

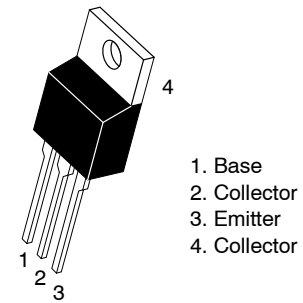
Plastic Medium-Power Complementary Silicon Transistors

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

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

Features

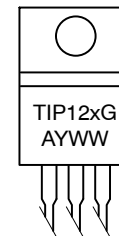
- High DC Current Gain –
 $h_{FE} = 2500 \text{ (Typ) @ } I_C$
 $= 4.0 \text{ Adc}$
- Collector-Emitter Sustaining Voltage – @ 100 mAdc
 $V_{CEO(sus)} = 60 \text{ Vdc (Min) – TIP120, TIP125}$
 $= 80 \text{ Vdc (Min) – TIP121, TIP126}$
 $= 100 \text{ Vdc (Min) – TIP122, TIP127}$
- Low Collector-Emitter Saturation Voltage –
 $V_{CE(sat)} = 2.0 \text{ Vdc (Max) @ } I_C = 3.0 \text{ Adc}$
 $= 4.0 \text{ Vdc (Max) @ } I_C = 5.0 \text{ Adc}$
- 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](#).

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
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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)

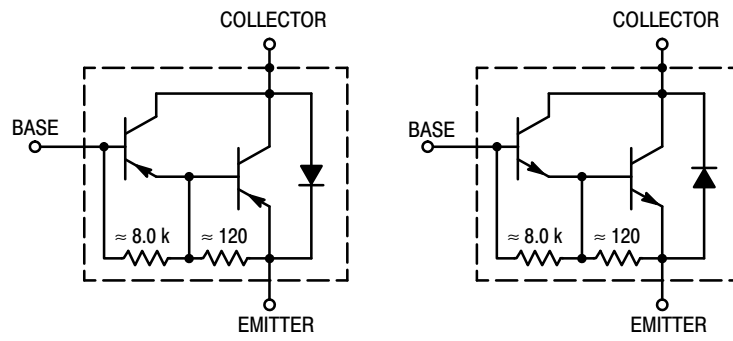


Figure 1. Darlington Circuit Schematic

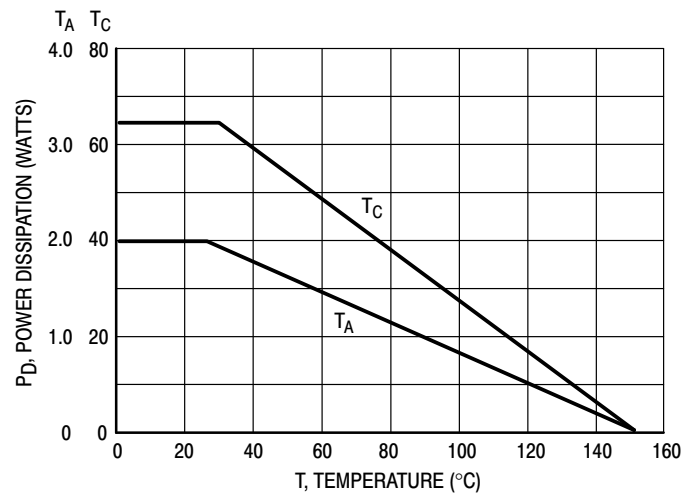


Figure 2. Power Derating

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

D₁ MUST BE FAST RECOVERY TYPE, eg:

MSD6100 USED BELOW $I_B \approx 100$ mA

R_B & R_C VARIED TO OBTAIN DESIRED CURRENT LEVELS
 D_1 MUST BE FAST RECOVERY TYPE, eg:
 1N5825 USED ABOVE $I_B \approx 100$ mA
 MSD6100 USED BELOW $I_B \approx 100$ mA

The timing diagram on the left shows two voltage signals, V_1 and V_2 , over a 25 μ s interval. V_1 is a square wave switching between approximately -12 V and 0 V. V_2 is a square wave switching between approximately 8.0 V and 0 V. The transition time for V_1 is indicated as $t_r, t_f \leq 10$ ns and the duty cycle is 1.0%.

