

# Darlington Complementary Silicon Power Transistors

## TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

Designed for general-purpose amplifier and low frequency switching applications.

### Features

- High DC Current Gain –  
 $\text{Min } h_{FE} = 1000 @ I_C$   
 $= 5.0 \text{ A}, V_{CE} = 4 \text{ V}$
- Collector-Emitter Sustaining Voltage – @ 30 mA  
 $V_{CEO(sus)} = 60 \text{ Vdc (Min) – TIP140, TIP145}$   
 $= 80 \text{ Vdc (Min) – TIP141, TIP146}$   
 $= 100 \text{ Vdc (Min) – TIP142, TIP147}$
- Monolithic Construction with Built-In Base-Emitter Shunt Resistor
- These are Pb-Free Devices\*

### MAXIMUM RATINGS

| Symbol         | Rating                                                | TIP140<br>TIP145 | TIP141<br>TIP146 | TIP142<br>TIP147 | Unit             |
|----------------|-------------------------------------------------------|------------------|------------------|------------------|------------------|
| $V_{CEO}$      | Collector – Emitter Voltage                           | 60               | 80               | 100              | Vdc              |
| $V_{CB}$       | Collector – Base Voltage                              | 60               | 80               | 100              | Vdc              |
| $V_{EB}$       | Emitter – Base Voltage                                | 5.0              |                  |                  | Vdc              |
| $I_C$          | Collector Current<br>– Continuous<br>– Peak (Note 1)  | 10<br>15         |                  |                  | Adc              |
| $I_B$          | Base Current – Continuous                             | 0.5              |                  |                  | Adc              |
| $P_D$          | Total Power Dissipation<br>@ $T_C = 25^\circ\text{C}$ | 125              |                  |                  | W                |
| $T_J, T_{stg}$ | Operating and Storage<br>Junction Temperature Range   | –65 to +150      |                  |                  | $^\circ\text{C}$ |

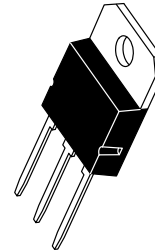
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL CHARACTERISTICS

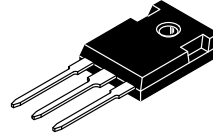
| Symbol          | Characteristic                             | Max  | Unit               |
|-----------------|--------------------------------------------|------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance,<br>Junction-to-Case    | 1.0  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance,<br>Junction-to-Ambient | 35.7 | $^\circ\text{C/W}$ |

1. 5 ms,  $\leq 10\%$  Duty Cycle.

\*For additional information on our Pb-Free strategy and soldering details, please download the [onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D](#).



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.

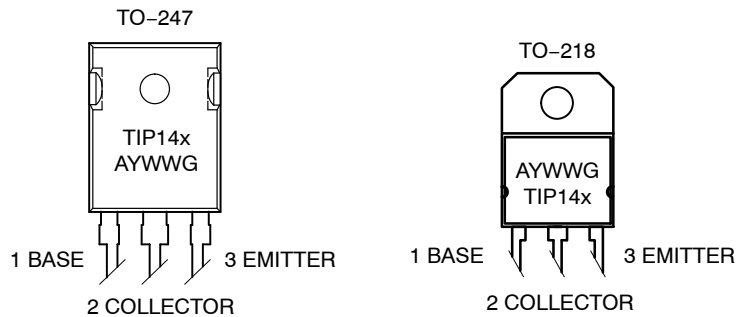
**10 AMPERE  
DARLINGTON  
COMPLEMENTARY SILICON  
POWER TRANSISTORS  
60–100 VOLTS, 125 WATTS**

