# 2N6351, 2N6353

## NPN Darlington Power Silicon Transistors

Rev. V2

### Features

- Available in JAN, JANTX, JANTXV per MIL-PRF-19500/472
- TO-33 (2N6351) and 3 Pin TO-66 (2N6353) Packages
- Designed for Use in High Gain Amplifier and Switching Applications

### Electrical Characteristics ($T_A$ = +25°C unless otherwise noted)

| Parameter | Test Conditions | Symbol | Units | Min. | Max. |
|---|---|---|---|---|---|
| | | | | | |
| Collector - Emitter Breakdown Voltage | $I_C$ = 25 mA dc; $R_{B1E}$ = 2.2 kΩ; $R_{B2E}$ = 100 Ω<br>2N6351, 2N6353 | $V_{(BR)CER}$ | V dc | 150 | — |
| Emitter to Base 1 Breakdown Voltage | $I_E$ = 12 mA dc; base 2 open | $V_{(BR)EBO1}$ | V dc | 12 | — |
| Emitter to Base 2 Breakdown Voltage | $I_E$ = 12 mA dc; base 1 open | $V_{(BR)EBO2}$ | V dc | 6 | — |
| Collector - Emitter Cutoff Current | $V_{EB1}$ = 2 V; $R_{B2E}$ = 100 Ω<br>$V_{CE}$ = 150V 2N6351, 2N6353 | $I_{CEX1}$ | µA dc | — | 1.0 |
| Saturation Voltage and Resistance | $I_C$ = 5.0 A dc; $R_{B2E}$ = 100 Ω<br>$I_B$ = 10 mA dc 2N6351, 2N6353 | $V_{CE(sat)1}$ | Vdc | — | 2.5 |
| Base - Emitter Voltage (nonsaturated) | $V_{CE}$ = 5 Vdc; $I_C$ = 5.0 A dc; $R_{B2E}$ = 100 Ω | $V_{BE(on)1}$ | Vdc | — | 2.5 |
| Forward-Current Transfer Ratio | $V_{CE}$ = 5 V dc; $I_C$ = 1.0 A dc; $R_{B2E}$ = 1 kΩ<br>2N6351, 2N6353 | $h_{FE1}$ | - | 1000 | |
| Forward-Current Transfer Ratio | $V_{CE}$ = 5 V dc; $I_C$ = 5.0 A dc; $R_{B2E}$ = 100 Ω<br>2N6351, 2N6353 | $h_{FE2}$ | - | 1000 | 10,000 |
| Forward-Current Transfer Ratio | $V_{CE}$ = 5 V dc; $I_C$ = 10 A dc; $R_{B2E}$ = 100 Ω<br>2N6351, 2N6353 | $h_{FE3}$ | - | 200 | |
| | | | | | |
| Collector - Emitter Cutoff Current | $T_A$ = +150°C<br>$V_{EB1}$ = 2 V dc; $R_{B2E}$ = 100 Ω<br>$V_{CE}$ = 150V 2N6351, 2N6353 | $I_{CEX2}$ | mA dc | — | 1.0 |
| Forward-Current Transfer Ratio | $T_A$ = -65°C<br>$V_{CE}$ = 5 V dc; $I_C$ = 5.0 A dc; $R_{B2E}$ = 100 Ω<br>2N6351, 2N6353 | $h_{FE4}$ | - | 200 | |

## Electrical Characteristics ($T_A$ = +25°C unless otherwise noted)

| | | | | | |
|---|---|---|---|---|---|
| Small-Signal Short-Circuit Forward Current Transfer Ratio | $V_{CE}$ = 10 Vdc; $I_C$ = 1.0 A dc; f = 10 MHz $R_{B2E}$ = 100 Ω | $\lvert h_{fe} \rvert$ | - | 5 | 25 |
| Open-Circuit Output Capacitance | $V_{CB1}$ = 10 V dc; $I_E$ = 0; 100 kHz ≤ f ≤ 1 MHz base 2 open | $C_{obo}$ | pF | — | 120 |
| **Switching Characteristics** | | | | | |
| Turn-On Time | $V_{CC}$ = 30 Vdc; $I_C$ = 5 A dc 2N6351, 2N6353 (see figure 5) | $t_{on}$ | µs | — | 0.5 |
| Turn-Off Time | $V_{CC}$ = 30 Vdc; $I_C$ = 5 A dc 2N6351, 2N6353 (see figure 5) | $t_{off}$ | µs | — | 1.2 |

