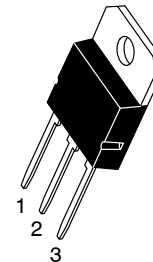
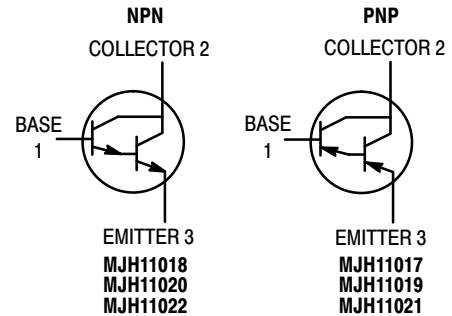
### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max  | Unit |
|--------------------------------------|-----------------|------|------|
| Thermal Resistance, Junction–to–Case | $R_{\theta JC}$ | 0.83 | °C/W |

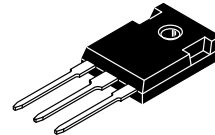
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

## 15 AMPERE DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS 150–250 VOLTS, 150 WATTS



SOT-93  
(TO-218)  
CASE 340D  
STYLE 1



TO-247  
CASE 340L  
STYLE 3

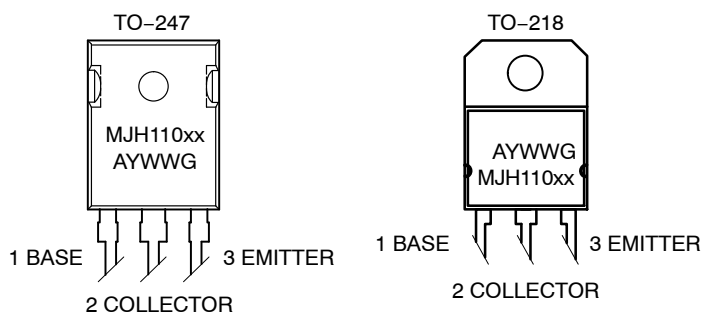
**NOTE:** Effective June 2012 this device will be available only in the TO-247 package. Reference FPCN# 16827.

### ORDERING INFORMATION

See detailed ordering and shipping information in on page 2 of this data sheet.

# MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)

## MARKING DIAGRAMS



A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package  
MJH110xx = Device Code  
xx = 17, 19, 21, 18, 20, 22

## ORDERING INFORMATION

| Device Order Number | Package Type        | Shipping        |
|---------------------|---------------------|-----------------|
| MJH11017G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11018G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11019G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11020G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11021G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11022G           | TO-218<br>(Pb-Free) | 30 Units / Rail |
| MJH11017G           | TO-247<br>(Pb-Free) | 30 Units / Rail |
| MJH11018G           | TO-247<br>(Pb-Free) | 30 Units / Rail |
| MJH11019G           | TO-247<br>(Pb-Free) | 30 Units / Rail |
| MJH11020G           | TO-247<br>(Pb-Free) | 30 Units / Rail |
| MJH11021G           | TO-247<br>(Pb-Free) | 30 Units / Rail |
| MJH11022G           | TO-247<br>(Pb-Free) | 30 Units / Rail |

# MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)

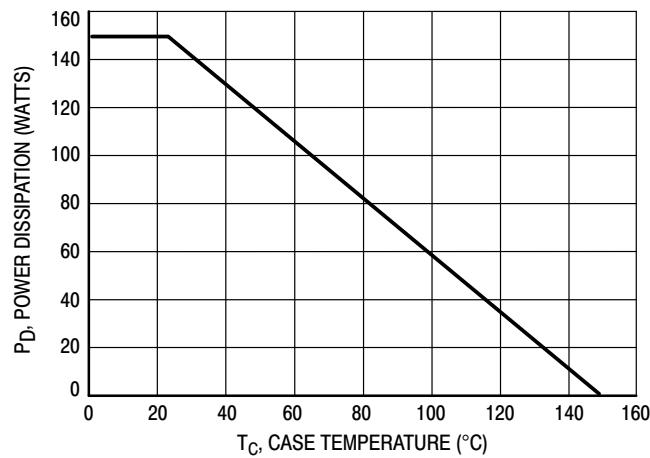


Figure 1. Power Derating

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

| Characteristic                                                                                                                                                                                               | Symbol                | Min               | Max               | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------|-------------------|------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                                                                                   |                       |                   |                   |      |
| Collector-Emitter Sustaining Voltage (Note 2)<br>(I <sub>C</sub> = 0.1 Adc, I <sub>B</sub> = 0)                                                                                                              | V <sub>CEO(sus)</sub> | 150<br>200<br>250 | –<br>–<br>–       | Vdc  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = 75 Vdc, I <sub>B</sub> = 0)<br>(V <sub>CE</sub> = 100 Vdc, I <sub>B</sub> = 0)<br>(V <sub>CE</sub> = 125 Vdc, I <sub>B</sub> = 0)                             | I <sub>CEO</sub>      | –<br>–<br>–       | 1.0<br>1.0<br>1.0 | mAdc |
| Collector Cutoff Current<br>(V <sub>CE</sub> = Rated V <sub>CB</sub> , V <sub>BE(off)</sub> = 1.5 Vdc)<br>(V <sub>CE</sub> = Rated V <sub>CB</sub> , V <sub>BE(off)</sub> = 1.5 Vdc, T <sub>J</sub> = 150°C) | I <sub>CEV</sub>      | –<br>–            | 0.5<br>5.0        | mAdc |
| Emitter Cutoff Current (V <sub>BE</sub> = 5.0 Vdc I <sub>C</sub> = 0)                                                                                                                                        | I <sub>EBO</sub>      | –                 | 2.0               | mAdc |

## ON CHARACTERISTICS (Note 2)

|                                                                                                                                                  |                      |            |             |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------|-------------|-----|
| DC Current Gain<br>(I <sub>C</sub> = 10 Adc, V <sub>CE</sub> = 5.0 Vdc)<br>(I <sub>C</sub> = 15 Adc, V <sub>CE</sub> = 5.0 Vdc)                  | h <sub>FE</sub>      | 400<br>100 | 15,000<br>– | –   |
| Collector-Emitter Saturation Voltage<br>(I <sub>C</sub> = 10 Adc, I <sub>B</sub> = 100 mA)<br>(I <sub>C</sub> = 15 Adc, I <sub>B</sub> = 150 mA) | V <sub>CE(sat)</sub> | –<br>–     | 2.5<br>4.0  | Vdc |
| Base-Emitter On Voltage (I <sub>C</sub> = 10 A, V <sub>CE</sub> = 5.0 Vdc)                                                                       | V <sub>BE(on)</sub>  | –          | 2.8         | Vdc |
| Base-Emitter Saturation Voltage (I <sub>C</sub> = 15 Adc, I <sub>B</sub> = 150 mA)                                                               | V <sub>BE(sat)</sub> | –          | 3.8         | Vdc |

## DYNAMIC CHARACTERISTICS

|                                                                                                                                             |                 |        |            |    |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|------------|----|
| Current-Gain Bandwidth Product (I <sub>C</sub> = 10 Adc, V <sub>CE</sub> = 3.0 Vdc, f = 1.0 MHz)                                            | f <sub>T</sub>  | 3.0    | –          | –  |
| Output Capacitance MJH11018, MJH11020, MJH11022<br>(V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 0.1 MHz) MJH11017, MJH11019, MJH11021 | C <sub>ob</sub> | –<br>– | 400<br>600 | pF |
| Small-Signal Current Gain (I <sub>C</sub> = 10 Adc, V <sub>CE</sub> = 3.0 Vdc, f = 1.0 kHz)                                                 | h <sub>fe</sub> | 75     | –          | –  |

## SWITCHING CHARACTERISTICS

| Characteristic | Symbol         | Typical |     | Unit |
|----------------|----------------|---------|-----|------|
|                |                | NPN     | PNP |      |
| Delay Time     | t <sub>d</sub> | 150     | 75  | ns   |
| Rise Time      | t <sub>r</sub> | 1.2     | 0.5 | μs   |
| Storage Time   | t <sub>s</sub> | 4.4     | 2.7 | μs   |
| Fall Time      | t <sub>f</sub> | 2.5     | 2.5 | μs   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

