

# Darlington Complementary Silicon Power Transistors



ON Semiconductor®

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## 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

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

### THERMAL CHARACTERISTICS

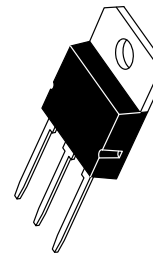
| Characteristic                             | Symbol          | Max  | Unit               |
|--|-----------------|------|--------------------|
| Thermal Resistance,<br>Junction–to–Case    | $R_{\theta JC}$ | 1.0  | $^\circ\text{C/W}$ |
| Thermal Resistance,<br>Junction–to–Ambient | $R_{\theta JA}$ |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

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.

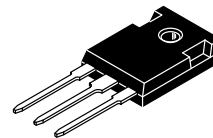
1. 5 ms,  $\leq 10\%$  Duty Cycle.

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

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



SOT–93 (TO–218)  
CASE 340D  
STYLE 1



TO–247  
CASE 340L  
STYLE 3

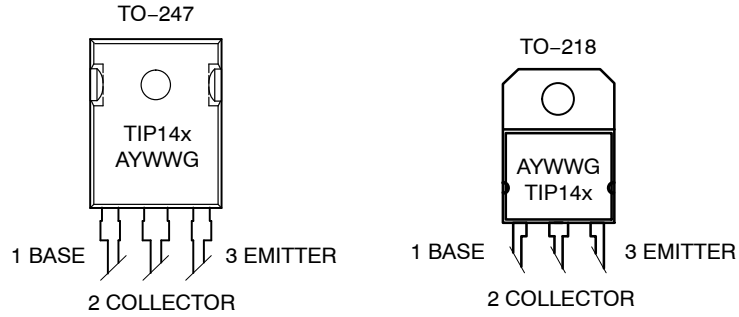
**NOTE:** Effective June 2012 this device will be available only in the TO–247 package. Reference FPCN# 16827.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

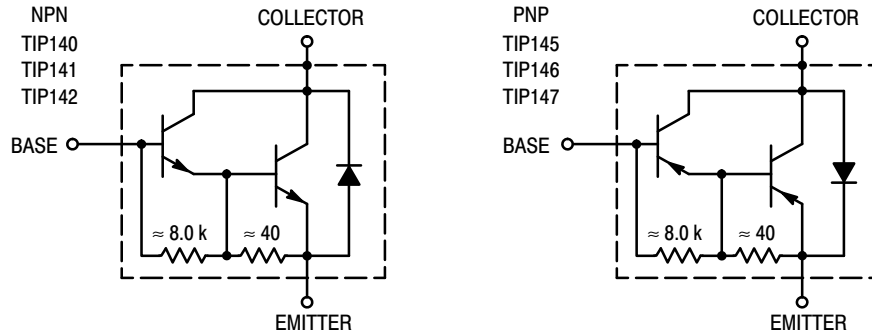
# TIP140, TIP141, TIP142, (NPN); TIP145, TIP146, TIP147, (PNP)

## MARKING DIAGRAMS



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

## DARLINGTON SCHEMATICS



## 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 |

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

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

| Characteristic   | Symbol                | Min             | Typ         | Max               | Unit |
|--|-----------------------|-----------------|-------------|-------------------|------|
| <b>OFF CHARACTERISTICS</b>   |                       |                 |             |                   |      |
| Collector–Emitter Sustaining Voltage (Note 2)<br>(I <sub>C</sub> = 30 mA, I <sub>B</sub> = 0)  | V <sub>CEO(sus)</sub> | 60<br>80<br>100 | –<br>–<br>– | –<br>–<br>–       | Vdc  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = 30 Vdc, I <sub>B</sub> = 0)<br>(V <sub>CE</sub> = 40 Vdc, I <sub>B</sub> = 0)<br>(V <sub>CE</sub> = 50 Vdc, I <sub>B</sub> = 0) | I <sub>CEO</sub>      | –<br>–<br>–     | –<br>–<br>– | 2.0<br>2.0<br>2.0 | mA   |
| Collector Cutoff Current<br>(V <sub>CB</sub> = 60 V, I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 80 V, I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 100 V, I <sub>E</sub> = 0)      | I <sub>CBO</sub>      | –<br>–<br>–     | –<br>–<br>– | 1.0<br>1.0<br>1.0 | mA   |
| Emitter Cutoff Current (V <sub>BE</sub> = 5.0 V)   | I <sub>EBO</sub>      | –               | –           | 2.0               | mA   |