The circuit diagram on the right shows a test setup for a Transistor Under Test (TUT). The base of the TUT is connected to a +4.0 V supply through a resistor R_B and a diode D_1 . The emitter is connected to ground. The collector is connected to a load resistor R_C and a -30 V supply (V_{CC}). The collector current is measured at the SCOPE. The TUT is represented by a dashed box containing a transistor model with parameters ≈ 8.0 k and ≈ 120 .

for t_d and t_r , D_1 is disconnected
 and $V_2 = 0$
 For NPN test circuit reverse all polarities.

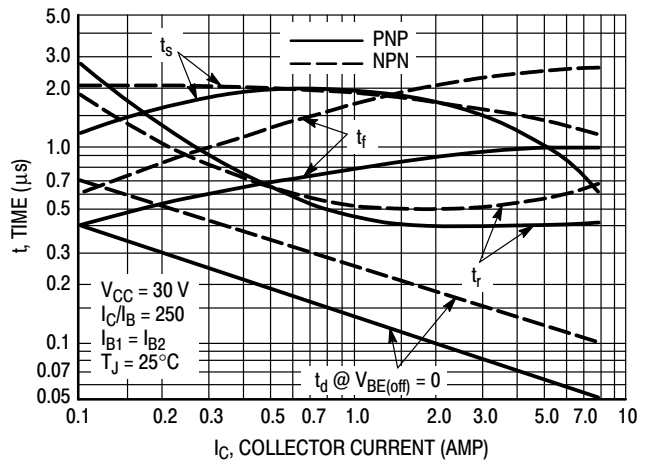