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

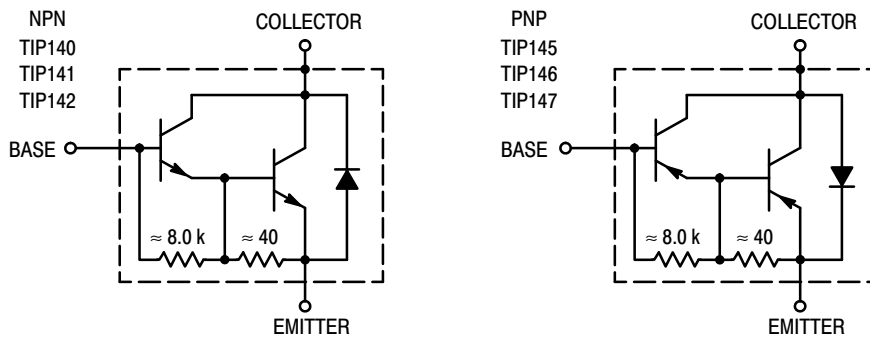
# TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

## MARKING DIAGRAMS



TIP14x = Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 G = Pb-Free Package

## DARLINGTON SCHEMATICS



# TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

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

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

### OFF CHARACTERISTICS

|                |                                                                                                                                                              |                                                    |                 |             |                   |     |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----------------|-------------|-------------------|-----|
| $V_{CEO(sus)}$ | Collector–Emitter Sustaining Voltage (Note 2)<br>( $I_C = 30\text{ mA}$ , $I_B = 0$ )                                                                        | TIP140, TIP145<br>TIP141, TIP146<br>TIP142, TIP147 | 60<br>80<br>100 | –<br>–<br>– | –<br>–<br>–       | Vdc |
| $I_{CEO}$      | Collector Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 40\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 50\text{ Vdc}$ , $I_B = 0$ ) | TIP140, TIP145<br>TIP141, TIP146<br>TIP142, TIP147 | –<br>–<br>–     | –<br>–<br>– | 2.0<br>2.0<br>2.0 | mA  |
| $I_{CBO}$      | Collector Cutoff Current<br>( $V_{CB} = 60\text{ V}$ , $I_E = 0$ )<br>( $V_{CB} = 80\text{ V}$ , $I_E = 0$ )<br>( $V_{CB} = 100\text{ V}$ , $I_E = 0$ )      | TIP140, TIP145<br>TIP141, TIP146<br>TIP142, TIP147 | –<br>–<br>–     | –<br>–<br>– | 1.0<br>1.0<br>1.0 | mA  |
| $I_{EBO}$      | Emitter Cutoff Current ( $V_{BE} = 5.0\text{ V}$ )                                                                                                           |                                                    | –               | –           | 2.0               | mA  |

### ON CHARACTERISTICS (Note 2)

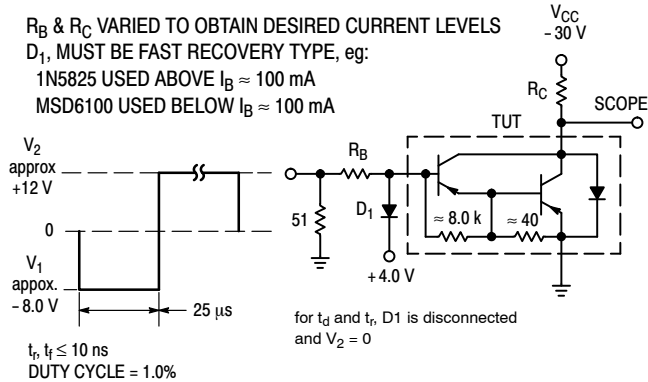
|               |                                                                                                                                           |             |        |            |     |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------|------------|-----|
| $h_{FE}$      | DC Current Gain<br>( $I_C = 5.0\text{ A}$ , $V_{CE} = 4.0\text{ V}$ )<br>( $I_C = 10\text{ A}$ , $V_{CE} = 4.0\text{ V}$ )                | 1000<br>500 | –<br>– | –<br>–     | –   |
| $V_{CE(sat)}$ | Collector–Emitter Saturation Voltage<br>( $I_C = 5.0\text{ A}$ , $I_B = 10\text{ mA}$ )<br>( $I_C = 10\text{ A}$ , $I_B = 40\text{ mA}$ ) | –<br>–      | –<br>– | 2.0<br>3.0 | Vdc |
| $V_{BE(sat)}$ | Base–Emitter Saturation Voltage<br>( $I_C = 10\text{ A}$ , $I_B = 40\text{ mA}$ )                                                         | –           | –      | 3.5        | Vdc |
| $V_{BE(on)}$  | Base–Emitter On Voltage<br>( $I_C = 10\text{ A}$ , $V_{CE} = 4.0\text{ Vdc}$ )                                                            | –           | –      | 3.0        | Vdc |

