MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

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MJE1320

Designer's™ Data Sheet

NPN Silicon Power Transistor

Switchmode Series

POWER TRANSISTOR
2 AMPERES
900 VOLTS
80 WATTS

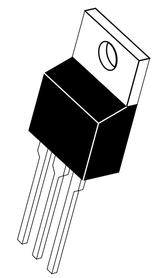
This transistor is designed for high–voltage, power switching in inductive circuits where RBSOA and breakdown voltage are critical. They are particularly suited for line–operated switchmode applications.

Typical Applications:

- Fluorescent Lamp Ballasts
- Inverters
- Solenoid and Relay Drivers
- Motor Controls
- Deflection Circuits

Features:

- High V_{CEV} Capability (1800 Volts)
- Low Saturation Voltage
- 100°C Performance Specified for:
  - Reverse–Biased SOA with Inductive Loads
  - Switching Times with Inductive Loads
  - Saturation Voltages
  - Leakage Currents



CASE 221A–06
TO–220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	$V_{CEO(sus)}$	900	Vdc
Collector–Emitter Voltage	V_{CEV}	1800	Vdc
Emitter Base Voltage	V_{EB}	9	Vdc
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 5	Adc
Base Current — Continuous Peak(1)	I_B I_{BM}	1.5 2.5	Adc
Total Power Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25°C	P_D	80 32 0.64	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8″ from Case for 5 Seconds	T_L	275	°C

(1) Pulse Test: Pulse Width = 5 ms, Duty Cycle ≤ 10%.

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. SOA Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

SWITCHMODE is a trademark of Motorola, Inc.

MOTOROLA

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic			Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS							
Collector–Emitter Sustaining Voltage (I_C = 50 mA, I_B = 0)			$V_{CEO(sus)}$	900	—	—	Vdc
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)			I_{CEV}	— —	— —	0.25 2.5	mAdc
Emitter Cutoff Current (V_{EB} = 9 Vdc, I_C = 0)			I_{EBO}	—	—	0.25	mAdc
SECOND BREAKDOWN							
Second Breakdown Collector Current with base forward biased			$I_{S/b}$	See Figure 13			
Clamped Inductive SOA with Base Reverse Biased			RBSOA	See Figure 14			
ON CHARACTERISTICS(1)							
DC Current Gain (V_{CE} = 5 Vdc)	I_C = 2 Adc I_C = 1 Adc		h_{FE}	2.5 3	4.5 7	— —	— —
Collector–Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.5 Adc) (I_C = 2 Adc, I_B = 1 Adc) (I_C = 1 Adc, I_B = 0.5 Adc, T_C = 100°C)			$V_{CE(sat)}$	— — —	0.18 0.3 0.3	1 2.5 1.5	Vdc
Base–Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.5 Adc) (I_C = 2 Adc, I_B = 1 Adc) (I_C = 1 Adc, I_B = 0.5 Adc, T_C = 100°C)			$V_{BE(sat)}$	— — —	0.2 0.9 0.15	1.5 2.8 1.5	Vdc
DYNAMIC CHARACTERISTICS							
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1 MHz)			C_{ob}	—	80	—	pF
SWITCHING CHARACTERISTICS							
Resistive Load (Table 1)							
Delay Time	V_{CC} = 250 Vdc, I_C = 1 A I_{B1} = I_{B2} = 0.5 Adc t_p = 25 µs, Duty Cycle ≤ 2%		t_d	—	0.1	—	µs
Rise Time			t_r	—	0.8	—	µs
Storage Time			t_s	—	4	—	µs
Fall Time			t_f	—	0.8	—	µs
Inductive Load, Clamped (Table 2)							
Storage Time	I_C = 1 A, V_{clamp} = 400 Vdc, $V_{BE(off)}$ = 2 Vdc, I_{B1} = 0.5 Adc	T_C = 25°C	t_{sv}	—	2.8	—	µs
Crossover Time			t_c	—	2.2	—	µs
Storage Time		T_C = 100°C	t_{sv}	—	3.7	10.5	µs
Crossover Time			t_c	—	3.5	10	µs
Fall Time							

(1) Pulse Test: Pulse Width = 300 µs. Duty Cycle ≤ 2%.