Figure 3. Switching Times Test Circuit

Figure 4. Switching Times

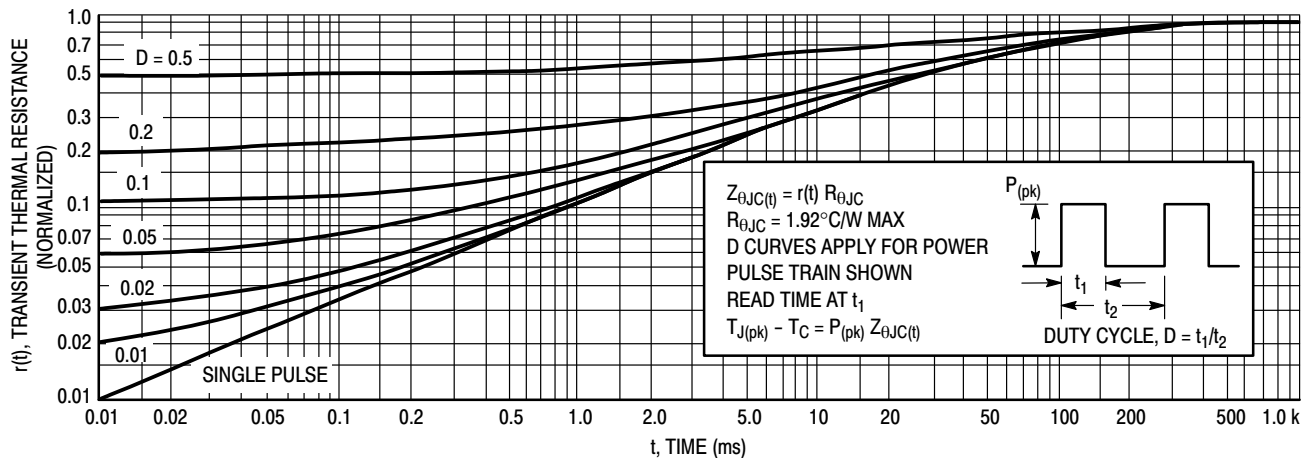


Figure 5. Thermal Response

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

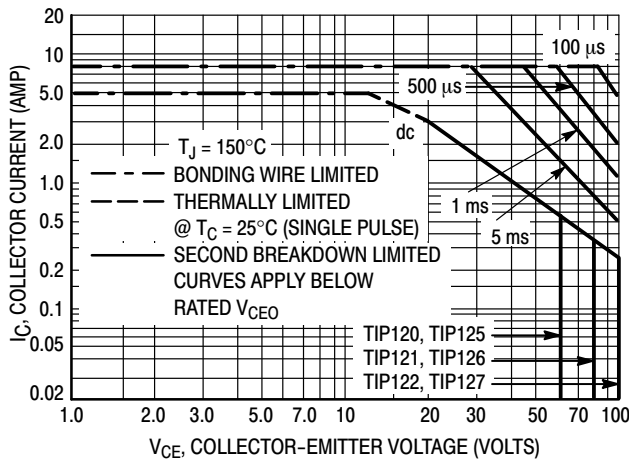


Figure 6. Active-Region Safe Operating Area

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

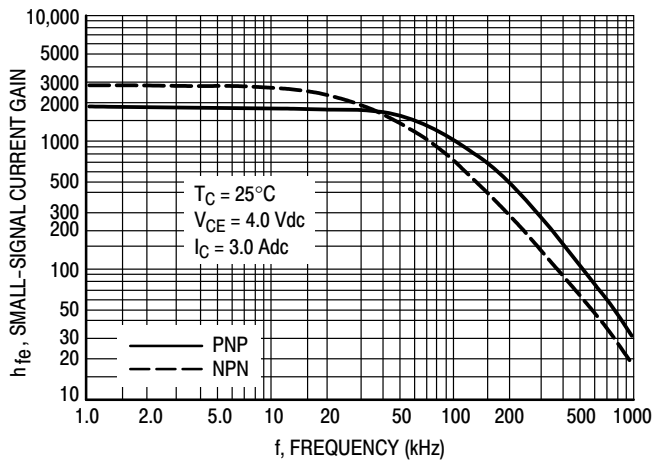


Figure 7. Small-Signal Current Gain

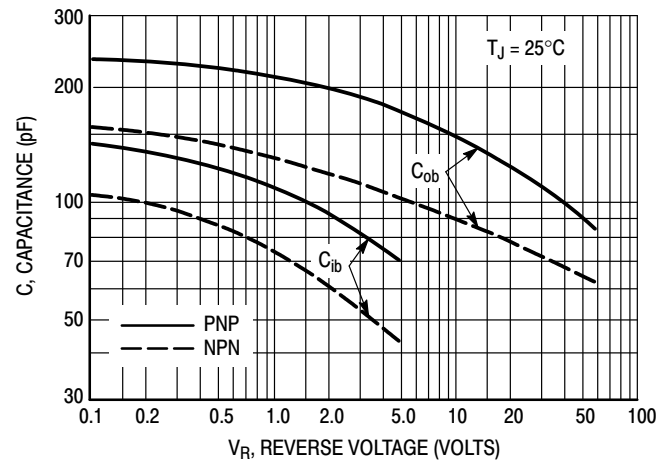


Figure 8. Capacitance

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

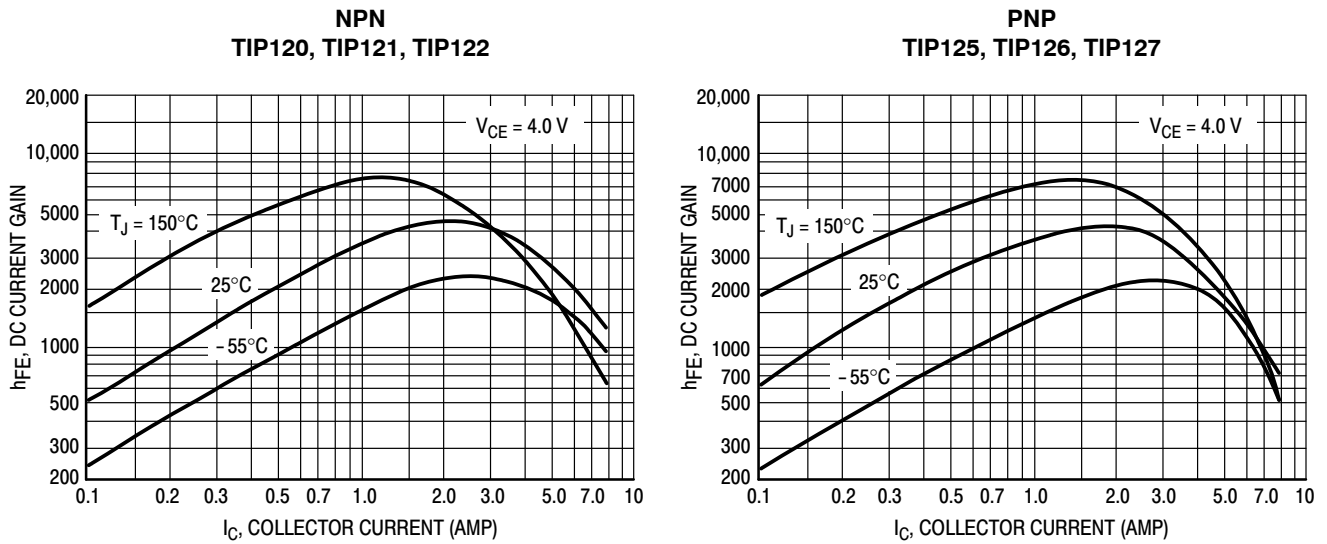


Figure 9. DC Current Gain