## ON CHARACTERISTICS (Note 2)

|   |                      |             |        |            |     |
|---|----------------------|-------------|--------|------------|-----|
| DC Current Gain<br>(I <sub>C</sub> = 5.0 A, V <sub>CE</sub> = 4.0 V)<br>(I <sub>C</sub> = 10 A, V <sub>CE</sub> = 4.0 V)                    | h <sub>FE</sub>      | 1000<br>500 | –<br>– | –<br>–     | –   |
| Collector–Emitter Saturation Voltage<br>(I <sub>C</sub> = 5.0 A, I <sub>B</sub> = 10 mA)<br>(I <sub>C</sub> = 10 A, I <sub>B</sub> = 40 mA) | V <sub>CE(sat)</sub> | –<br>–      | –<br>– | 2.0<br>3.0 | Vdc |
| Base–Emitter Saturation Voltage<br>(I <sub>C</sub> = 10 A, I <sub>B</sub> = 40 mA)  | V <sub>BE(sat)</sub> | –           | –      | 3.5        | Vdc |
| Base–Emitter On Voltage<br>(I <sub>C</sub> = 10 A, V <sub>CE</sub> = 4.0 Vdc)   | V <sub>BE(on)</sub>  | –           | –      | 3.0        | Vdc |

## SWITCHING CHARACTERISTICS

| Resistive Load (See Figure 1) |  |                |   |      |   |    |
|-------------------------------|--|----------------|---|------|---|----|
| 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) | t <sub>d</sub> | – | 0.15 | – | μs |
| Rise Time                     |  | t <sub>r</sub> | – | 0.55 | – | μs |
| Storage Time                  |  | t <sub>s</sub> | – | 2.5  | – | μs |
| Fall Time                     |  | t <sub>f</sub> | – | 2.5  | – | μs |

