

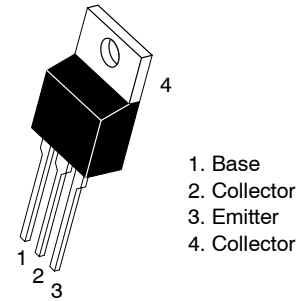
Plastic Medium-Power Complementary Silicon Transistors

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

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

Features

- High DC Current Gain –
 - $h_{FE} = 2500$ (Typ) @ I_C
 - $= 4.0$ Adc
- Collector–Emitter Sustaining Voltage – @ 100 mAdc
 - $V_{CEO(sus)} = 60$ Vdc (Min) – TIP120, TIP125
 - $= 80$ Vdc (Min) – TIP121, TIP126
 - $= 100$ Vdc (Min) – TIP122, TIP127
- Low Collector–Emitter Saturation Voltage –
 - $V_{CE(sat)} = 2.0$ Vdc (Max) @ $I_C = 3.0$ Adc
 - $= 4.0$ Vdc (Max) @ $I_C = 5.0$ Adc
- Monolithic Construction with Built-In Base–Emitter Shunt Resistors
- Pb–Free Packages are Available*



TO-220AB
 CASE 221A
 STYLE 1

DARLINGTON 5 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS 60–80–100 VOLTS, 65 WATTS

MARKING DIAGRAM



- TIP12x = Device Code
- x = 0, 1, 2, 5, 6, or 7
- A = Assembly Location
- Y = Year
- WW = Work Week
- G = Pb–Free Package

ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

*For additional information on our Pb–Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, [SOLDERRM/D](http://www.onsemi.com/SOLDERRM/D).

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

MAXIMUM RATINGS

| Symbol | Rating | TIP120, TIP125 | TIP121, TIP126 | TIP122, TIP127 | 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 – Continuous – Peak | 5.0 8.0 | | | Adc |
| I_B | Base Current | 120 | | | mAdc |
| P_D | Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | 65 0.52 | | | W W/ $^\circ\text{C}$ |
| P_D | Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C | 2.0 0.016 | | | W W/ $^\circ\text{C}$ |
| E | Unclamped Inductive Load Energy (Note 1) | 50 | | | mJ |
| T_J, T_{stg} | Operating and Storage 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, Junction–to–Case | 1.92 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction–to–Ambient | 62.5 | $^\circ\text{C}/\text{W}$ |

1. $I_C = 1\text{ A}$, $L = 100\text{ mH}$, P.R.F. = 10 Hz, $V_{CC} = 20\text{ V}$, $R_{BE} = 100\ \Omega$

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

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

OFF CHARACTERISTICS

| | | | | | |
|----------------|---|--|-----------------|-------------------|------|
| $V_{CEO(sus)}$ | Collector–Emitter Sustaining Voltage (Note 2) ($I_C = 100\text{ mAdc}$, $I_B = 0$) | TIP120, TIP125 TIP121, TIP126 TIP122, TIP127 | 60 80 100 | – – – | Vdc |
| I_{CEO} | Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 40\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 50\text{ Vdc}$, $I_B = 0$) | TIP120, TIP125 TIP121, TIP126 TIP122, TIP127 | – – – | 0.5 0.5 0.5 | mAdc |
| I_{CBO} | Collector Cutoff Current ($V_{CB} = 60\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 80\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 100\text{ Vdc}$, $I_E = 0$) | TIP120, TIP125 TIP121, TIP126 TIP122, TIP127 | – – – | 0.2 0.2 0.2 | mAdc |
| I_{EBO} | Emitter Cutoff Current ($V_{BE} = 5.0\text{ Vdc}$, $I_C = 0$) | | – | 2.0 | mAdc |

ON CHARACTERISTICS (Note 2)

| | | | | |
|---------------|--|--------------|------------|-----|
| h_{FE} | DC Current Gain ($I_C = 0.5\text{ Adc}$, $V_{CE} = 3.0\text{ Vdc}$) ($I_C = 3.0\text{ Adc}$, $V_{CE} = 3.0\text{ Vdc}$) | 1000 1000 | – – | – |
| $V_{CE(sat)}$ | Collector–Emitter Saturation Voltage ($I_C = 3.0\text{ Adc}$, $I_B = 12\text{ mAdc}$) ($I_C = 5.0\text{ Adc}$, $I_B = 20\text{ mAdc}$) | – – | 2.0 4.0 | Vdc |
| $V_{BE(on)}$ | Base–Emitter On Voltage ($I_C = 3.0\text{ Adc}$, $V_{CE} = 3.0\text{ Vdc}$) | – | 2.5 | Vdc |