### SWITCHING CHARACTERISTICS

| Resistive Load (See Figure 1) | Resistive Load (See Figure 1) |                                                                                                                                                                                                      |   |      |   |    |
|-------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------|---|----|
| t <sub>d</sub>                | Delay Time                    | (V <sub>CC</sub> = 30 V, I <sub>C</sub> = 5.0 A,<br>I <sub>B</sub> = 20 mA, Duty Cycle ≤ 2.0%,<br>I <sub>B1</sub> = I <sub>B2</sub> , R <sub>C</sub> & R <sub>B</sub> Varied, T <sub>J</sub> = 25°C) | – | 0.15 | – | μs |
| t <sub>r</sub>                | Rise Time                     |                                                                                                                                                                                                      | – | 0.55 | – | μs |
| t <sub>s</sub>                | Storage Time                  |                                                                                                                                                                                                      | – | 2.5  | – | μs |
| t <sub>f</sub>                | Fall Time                     |                                                                                                                                                                                                      | – | 2.5  | – | μs |

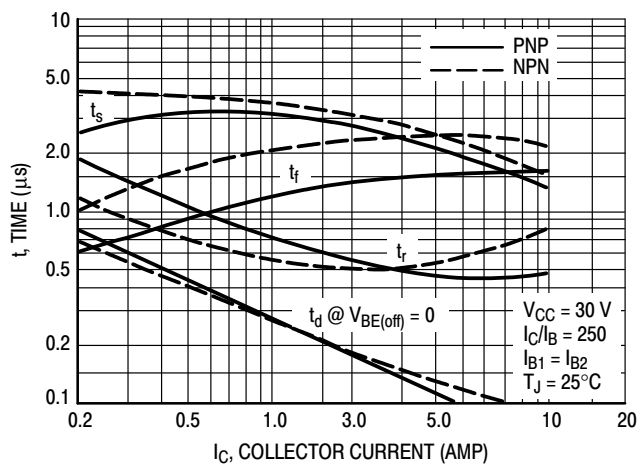
2. Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

## TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)



For NPN test circuit reverse diode and voltage polarities.