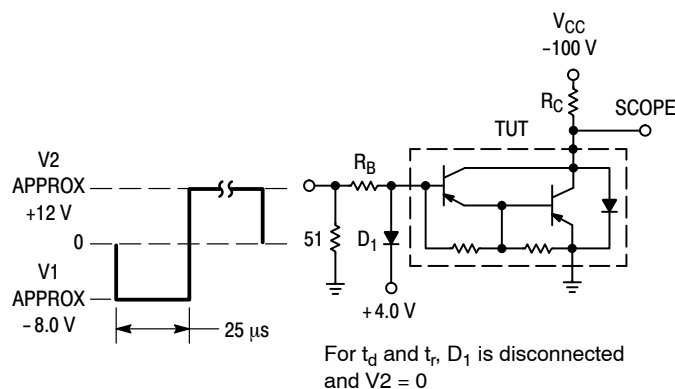
# MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)

$R_B$  &  $R_C$  varied to obtain desired current levels

$D_1$ , must be fast recovery types, e.g.:

1N5825 used above  $I_B \approx 100$  mA

MSD6100 used below  $I_B \approx 100$  mA



$t_r, t_f \leq 10$  ns

Duty Cycle = 1.0%

For NPN test circuit, reverse diode and voltage polarities.

Figure 2. Switching Times Test Circuit

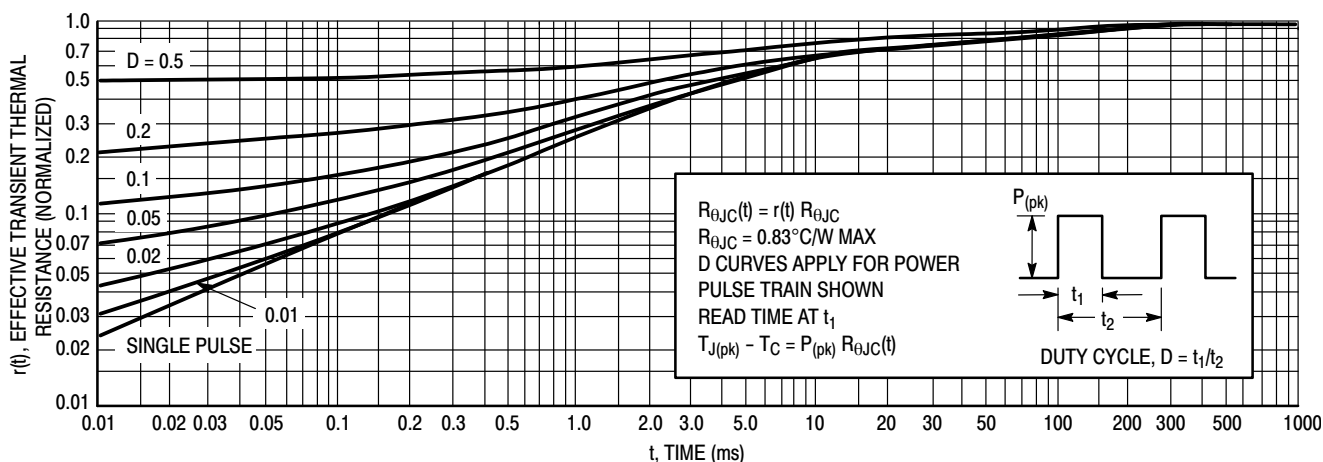


Figure 3. Thermal Response

