

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



ON Semiconductor®

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## Complementary Darlington Silicon Power Transistors

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
- Pb–Free Packages are Available\*

### 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<br>– 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/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range  | $T_J, T_{stg}$ | –65 to<br>+150    | $^\circ\text{C}$         |

### THERMAL CHARACTERISTICS

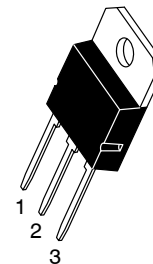
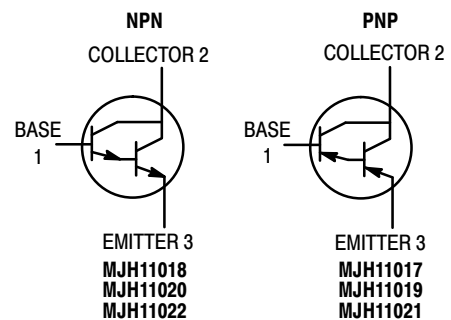
| Characteristic                       | Symbol          | Max  | Unit                      |
|--------------------------------------|-----------------|------|---------------------------|
| Thermal Resistance, Junction–to–Case | $R_{\theta JC}$ | 0.83 | $^\circ\text{C}/\text{W}$ |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

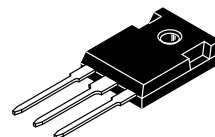
1. Pulse Test: Pulse Width = 5.0 ms, Duty Cycle  $\leq 10\%$ .

\*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## 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

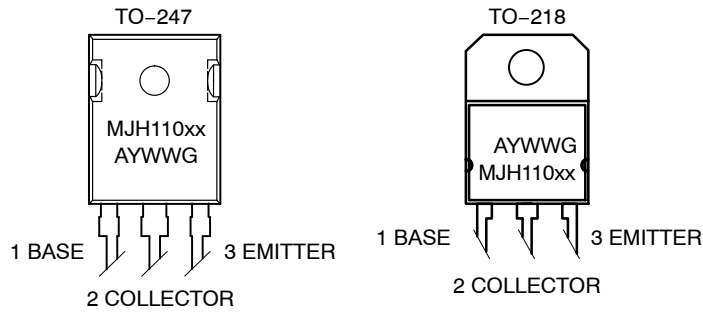
**NOTE:** Effective June 2012 this device will be available only in the TO-247 package. Reference FPCN# 16827.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section 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)

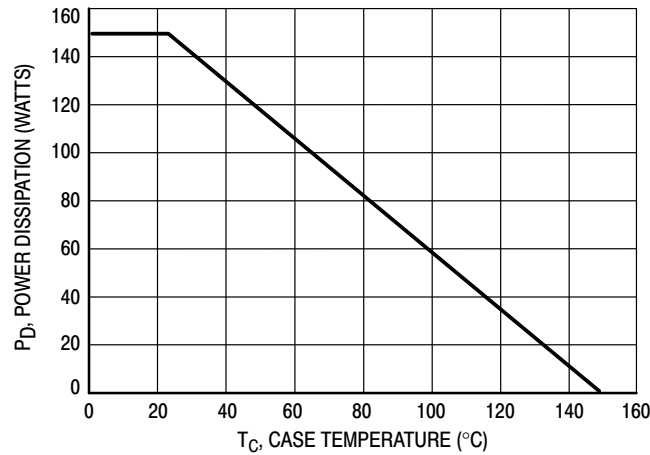


Figure 1. Power Derating

## 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<br>(V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 0.1 MHz)                | 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

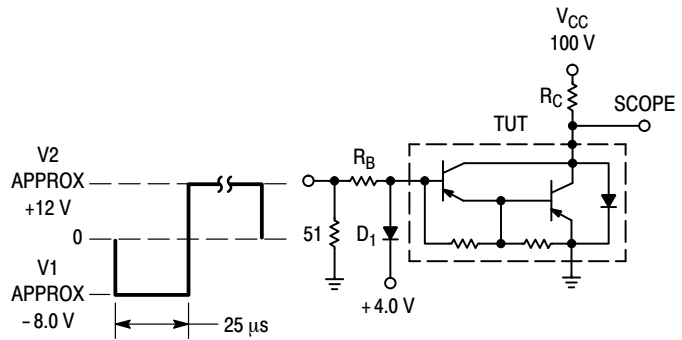
| Characteristic | Symbol         | Typical |     | Unit |
|----------------|----------------|---------|-----|------|
|                |                | NPN     | PNP |      |
| Delay Time     | t <sub>d</sub> | 150     | 75  | ns   |
| Rise Time      | t <sub>r</sub> | 1.2     | 0.5 | μs   |
| Storage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

(V<sub>CC</sub> = 100 V, I<sub>C</sub> = 10 A, I<sub>B</sub> = 100 mA  
V<sub>BE(off)</sub> = 5.0 V) (See Figure 2)

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

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$R_B$  &  $R_C$  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



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

$t_r, t_f \leq 10$  ns

Duty Cycle = 1.0%

For NPN test circuit, reverse diode and voltage polarities.