DYNAMIC CHARACTERISTICS

| | | | | | |
|----------|---|--|--------|------------|----|
| h_{fe} | Small–Signal Current Gain ($I_C = 3.0\text{ Adc}$, $V_{CE} = 4.0\text{ Vdc}$, $f = 1.0\text{ MHz}$) | 4.0 | – | – | |
| C_{ob} | Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$) | TIP125, TIP126, TIP127 TIP120, TIP121, TIP122 | – – | 300 200 | pF |

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 $\leq 300\ \mu\text{s}$, Duty Cycle $\leq 2\%$

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

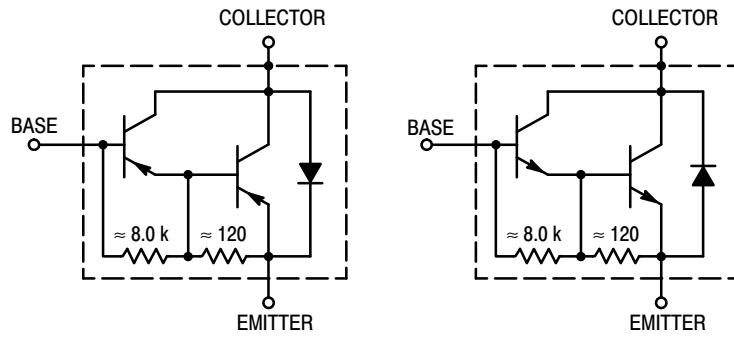


Figure 1. Darlington Circuit Schematic

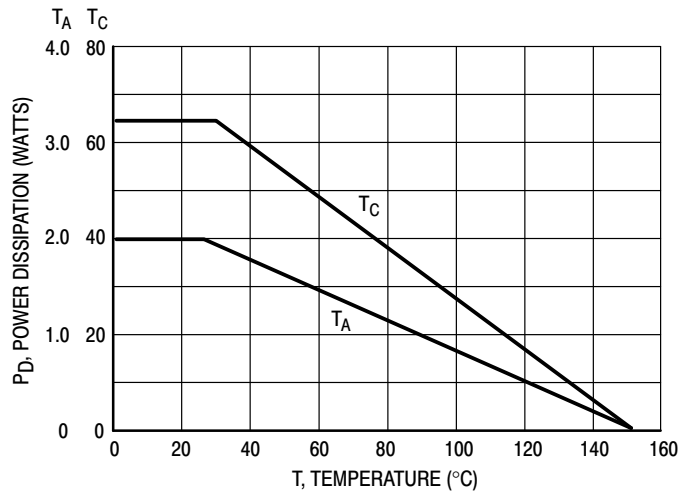


Figure 2. Power Derating

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

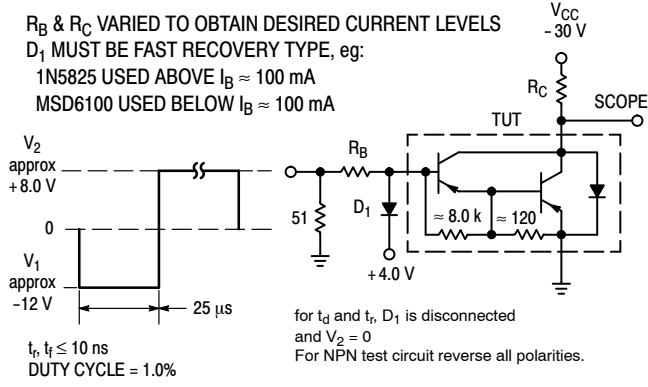


Figure 3. Switching Times Test Circuit

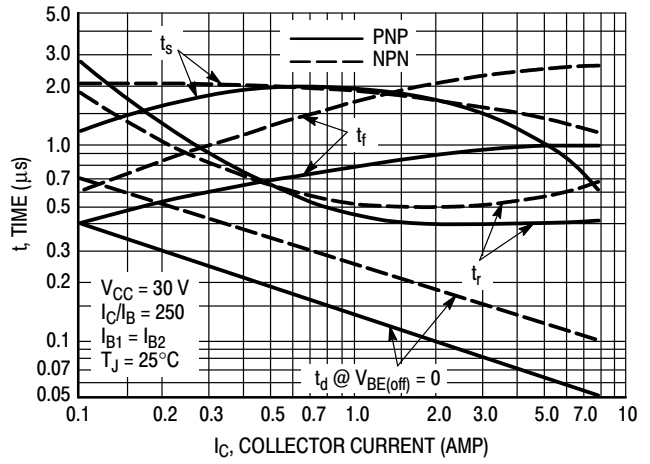


Figure 4. Switching Times

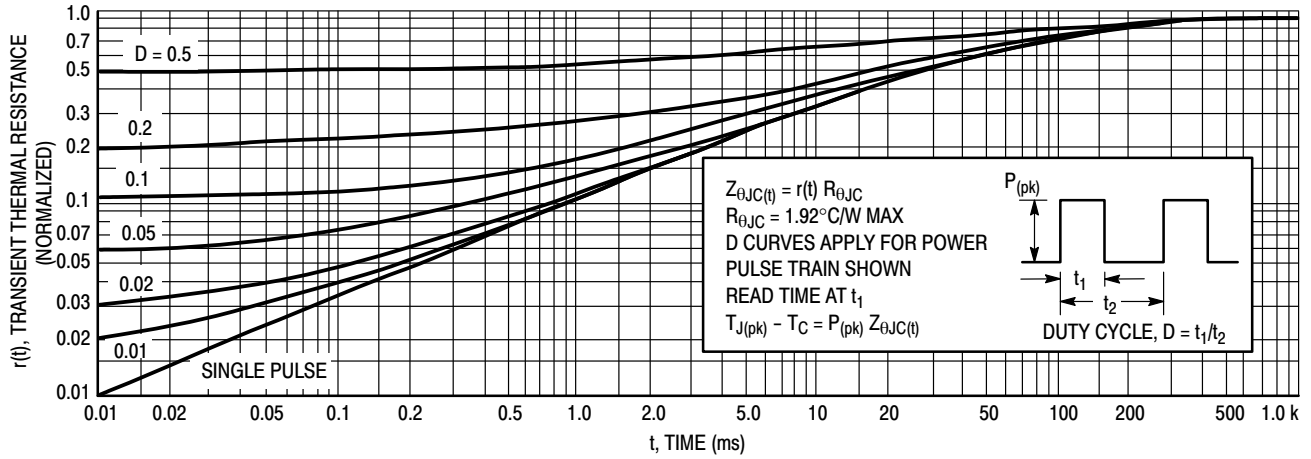


Figure 5. Thermal Response

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

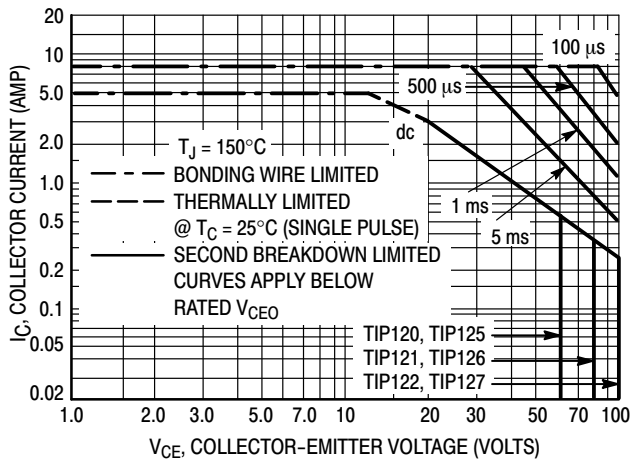