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

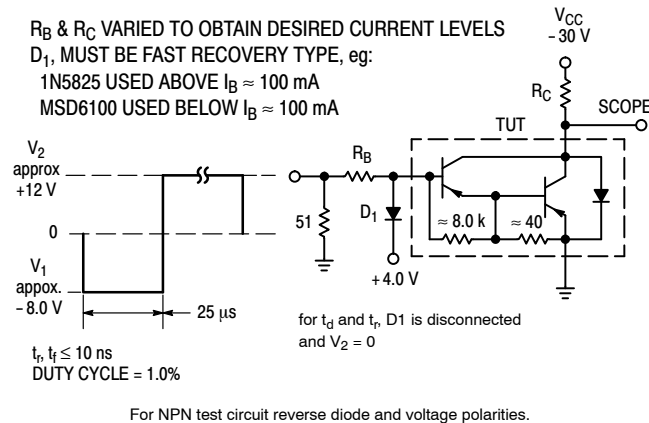


Figure 1. Switching Times Test Circuit

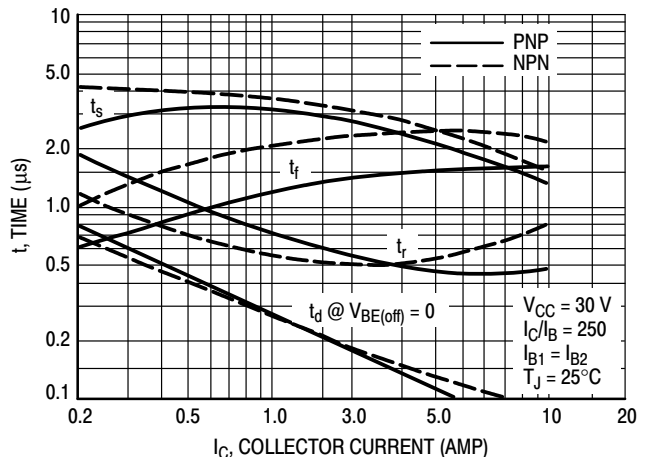


Figure 2. Switching Times

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