Figure 2. Switching Times Test Circuit

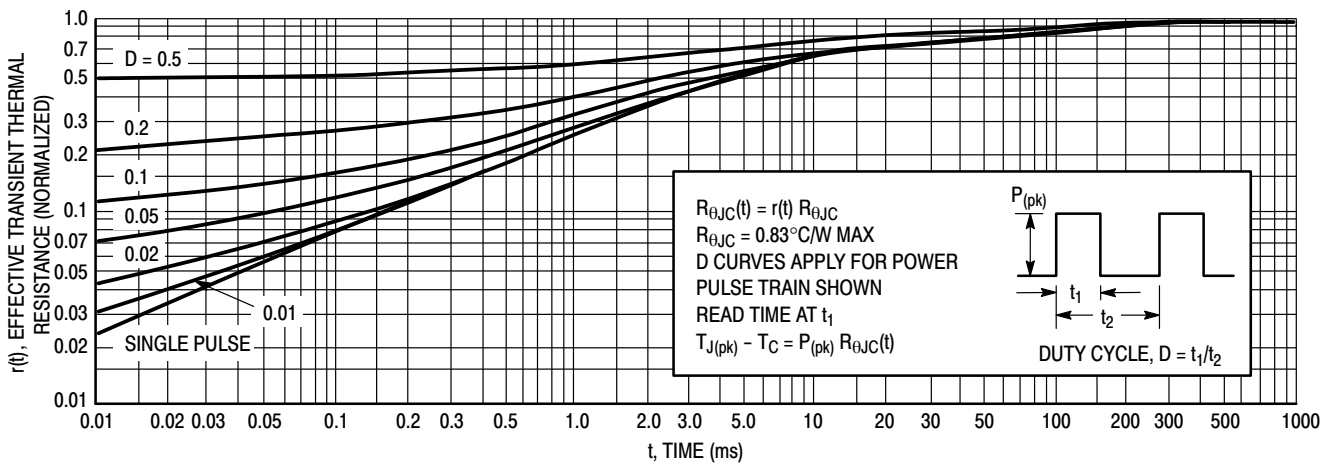


Figure 3. Thermal Response

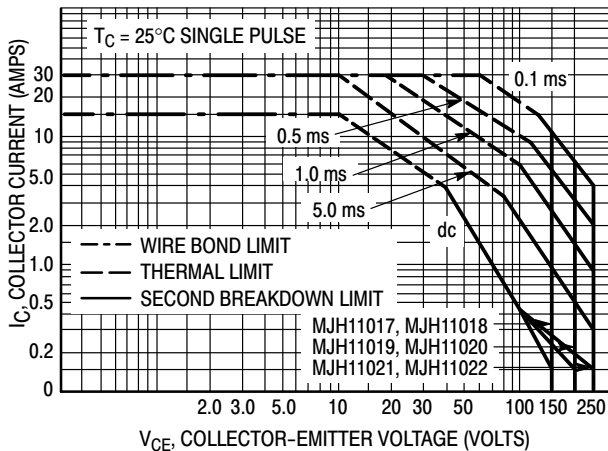


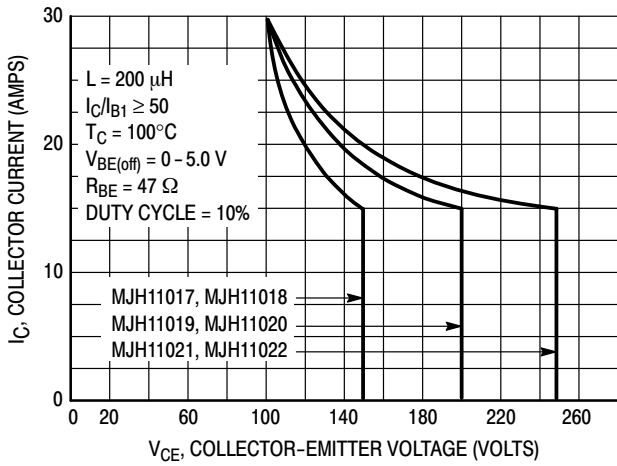
Figure 4. Maximum Rated Forward Bias Safe Operating Area (FBSOA)

## 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  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  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 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.