TYPICAL STATIC CHARACTERISTICS

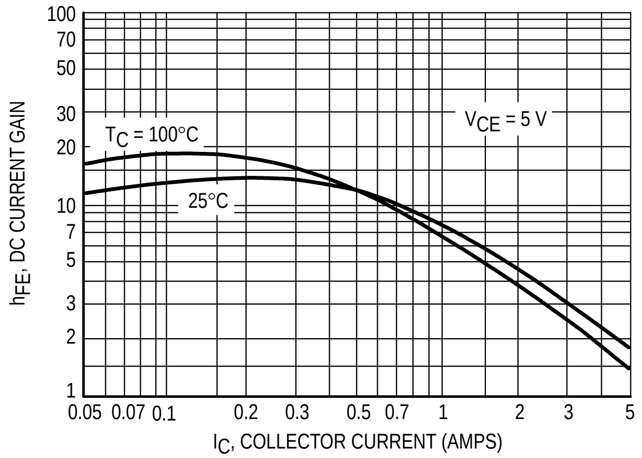


Figure 1. DC Current Gain

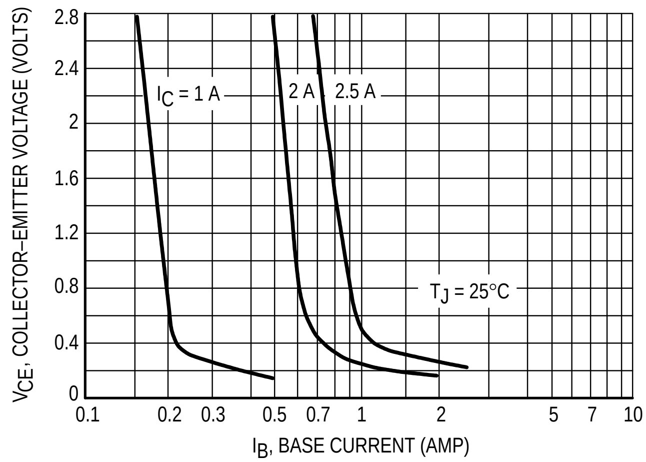


Figure 2. Collector Saturation Region

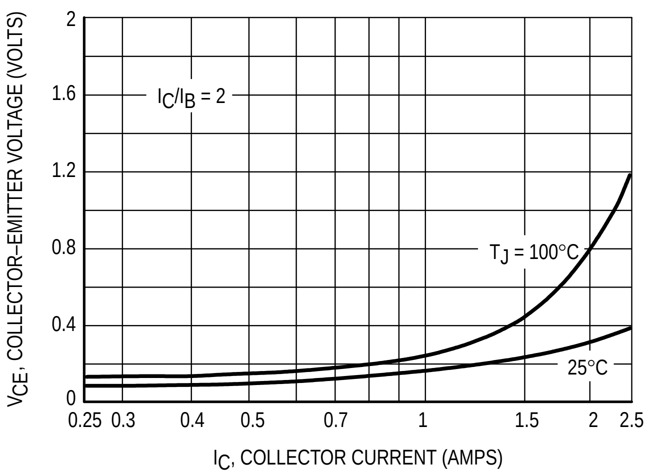


Figure 3. Collector–Emitter Saturation Voltage

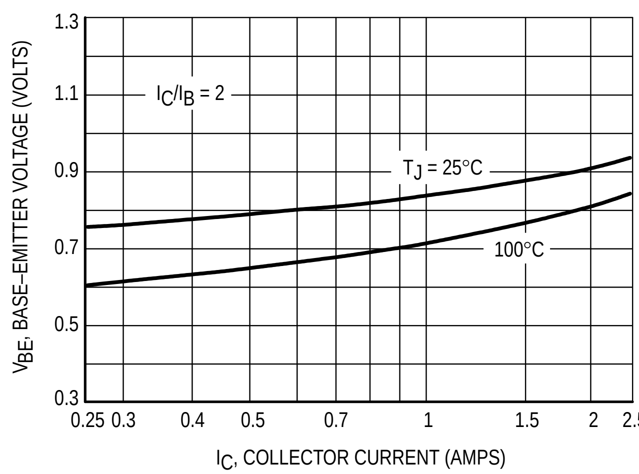


Figure 4. Base–Emitter Saturation Voltage

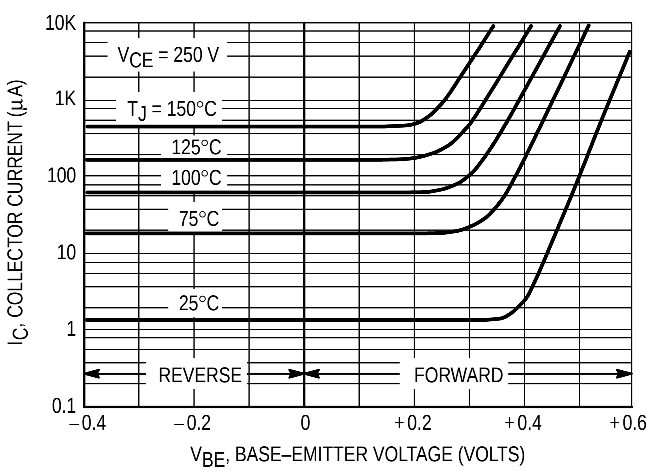