Figure 6. Active-Region Safe Operating Area

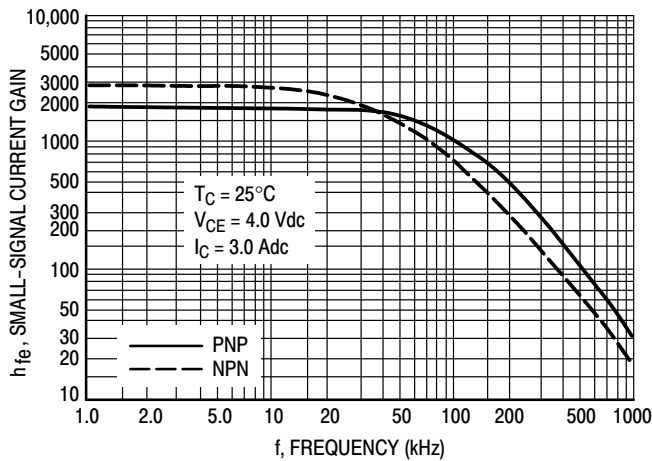


Figure 7. Small-Signal Current Gain

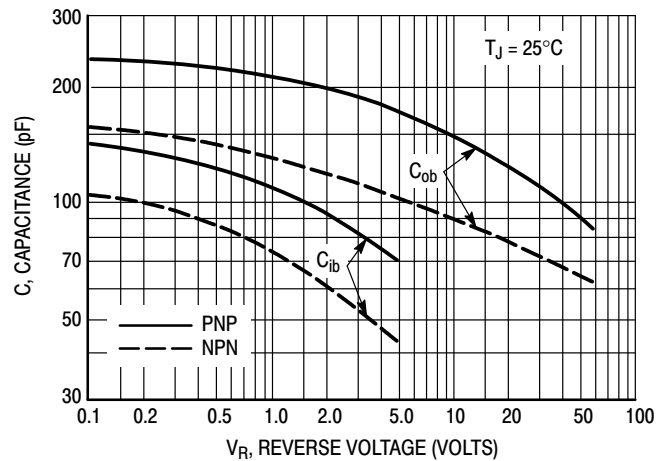


Figure 8. Capacitance

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. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} < 150^\circ\text{C}$. $T_{J(pk)}$ may be calculated from the data in Figure 5. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

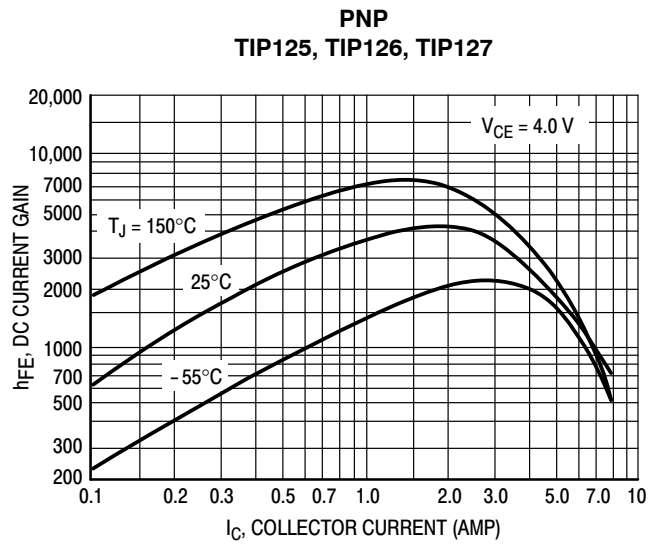
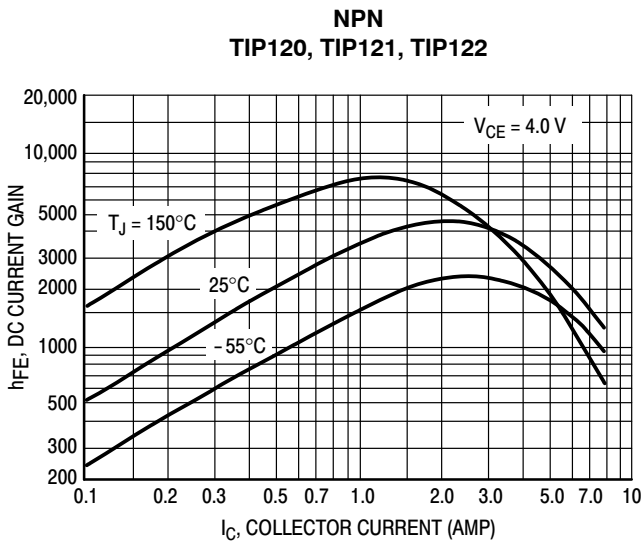