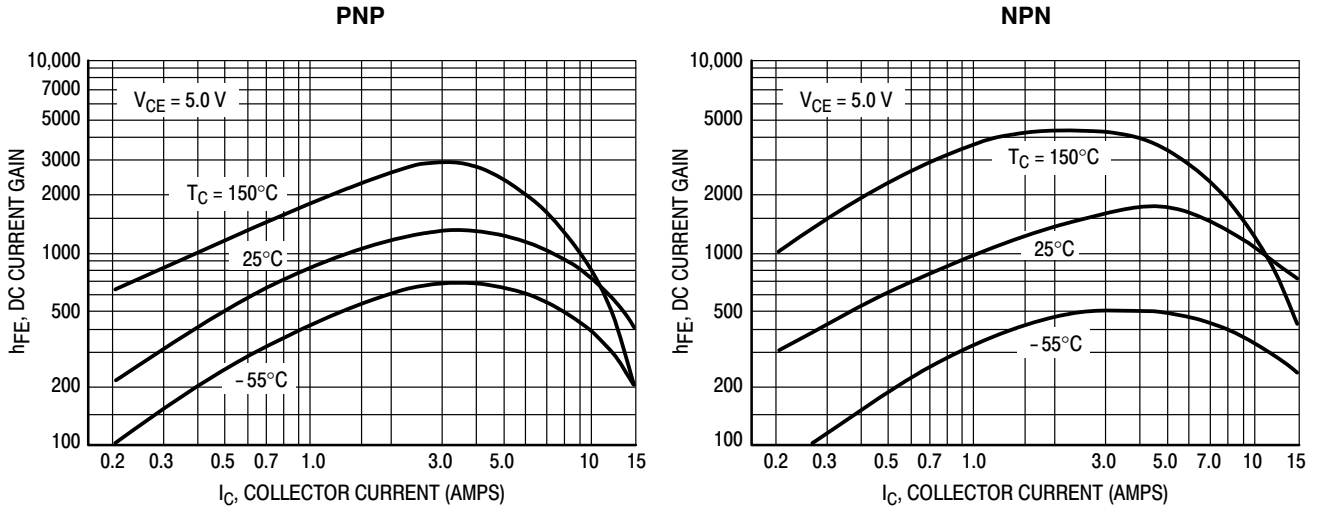
**MJH11017, MJH11019, MJH11021 (PNP) MJH11018, MJH11020, MJH11022 (NPN)**