**Figure 1. Switching Times Test Circuit**



**Figure 2. Switching Times**

# TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

## TYPICAL CHARACTERISTICS

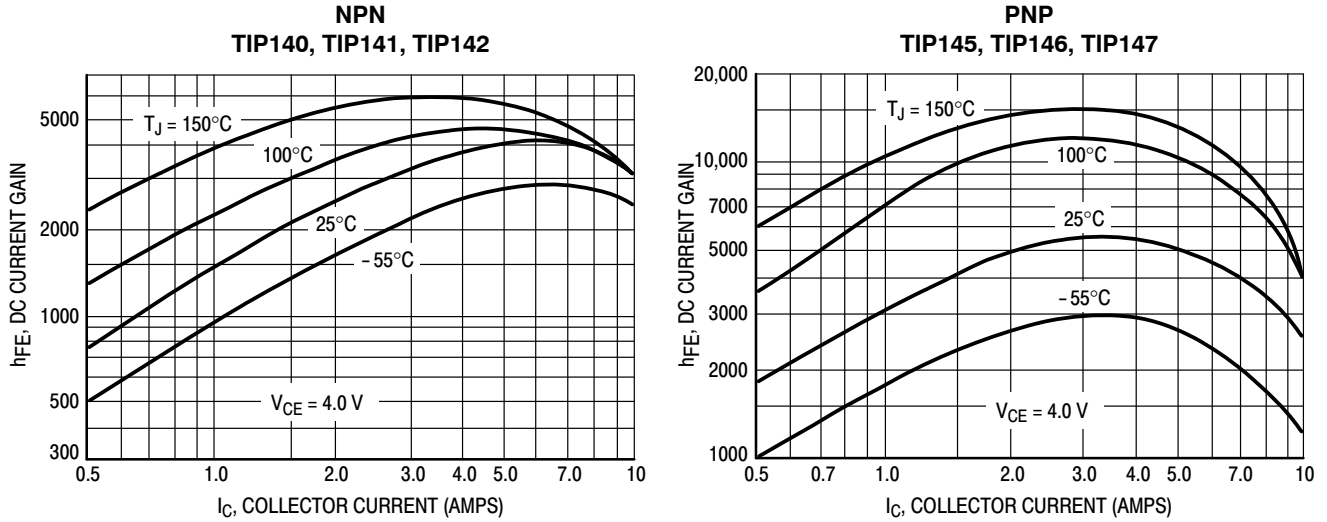


Figure 3. DC Current Gain versus Collector Current

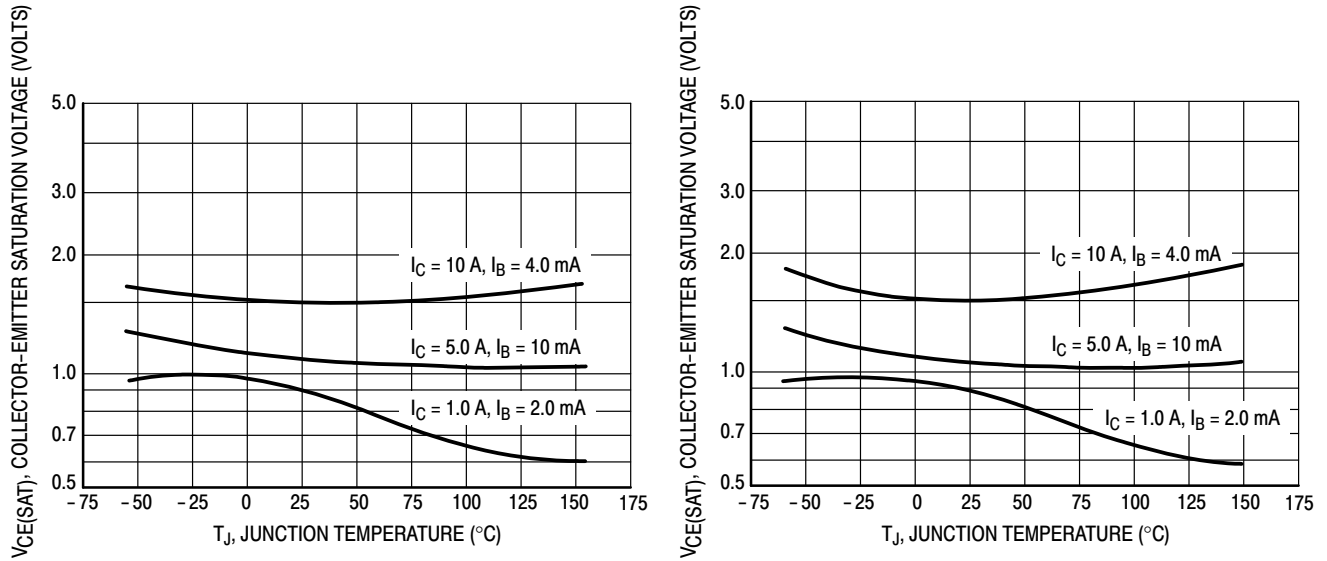


Figure 4. Collector-Emitter Saturation Voltage

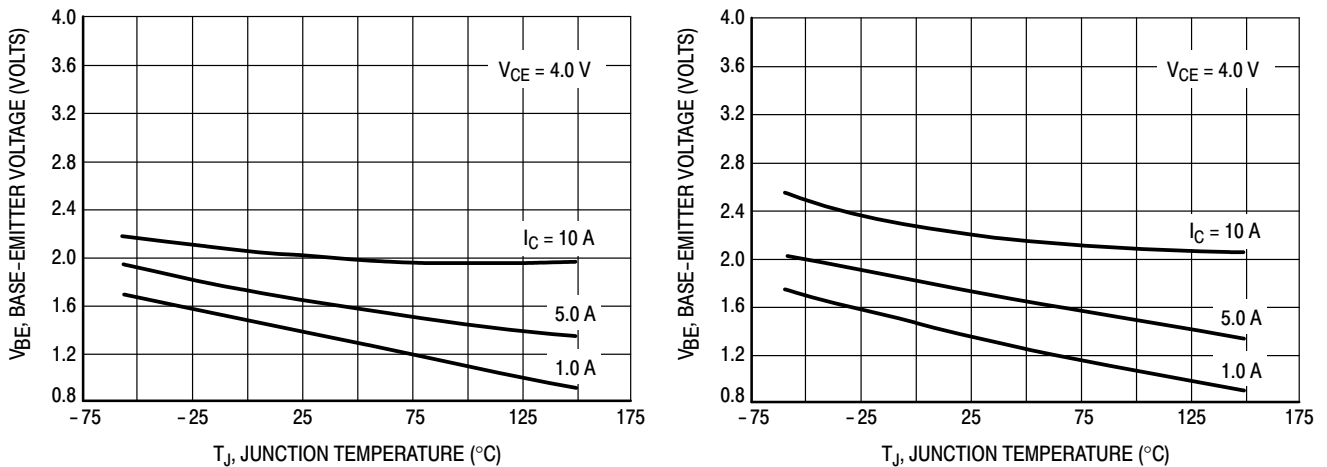