**Safe Operating Area**

DC Tests: $T_C$ = +100°C; t ≥ 1.0 s; 1 cycle; $t_r = t_f$ = 10 µS (see figure 6); $R_{B2E}$ = 100 Ω

(2N6351 type only)

Test 1: 2N6351 $V_{CE}$ = 1.5 Vdc; $I_C$ = 3.3 A dc
Test 2: 2N6351 $V_{CE}$ = 30 Vdc, $I_C$ = 167 mA dc
Test 4: 2N6351 $V_{CE}$ = 150 Vdc, $I_C$ = 13 mA dc

DC Tests: $T_C$ = +100°C; t ≥ 1.0 s; 1 cycle; $t_r = t_f$ = 10 µS (see figure 6); $R_{B2E}$ = 100 Ω

(2N6353 type only)

Test 1: 2N6353 $V_{CE}$ = 5.0 Vdc; $I_C$ = 5 A dc
Test 2: 2N6353 $V_{CE}$ = 10 Vdc, $I_C$ = 2.5 A dc
Test 4: 2N6353 $V_{CE}$ = 150 Vdc, $I_C$ = 35 mA dc

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## Absolute Maximum Ratings ($T_A$ = +25°C unless otherwise noted)

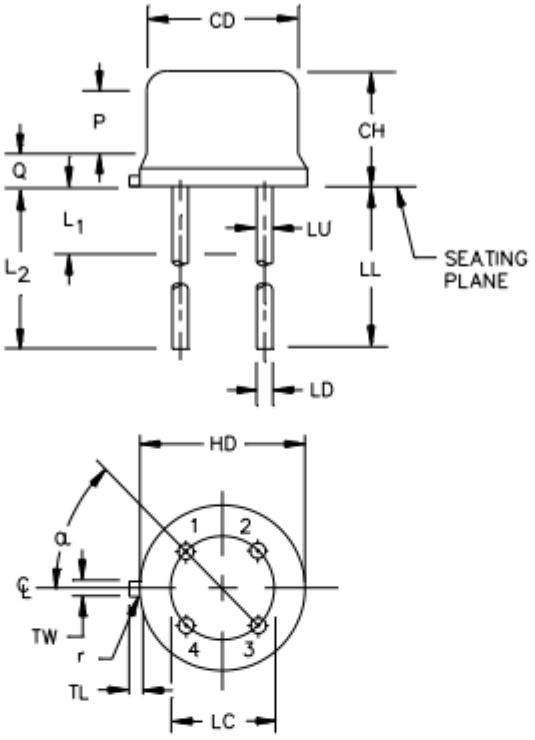
| Ratings | Symbol | Value |
|---|---|---|
| Collector - Base Voltage<br>2N6351, 2N6353 | $V_{CBO1}$<br>$V_{CER}$ | 150 V dc |
| Emitter - Base Voltage | $V_{EB1}$ | 12 V dc |
| Emitter - Base Voltage | $V_{EB2}$ | 6 V dc |
| Collector Current | $I_C$ | 5 A dc |
| Collector Current | $I_C$ (1) | 10 A dc |
| Base Current | $I_{B1}$ | 0.5 A dc |
| Total Power Dissipation<br>@ $T_A$ = +25°C<br><br>2N6351<br>2N6353 | $P_T$ | 1.0 W (2)<br>2.0 W (4) |
| Total Power Dissipation<br>@ $T_C$ = +100°C<br><br>2N6351<br>2N6353 | $P_T$ | 5 W (3)<br>25 W (5) |
| Operating & Storage Temperature Range | $T_J$, $T_{STG}$ | -65°C to +200°C |