## TYPICAL CHARACTERISTICS

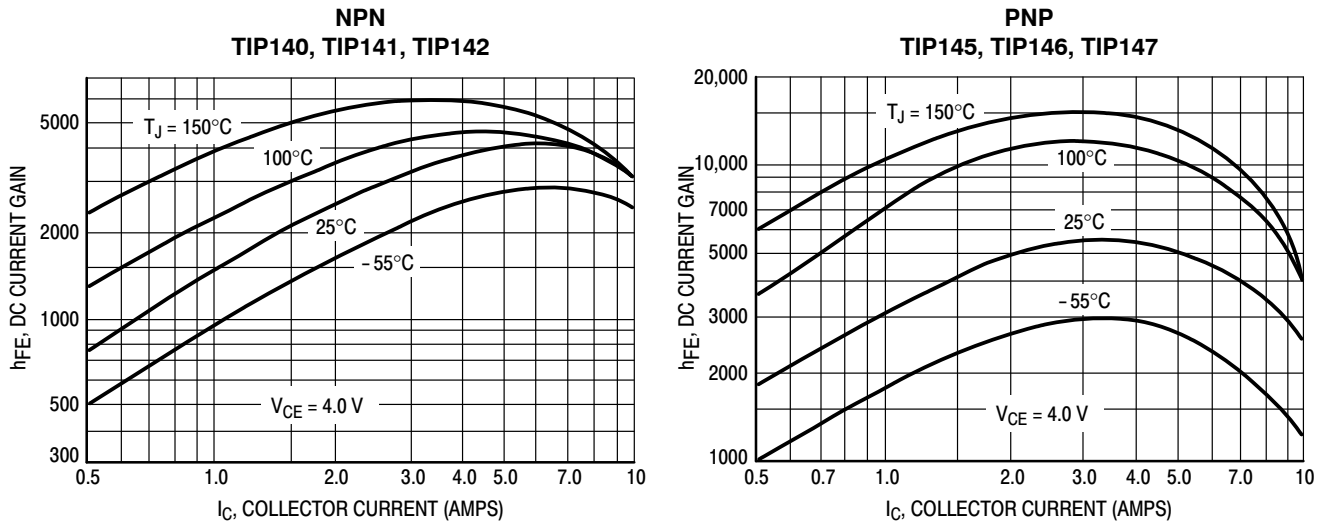


Figure 3. DC Current Gain versus Collector Current

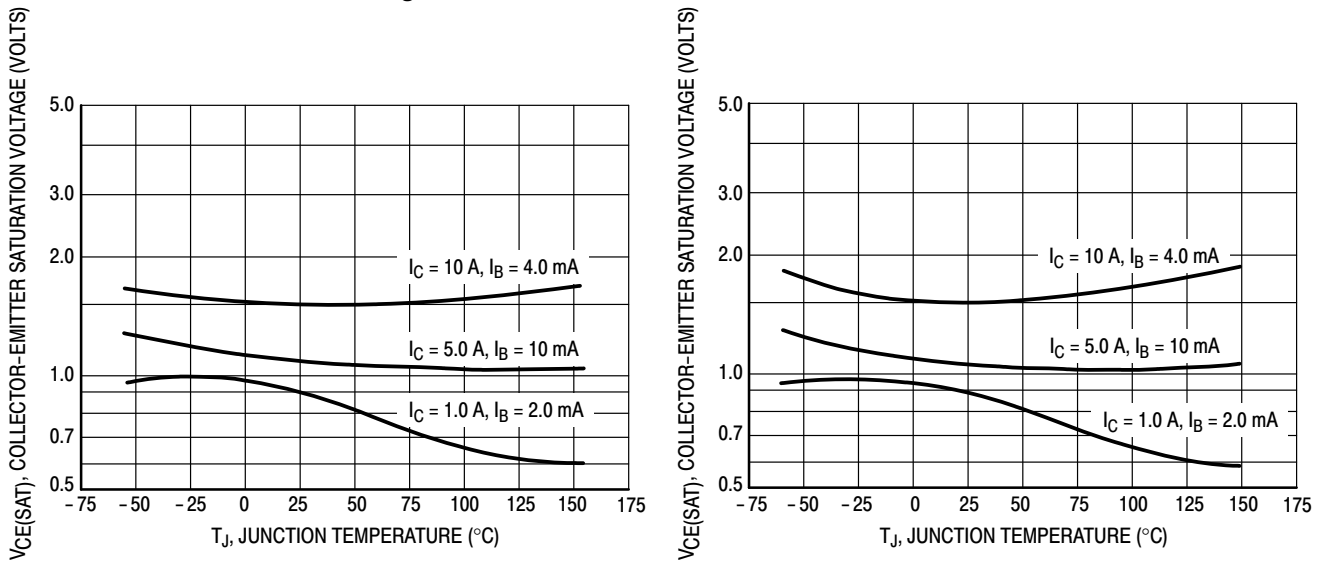


Figure 4. Collector-Emitter Saturation Voltage

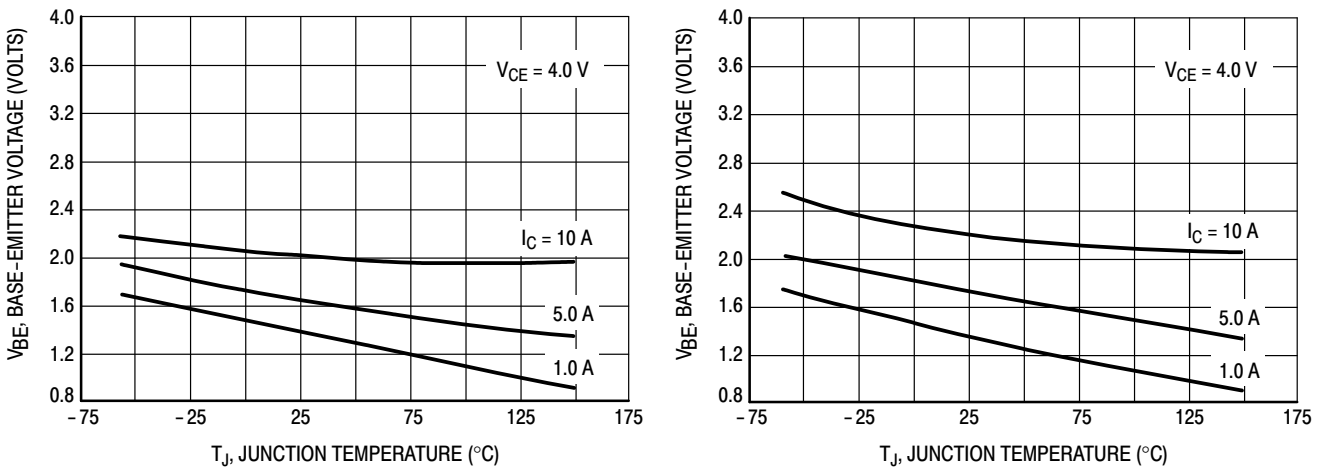


Figure 5. Base-Emitter Voltage