Figure 5. Base-Emitter Voltage

# TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

## 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. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

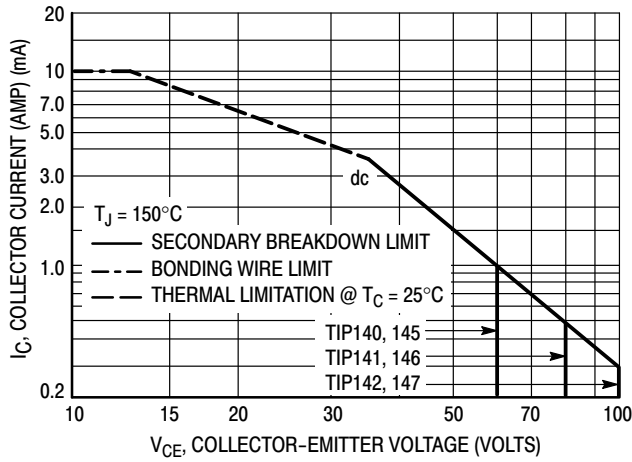


Figure 6. Active-Region Safe Operating Area

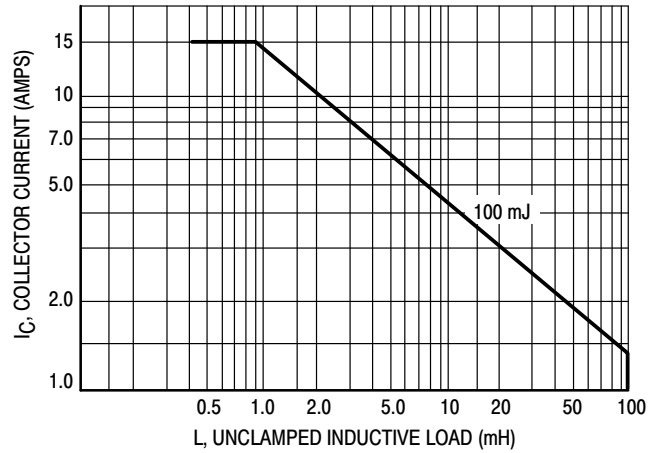
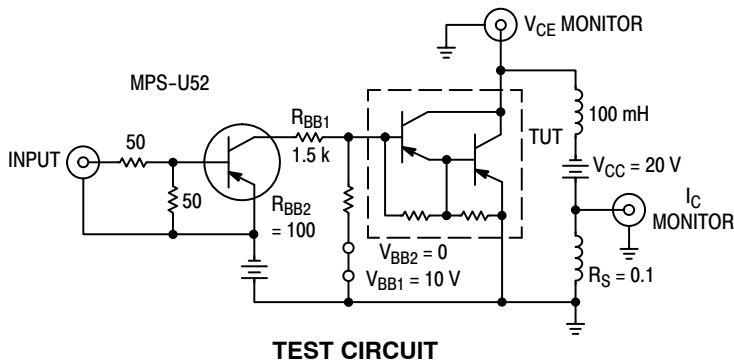