Figure 9. DC Current Gain

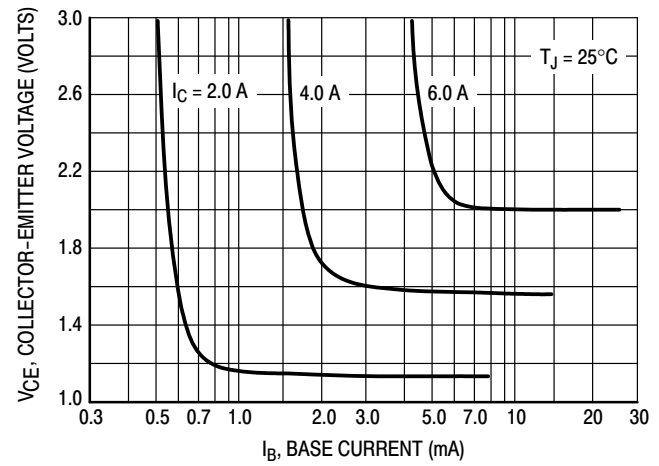
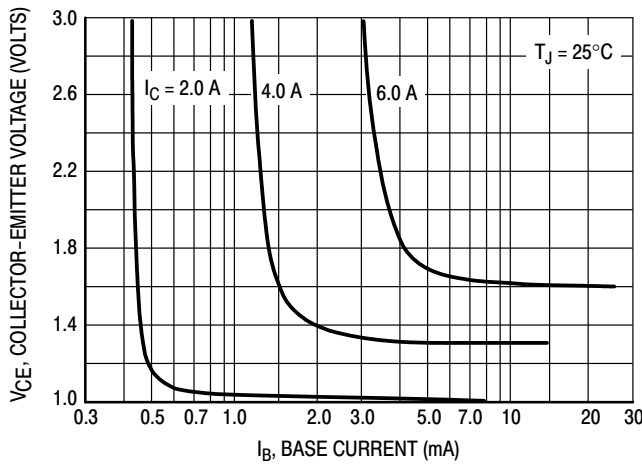


Figure 10. Collector Saturation Region

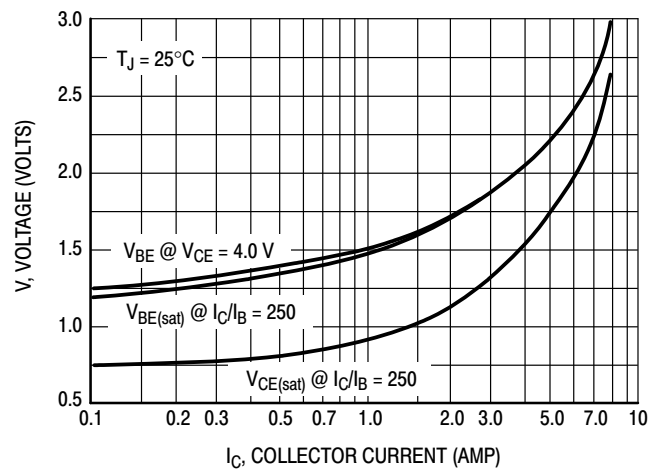
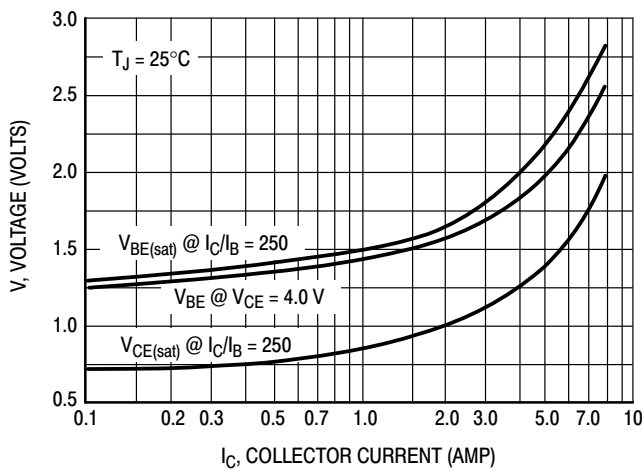
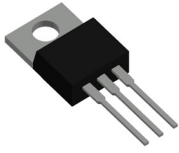


Figure 11. "On" Voltages

TIP120, TIP121, TIP122 (NPN); TIP125, TIP126, TIP127 (PNP)