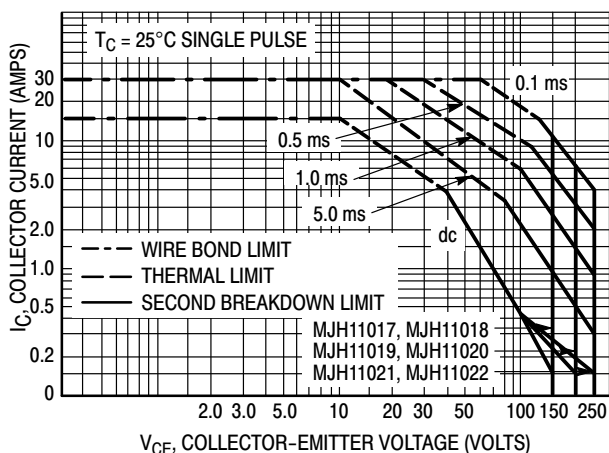


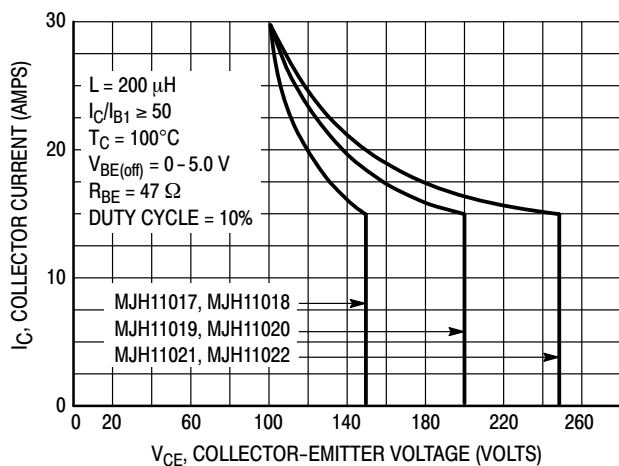
Figure 4. Maximum Rated Forward Bias Safe Operating Area (FBSOA)

## 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  $T_{J(pk)} = 150^{\circ}C$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 150^{\circ}C$ .  $T_{J(pk)}$  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.

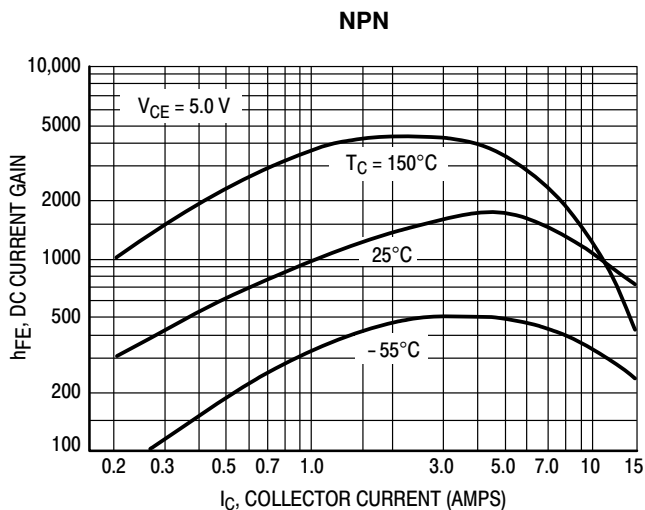
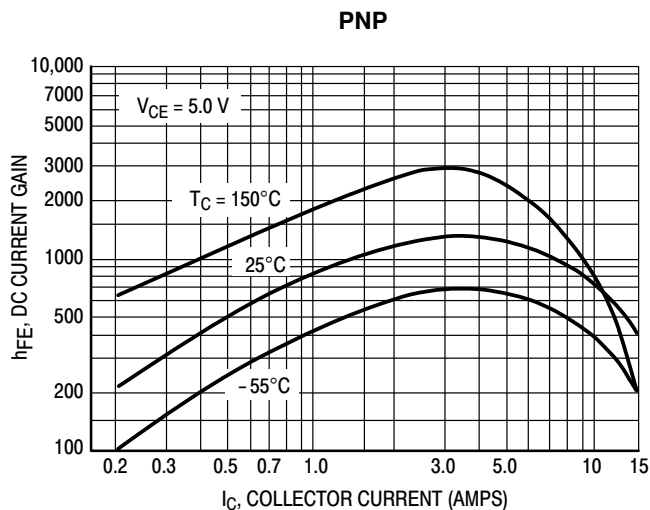
# MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)