# 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.

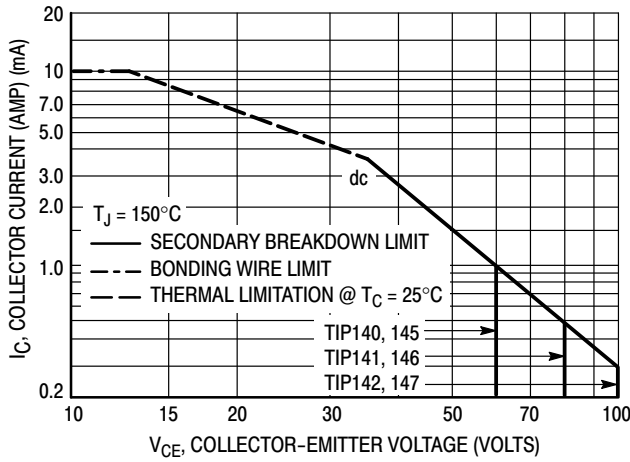


Figure 6. Active-Region Safe Operating Area

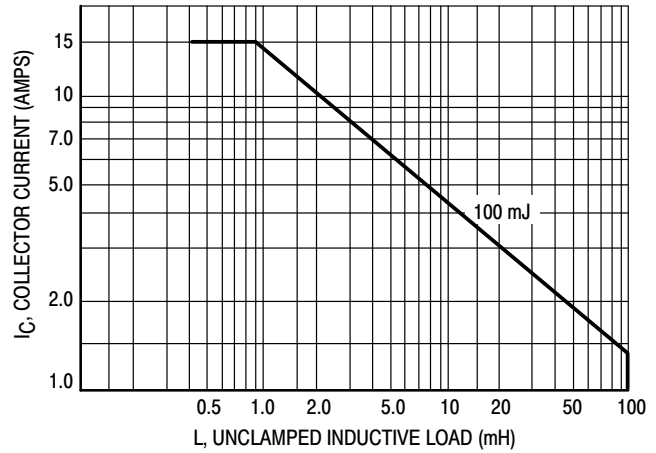
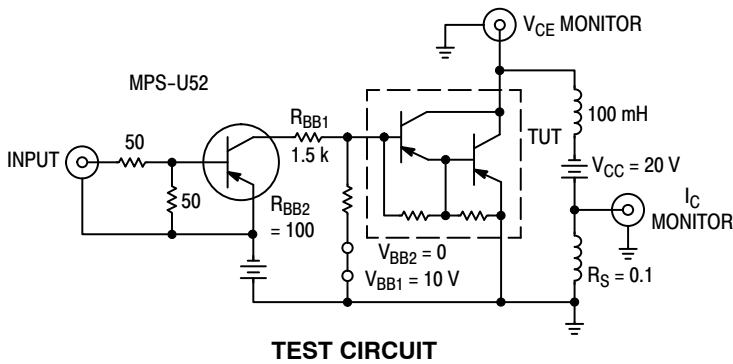
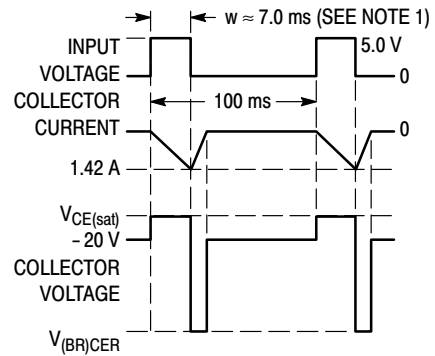