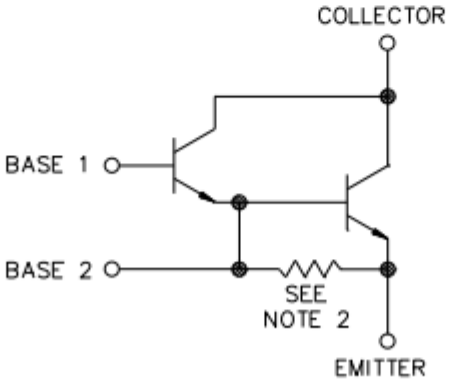
## Thermal Characteristics

| Characteristics | Symbol | Max. Value |
|---|---|---|
| Thermal Resistance, Junction to Case<br>2N6351<br>2N6353 | $R_{\theta JC}$ | 20°C/W<br>4.0°C/W |

(1) Applies for $t_p \leq 10$ ms, duty cycle $\leq$ 50 percent.
(2) Derate linearly 5.72 mW/°C for $T_A$ > +25°C.
(3) Derate linearly 50 mW/°C for $T_C$ > +100°C.
(4) Derate linearly 11.4 mW/°C for $T_A$ > +25°C.
(5) Derate linearly 250 mW/°C for $T_C$ > +100°C.

## Outline Drawing 2N6351 (TO-33)




SCHEMATIC CIRCUIT

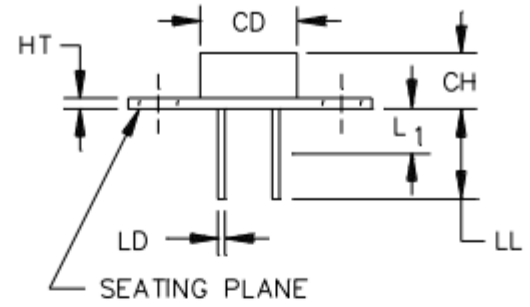
## Outline Dimensions 2N6351 (TO-33)

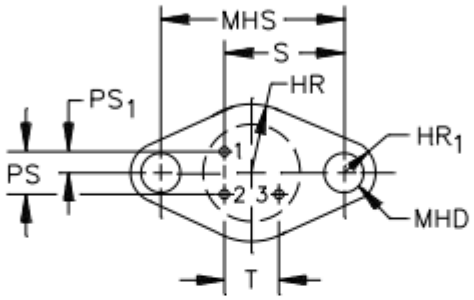
| Symbol | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| CD | .305 | .335 | 7.75 | 8.51 | 3 |
| CH | .184 | .260 | 4.67 | 6.60 | |
| HD | .335 | .370 | 8.51 | 9.40 | |
| LC | 0.200 TP | | 5.080 TP | | 4 |
| LD | .016 | .021 | 0.407 | 0.533 | 5, 6 |
| LL | 1.500 | 1.750 | 38.10 | 44.45 | 5, 6 |
| $L_1$ | | .050 | | 1.27 | 5, 6 |
| $L_2$ | .250 | | 6.35 | | 5, 6 |
| LU | .016 | .019 | 0.407 | 0.482 | 5, 6 |
| TL | .029 | .045 | 0.74 | 1.14 | 7 |
| TW | .028 | .034 | 0.712 | 0.863 | 8 |
| P | .100 | | 2.54 | | 3 |
| Q | | .050 | | 1.27 | 9 |
| r | | .010 | | 0.254 | 10 |
| α | 45° TP | | 45° TP | | 4 |

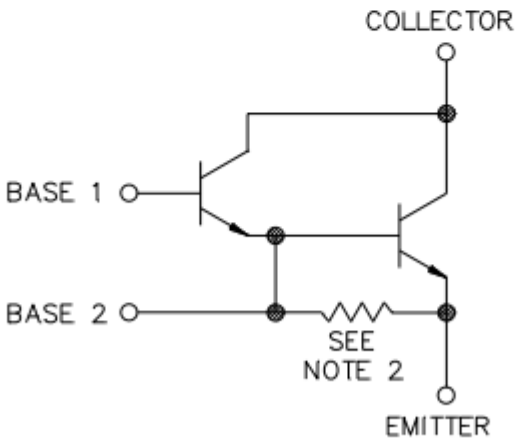
NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Internal resistance (typically 750 ohms). This resistor is optional.
3. Dimension CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
4. Leads at gauge plane .054 +.001 –.000 inch (1.37 +0.03 –0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
5. Dimension LU applies between dimension $L_1$ and dimension $L_2$. Dimension LD applies between $L_2$ and LL minimum. Diameter is uncontrolled in dimension $L_1$ and beyond dimension LL minimum.
6. All terminals.
7. Dimension TL measured from maximum HD.
8. Beyond r (radius) maximum, dimension TW shall be held for a minimum length of .011 inch (0.28 mm).
9. Outline in this zone is not controlled.
10. The-radius (dimension r) applies to both inside corners of the tab.
11. Terminal designation is as follows: 1 – emitter, 2 – base 2 (B2), 3 – base 1 (B1), 4 – collector. The collector shall be connected to the case.
12. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