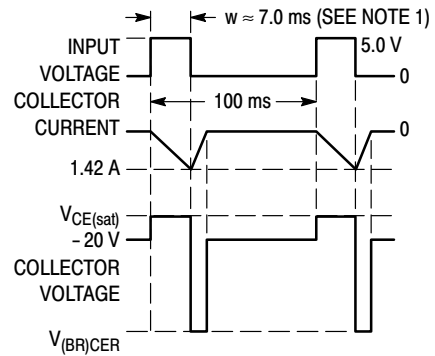
Figure 7. Unclamped Inductive Load



TEST CIRCUIT

NOTE 1: Input pulse width is increased until  $I_{CM} = 1.42\text{ A}$ .

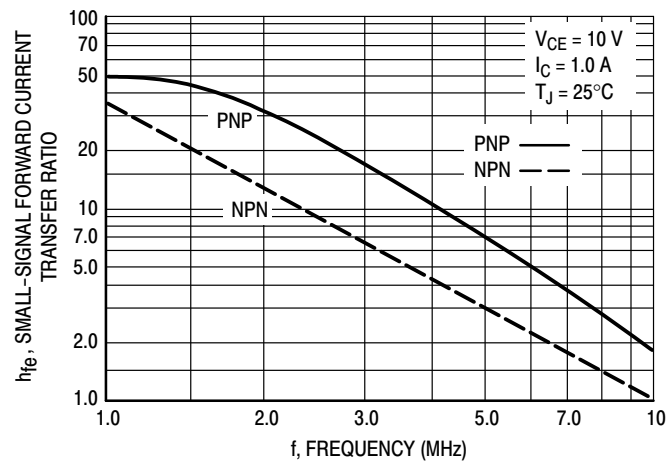
NOTE 2: For NPN test circuit reverse polarities.



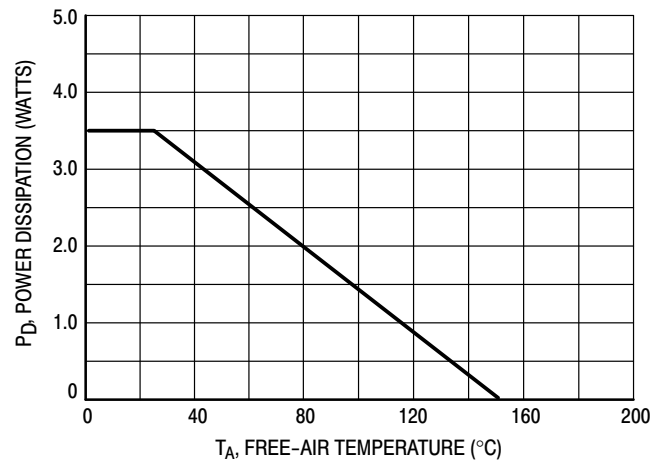
VOLTAGE AND CURRENT WAVEFORMS

Figure 8. Inductive Load

**TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)**



**Figure 9. Magnitude of Common Emitter Small-Signal Short-Circuit Forward Current Transfer Ratio**



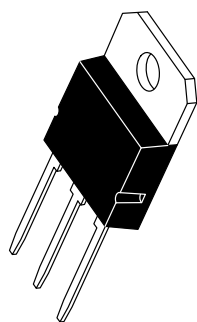
**Figure 10. Free-Air Temperature Power Derating**

## TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

### ORDERING INFORMATION

| Device  | Package                      | Shipping        |
|---------|------------------------------|-----------------|
| TIP140G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP141G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP142G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP145G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP146G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP147G | SOT-93 (TO-218)<br>(Pb-Free) | 30 Units / Rail |
| TIP140G | TO-247<br>(Pb-Free)          | 30 Units / Rail |
| TIP141G | TO-247<br>(Pb-Free)          | 30 Units / Rail |
| TIP142G | TO-247<br>(Pb-Free)          | 30 Units / Rail |
| TIP145G | TO-247<br>(Pb-Free)          | 30 Units / Rail |
| TIP146G | TO-247<br>(Pb-Free)          | 30 Units / Rail |
| TIP147G | TO-247<br>(Pb-Free)          | 30 Units / Rail |

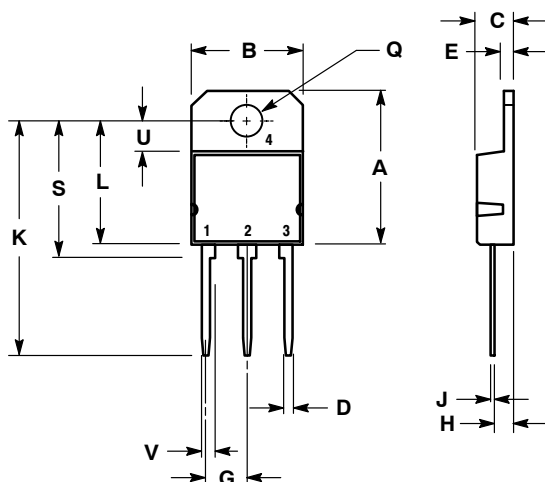




SCALE 1:1

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

DATE 03 JAN 2002



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

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

- 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\*

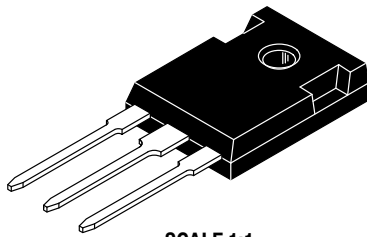


A = Assembly Location  
Y = Year  
WW = Work Week  
XXXXX = Device Code

\*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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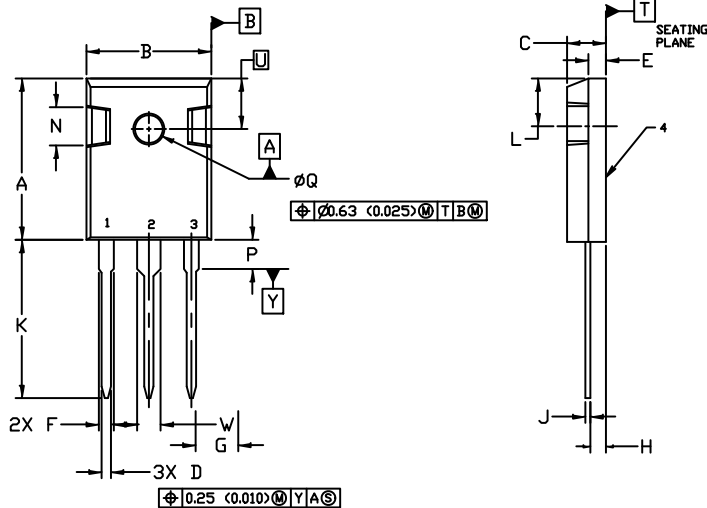
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TO-247  
CASE 340L  
ISSUE G

DATE 06 OCT 2021

SCALE 1:1

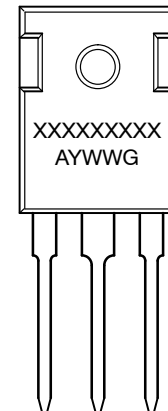


NOTES:

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

XXXXXX = 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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