Figure 7. Unclamped Inductive Load



TEST CIRCUIT

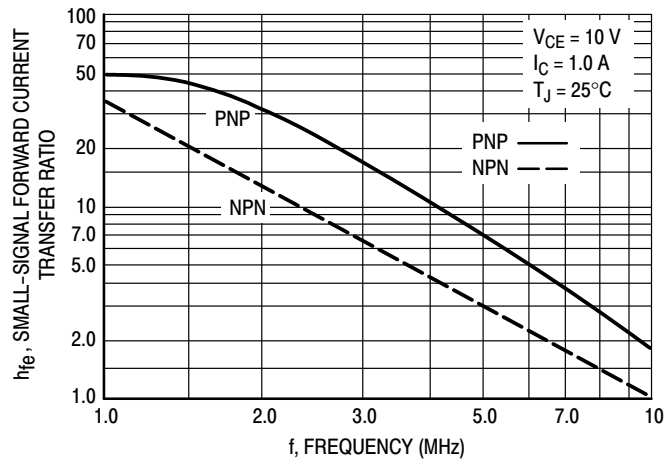
NOTE 1: Input pulse width is increased until  $I_{CM} = 1.42\text{ A}$ .  
NOTE 2: For NPN test circuit reverse polarities.



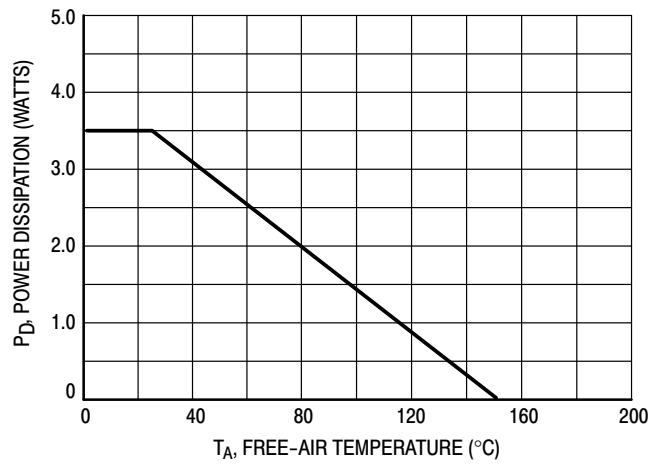
VOLTAGE AND CURRENT WAVEFORMS

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**

# MECHANICAL CASE OUTLINE

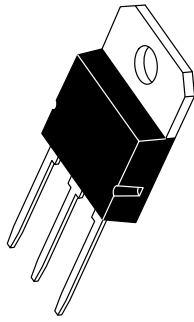
## PACKAGE DIMENSIONS

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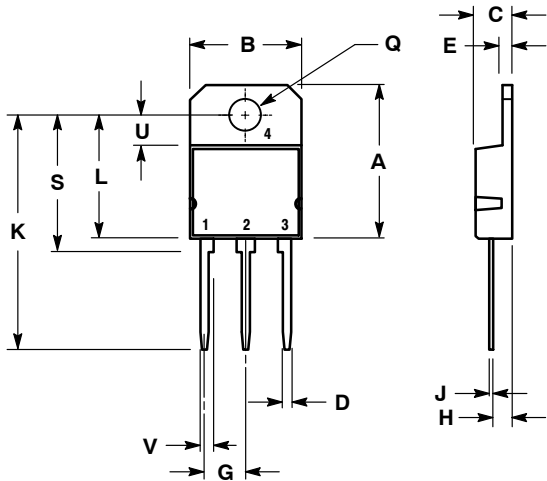


SOT-93 (TO-218)  
CASE 340D-02  
ISSUE E

DATE 01/03/2002



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

- 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     |       |

### MARKING DIAGRAM



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

|                  |             |  |
|------------------|-------------|--|
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| DESCRIPTION:     | SOT-93      | PAGE 1 OF 1  |

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



TO-247  
CASE 340L  
ISSUE G

DATE 06 OCT 2021

SCALE 1:1

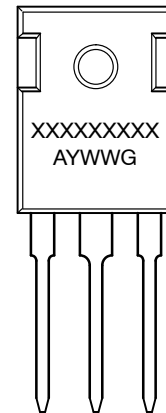


NOTES:

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

| 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 |

### GENERIC MARKING DIAGRAM\*



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

- 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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