## Outline Drawing 2N6353 (3 pin TO-66)




SCHEMATIC CIRCUIT

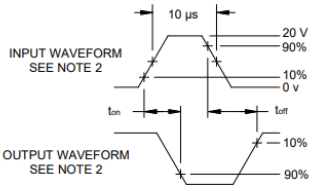
## Dimensions 2N6353 (3 pin TO-66)

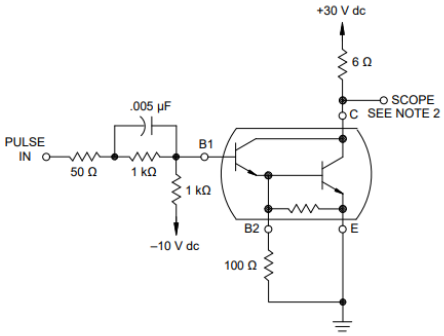
| Symbol | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| CD | .305 | .335 | 7.75 | 8.51 | 3 |
| CH | .184 | .260 | 4.67 | 6.60 | |
| HD | .335 | .370 | 8.51 | 9.40 | |
| LC | 0.200 TP | | 5.080 TP | | 4 |
| LD | .016 | .021 | 0.407 | 0.533 | 5, 6 |
| LL | 1.500 | 1.750 | 38.10 | 44.45 | 5, 6 |
| $L_1$ | | .050 | | 1.27 | 5, 6 |
| $L_2$ | .250 | | 6.35 | | 5, 6 |
| LU | .016 | .019 | 0.407 | 0.482 | 5, 6 |
| TL | .029 | .045 | 0.74 | 1.14 | 7 |
| TW | .028 | .034 | 0.712 | 0.863 | 8 |
| P | .100 | | 2.54 | | 3 |
| Q | | .050 | | 1.27 | 9 |
| r | | .010 | | 0.254 | 10 |
| α | 45° TP | | 45° TP | | 4 |

NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Internal resistance (typically 750 ohms). This resistor is optional.
3. Dimension CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
4. Leads at gauge plane .054 +.001 –.000 inch (1.37 +0.03 –0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
5. Dimension LU applies between dimension $L_1$ and dimension $L_2$. Dimension LD applies between $L_2$ and LL minimum. Diameter is uncontrolled in dimension $L_1$ and beyond dimension LL minimum.
6. All terminals.
7. Dimension TL measured from maximum HD.
8. Beyond r (radius) maximum, dimension TW shall be held for a minimum length of .011 inch (0.28 mm).
9. Outline in this zone is not controlled.
10. The radius (dimension r) applies to both inside corners of the tab.
11. Terminal designation is as follows: 1 – emitter, 2 – base 2 (B2), 3 – base 1 (B1), 4 – collector. The collector shall be connected to the case.
12. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

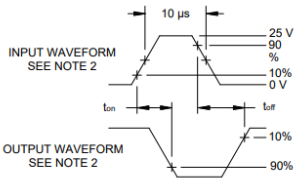
## Graphs

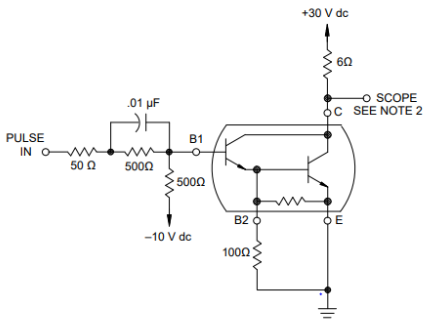



NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \le 15$ ns, $t_f \le 15$ ns, $Z_{OUT} = 50\ \Omega$, PW = 10 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \le 15$ ns, $Z_{IN} \ge 10\ M\Omega$, $C_{IN} \le 11.5$ pF.
3. Resistors shall be non-inductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 4. Pulse response test circuit for device types 2N6350 and 2N6352.




NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \le 15$ ns, $Z_{OUT} = 50\ \Omega$, PW = 10 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \le 15$ ns, $Z_{IN} \ge 10\ M\Omega$, $C_{IN} \le 11.5$ pF.
3. Resistors shall be non-inductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 5. Pulse response test circuit for device types 2N6351 and 2N6353.

## Graphs

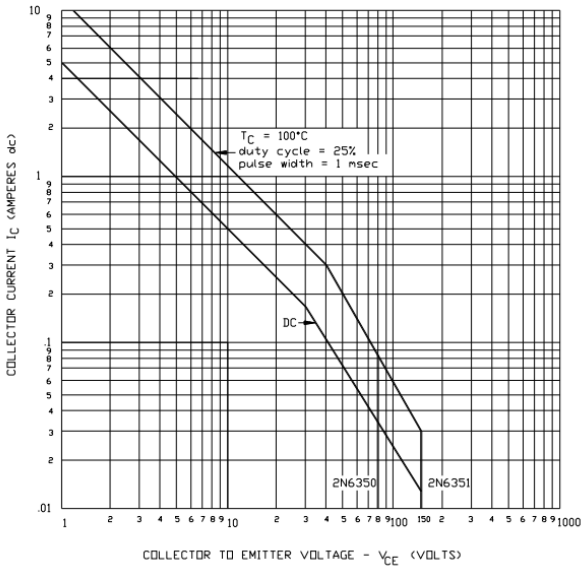



FIGURE 6. Maximum safe operating area graph for device types 2N6350 and 2N6351.

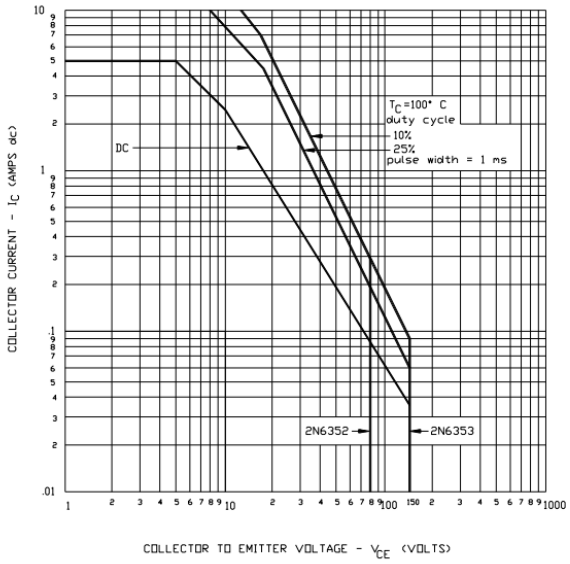



FIGURE 7. Maximum safe operating area graph for device types 2N6352 and 2N6353.

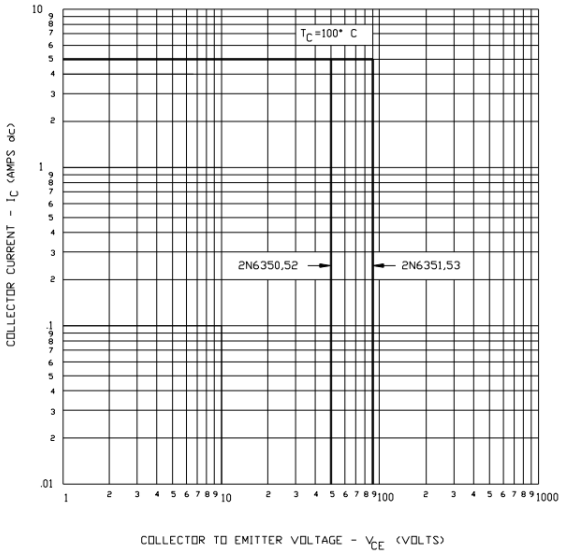



FIGURE 8. Safe operating area for switching between saturation and cutoff – (clamped inductive load).