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

## 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**

# MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)

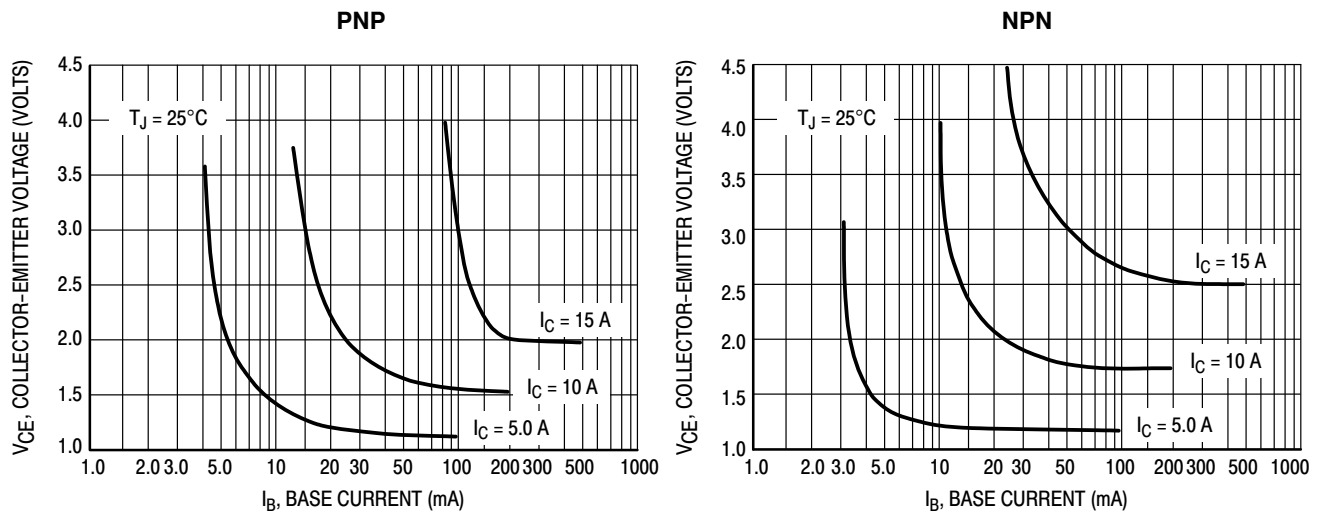


Figure 7. Collector Saturation Region

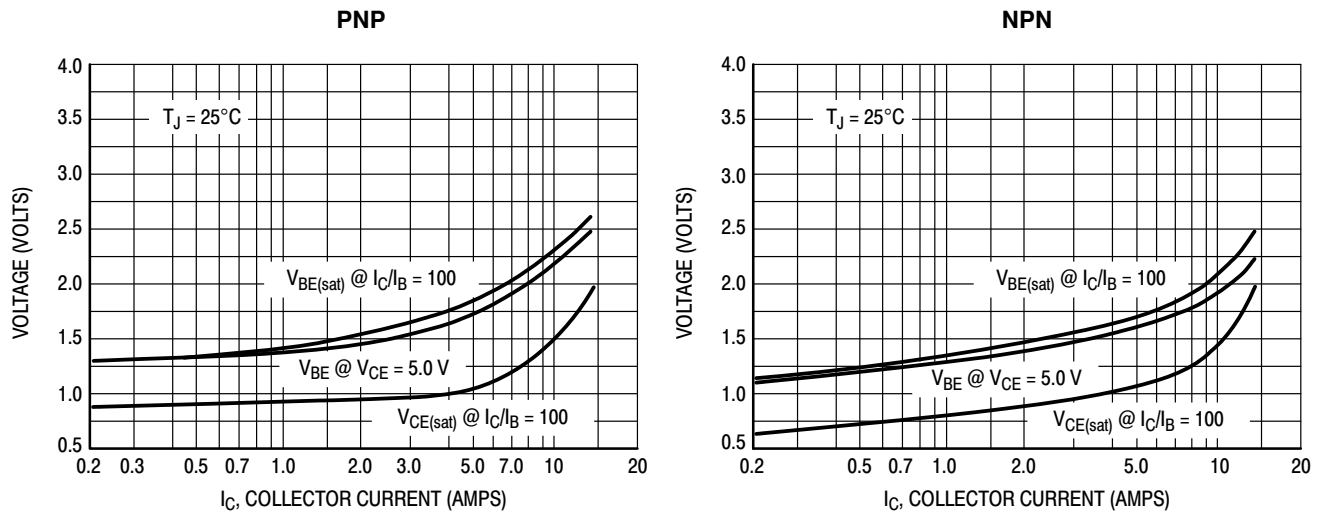


Figure 8. "On" Voltages

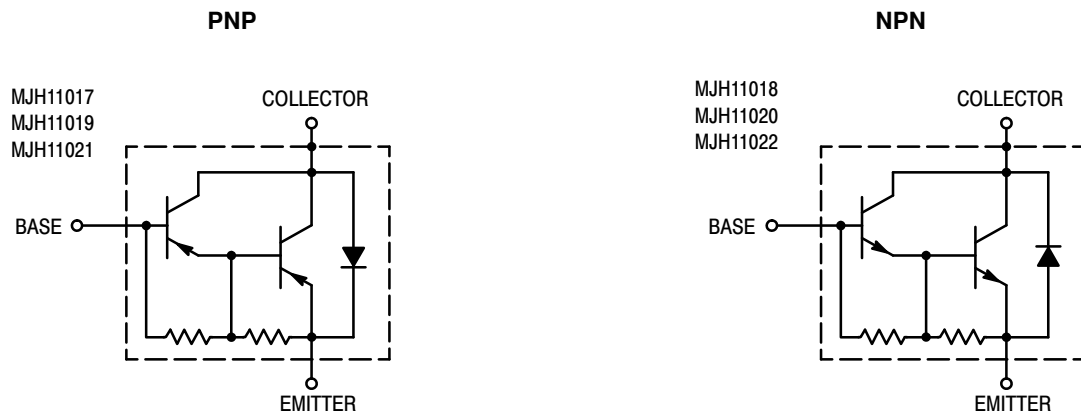
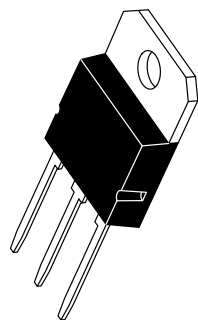
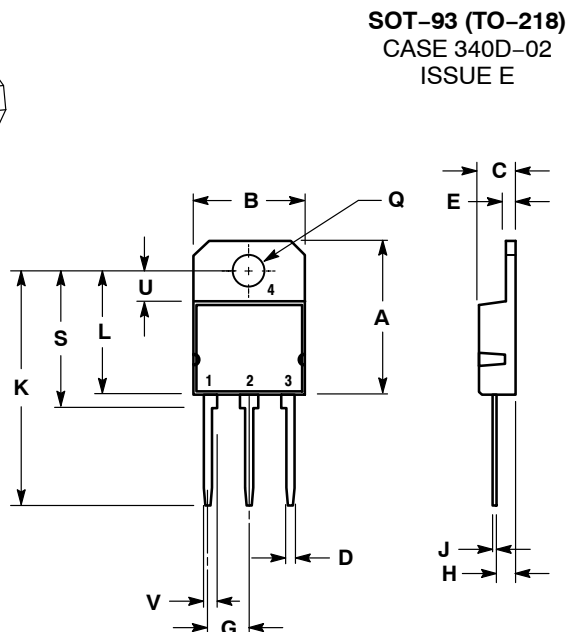


Figure 9. Darlington Schematic



SCALE 1:1



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

STYLE 2:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

**SOT-93 (TO-218)**  
CASE 340D-02  
ISSUE E

DATE 03 JAN 2002

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

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | ---         | 20.35 | ---       | 0.801 |
| B   | 14.70       | 15.20 | 0.579     | 0.598 |
| C   | 4.70        | 4.90  | 0.185     | 0.193 |
| D   | 1.10        | 1.30  | 0.043     | 0.051 |
| E   | 1.17        | 1.37  | 0.046     | 0.054 |
| G   | 5.40        | 5.55  | 0.213     | 0.219 |
| H   | 2.00        | 3.00  | 0.079     | 0.118 |
| J   | 0.50        | 0.78  | 0.020     | 0.031 |
| K   | 31.00 REF   |       | 1.220 REF |       |
| L   | ---         | 16.20 | ---       | 0.638 |
| Q   | 4.00        | 4.10  | 0.158     | 0.161 |
| S   | 17.80       | 18.20 | 0.701     | 0.717 |
| U   | 4.00 REF    |       | 0.157 REF |       |
| V   | 1.75 REF    |       | 0.069     |       |