**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)

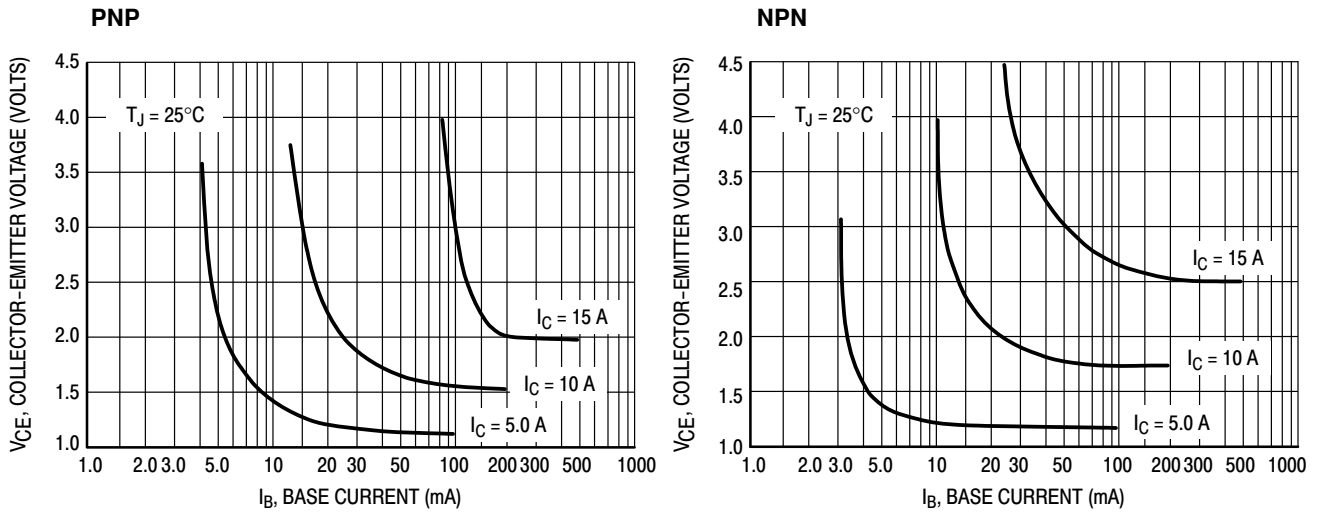


Figure 7. Collector Saturation Region

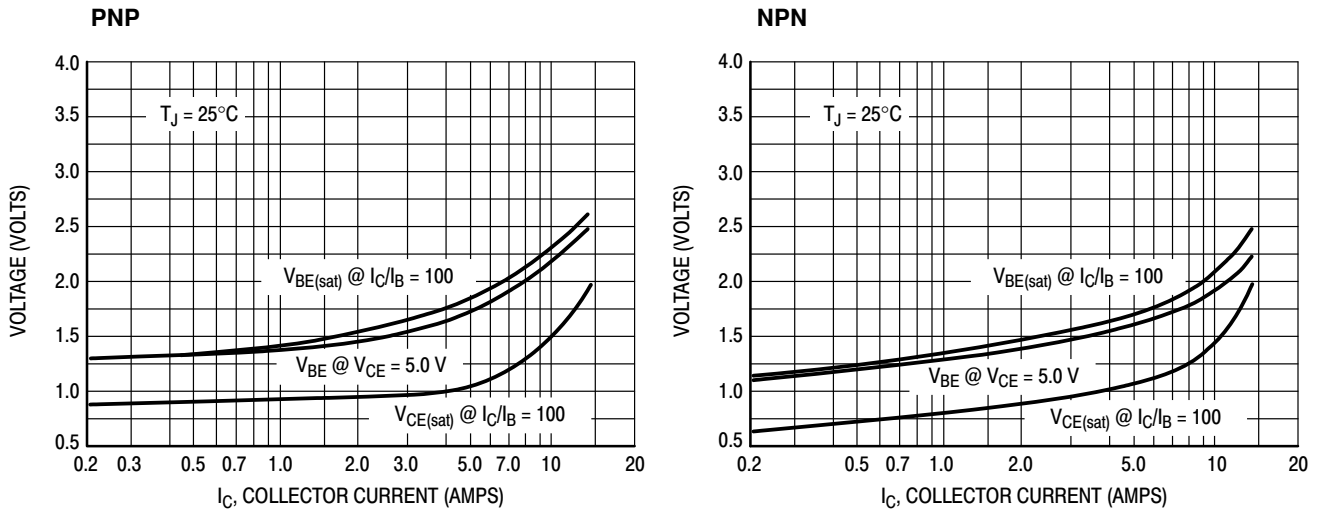
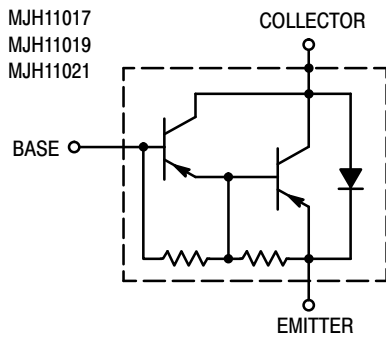


Figure 8. "On" Voltages

PNP



NPN

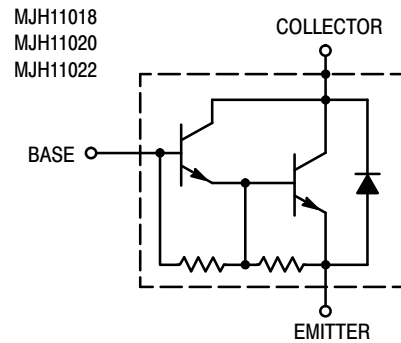
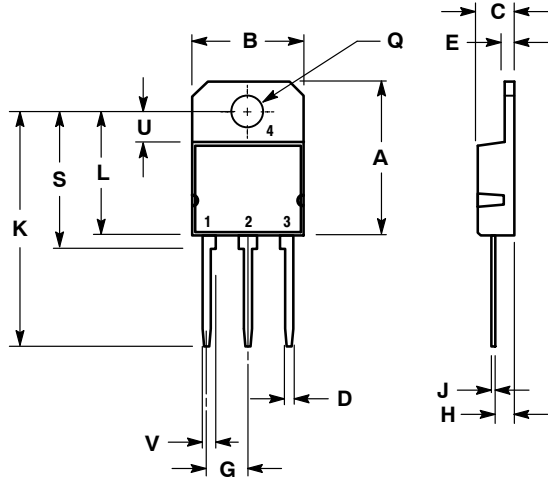


Figure 9. Darlington Schematic

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

## PACKAGE DIMENSIONS

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



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     |       |

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

### TO-247 CASE 340L-02 ISSUE F



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

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | 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 |

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

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