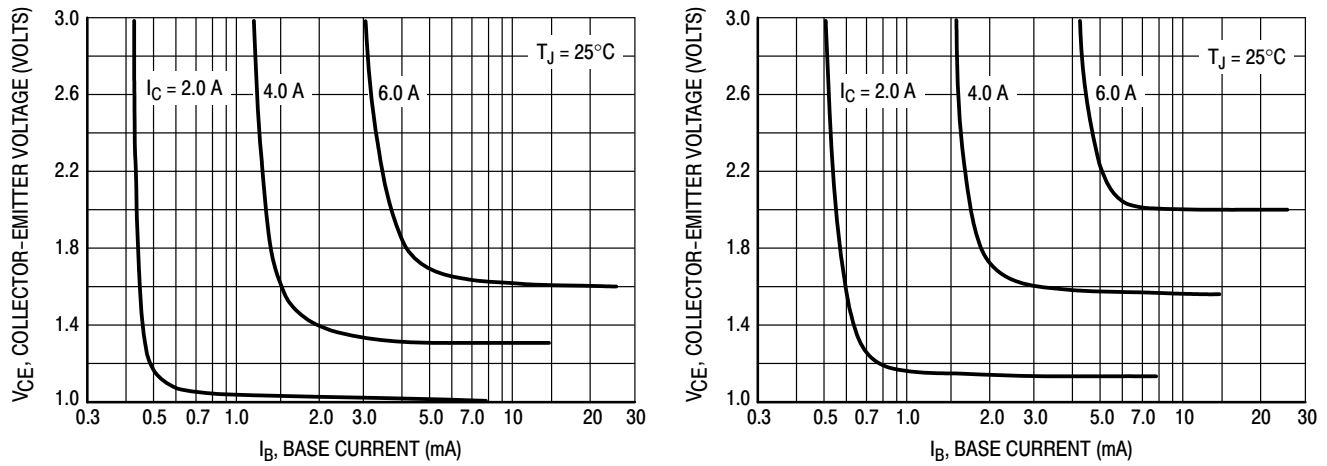


Figure 10. Collector Saturation Region

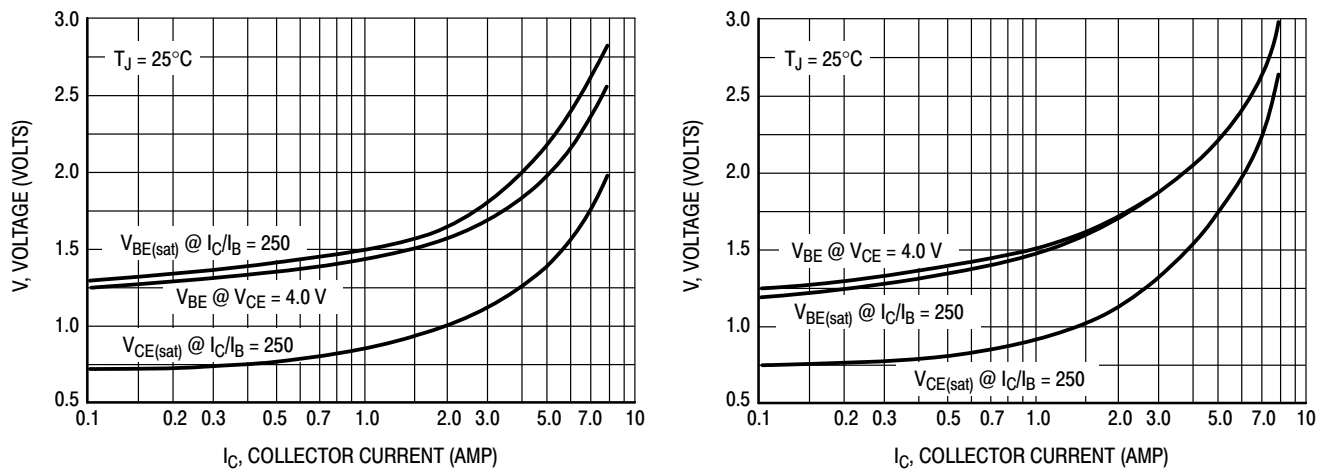
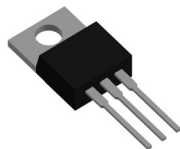


Figure 11. "On" Voltages

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

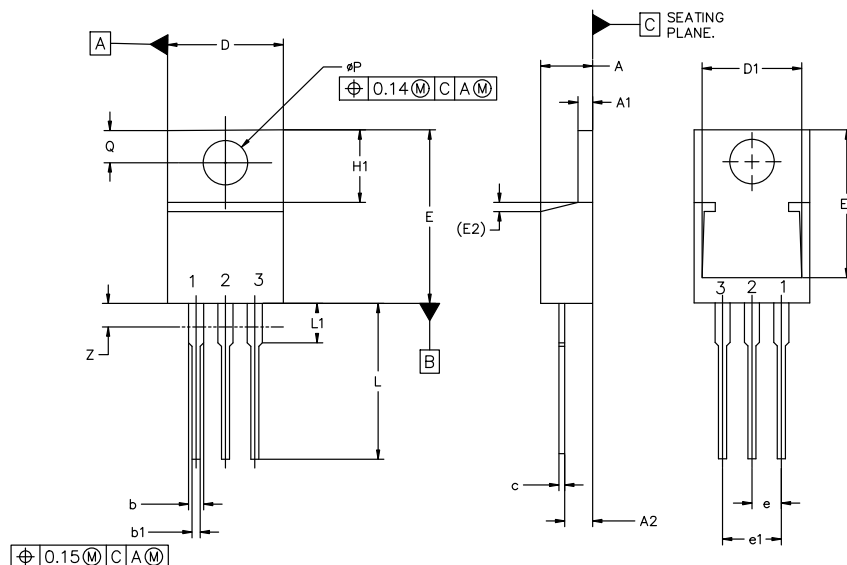


TO-220-3 10.10x15.12x4.45, 2.54P

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
øP	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.

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

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

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

STYLE 4:
PIN 1. MAIN TERMINAL 1
2. MAIN TERMINAL 2
3. GATE
4. MAIN TERMINAL 2

STYLE 5:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

STYLE 6:
PIN 1. ANODE
2. CATHODE
3. ANODE
4. CATHODE

STYLE 7:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. ANODE

STYLE 8:
PIN 1. CATHODE
2. ANODE
3. EXTERNAL TRIP/DELAY
4. ANODE

STYLE 9:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 10:
PIN 1. GATE
2. SOURCE
3. DRAIN
4. SOURCE

STYLE 11:
PIN 1. DRAIN
2. SOURCE
3. GATE
4. SOURCE

STYLE 12:
PIN 1. MAIN TERMINAL 1
2. MAIN TERMINAL 2
3. GATE
4. NOT CONNECTED

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