### GENERIC MARKING DIAGRAM\*

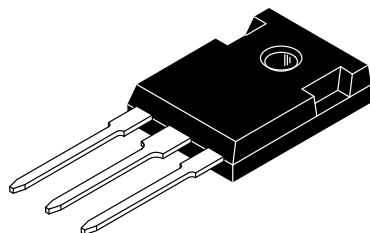


A = Assembly Location  
Y = Year  
WW = Work Week  
XXXXX = Device Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                         |                        |                                                                                                                                                                                     |
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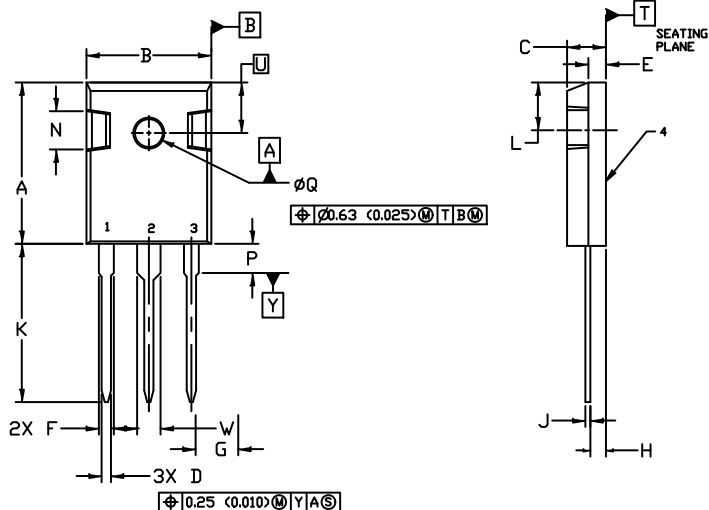
**SCALE 1:1**

**TO-247**  
CASE 340L  
ISSUE G

DATE 06 OCT 2021

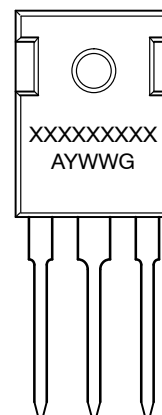
## NOTES:

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



|     | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
| DIM | MIN.        | MAX.  | MIN.   | MAX.  |
| A   | 20.32       | 21.08 | 0.800  | 0.830 |
| B   | 15.75       | 16.26 | 0.620  | 0.640 |
| C   | 4.70        | 5.30  | 0.185  | 0.209 |
| D   | 1.00        | 1.40  | 0.040  | 0.055 |
| E   | 1.90        | 2.60  | 0.075  | 0.102 |
| F   | 1.65        | 2.13  | 0.065  | 0.084 |
| G   | 5.45        | BSC   | 0.215  | BSC   |
| H   | 1.50        | 2.49  | 0.059  | 0.098 |
| J   | 0.40        | 0.80  | 0.016  | 0.031 |
| K   | 19.81       | 20.83 | 0.780  | 0.820 |
| L   | 5.40        | 6.20  | 0.212  | 0.244 |
| N   | 4.32        | 5.49  | 0.170  | 0.216 |
| P   | ----        | 4.50  | ----   | 0.177 |
| Q   | 3.55        | 3.65  | 0.140  | 0.144 |
| U   | 6.15        | BSC   | 0.242  | BSC   |
| W   | 2.87        | 3.12  | 0.113  | 0.123 |

### GENERIC MARKING DIAGRAM\*



- |                |                        |              |              |
|----------------|------------------------|--------------|--------------|
| STYLE 1:       | STYLE 2:               | STYLE 3:     | STYLE 4:     |
| PIN 1. GATE    | PIN 1. ANODE           | PIN 1. BASE  | PIN 1. GATE  |
| 2. DRAIN       | 2. CATHODE (S)         | 2. COLLECTOR | 2. COLLECTOR |
| 3. SOURCE      | 3. ANODE 2             | 3. EMITTER   | 3. EMITTER   |
| 4. DRAIN       | 4. CATHODES (S)        | 4. COLLECTOR | 4. COLLECTOR |
|                |                        |              |              |
| STYLE 5:       | STYLE 6:               |              |              |
| PIN 1. CATHODE | PIN 1. MAIN TERMINAL 1 |              |              |
| 2. ANODE       | 2. MAIN TERMINAL 2     |              |              |
| 3. GATE        | 3. GATE                |              |              |
| 4. ANODE       | 4. MAIN TERMINAL 2     |              |              |

XXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                         |                    |                                                                                                                                                                                     |
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