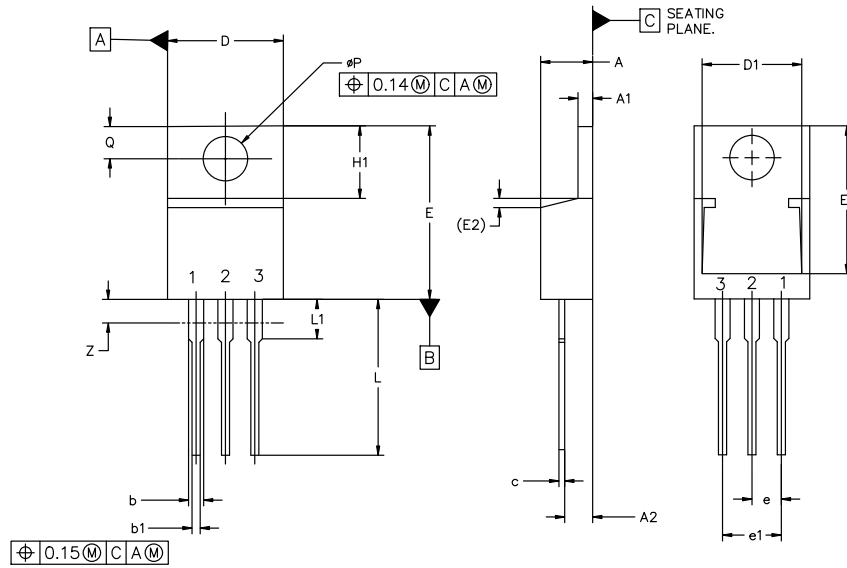
ORDERING INFORMATION

| Device | Package | Shipping |
|---------|---------------------|-----------------|
| TIP120 | TO-220 | 50 Units / Rail |
| TIP120G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP121 | TO-220 | 50 Units / Rail |
| TIP121G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP122 | TO-220 | 50 Units / Rail |
| TIP122G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP125 | TO-220 | 50 Units / Rail |
| TIP125G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP126 | TO-220 | 50 Units / Rail |
| TIP126G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP127 | TO-220 | 50 Units / Rail |
| TIP127G | TO-220 (Pb-Free) | 50 Units / Rail |



TO-220-3 10.10x15.12x4.45, 2.54P
CASE 221A
ISSUE AL

DATE 05 FEB 2025



| MILLIMETERS | | | |
|-------------|----------|-------|-------|
| DIM | MIN | NOM | MAX |
| A | 4.07 | 4.45 | 4.83 |
| A1 | 1.15 | 1.28 | 1.41 |
| A2 | 2.04 | 2.42 | 2.79 |
| b | 1.15 | 1.34 | 1.52 |
| b1 | 0.64 | 0.80 | 0.96 |
| c | 0.36 | 0.49 | 0.61 |
| D | 9.66 | 10.10 | 10.53 |
| D1 | 8.43 | 8.63 | 8.83 |
| E | 14.48 | 15.12 | 15.75 |
| E1 | 12.58 | 12.78 | 12.98 |
| E2 | 1.27 REF | | |

| MILLIMETERS | | | |
|-------------|-------|-------|-------|
| DIM | MIN | NOM | MAX |
| e | 2.42 | 2.54 | 2.66 |
| e1 | 4.83 | 5.08 | 5.33 |
| H1 | 5.97 | 6.22 | 6.47 |
| L | 12.70 | 13.49 | 14.27 |
| L1 | 2.80 | 3.45 | 4.10 |
| Q | 2.54 | 2.79 | 3.04 |
| φP | 3.60 | 3.85 | 4.09 |
| Z | --- | --- | 3.48 |

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
 2. CONTROLLING DIMENSION: MILLIMETERS.
 3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

- | | | | |
|--|--|---|--|
| <p>STYLE 1: PIN 1. BASE 2. COLLECTOR 3. EMITTER 4. COLLECTOR</p> | <p>STYLE 2: PIN 1. BASE 2. EMITTER 3. COLLECTOR 4. EMITTER</p> | <p>STYLE 3: PIN 1. CATHODE 2. ANODE 3. GATE 4. ANODE</p> | <p>STYLE 4: PIN 1. MAIN TERMINAL 1 2. MAIN TERMINAL 2 3. GATE 4. MAIN TERMINAL 2</p> |
| <p>STYLE 5: PIN 1. GATE 2. DRAIN 3. SOURCE 4. DRAIN</p> | <p>STYLE 6: PIN 1. ANODE 2. CATHODE 3. ANODE 4. CATHODE</p> | <p>STYLE 7: PIN 1. CATHODE 2. ANODE 3. CATHODE 4. ANODE</p> | <p>STYLE 8: PIN 1. CATHODE 2. ANODE 3. EXTERNAL TRIP/DELAY 4. ANODE</p> |
| <p>STYLE 9: PIN 1. GATE 2. COLLECTOR 3. EMITTER 4. COLLECTOR</p> | <p>STYLE 10: PIN 1. GATE 2. SOURCE 3. DRAIN 4. SOURCE</p> | <p>STYLE 11: PIN 1. DRAIN 2. SOURCE 3. GATE 4. SOURCE</p> | <p>STYLE 12: PIN 1. MAIN TERMINAL 1 2. MAIN TERMINAL 2 3. GATE 4. NOT CONNECTED</p> |

| | | |
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