Figure 5. Collector Cutoff Region

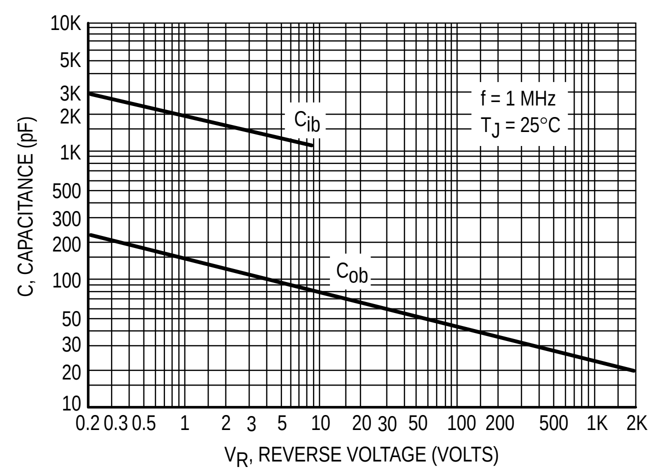


Figure 6. Capacitance Variation

TYPICAL DYNAMIC CHARACTERISTICS

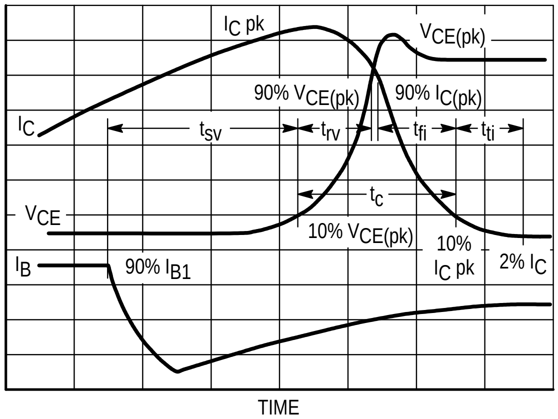


Figure 7. Inductive Switching Measurements

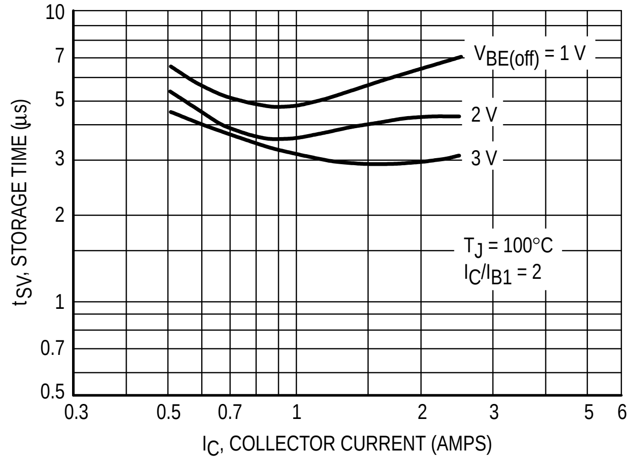


Figure 8. Inductive Storage Time

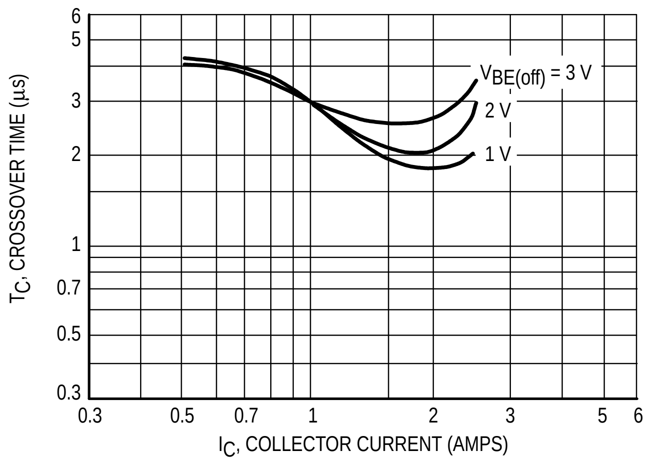


Figure 9. Inductive Crossover Time

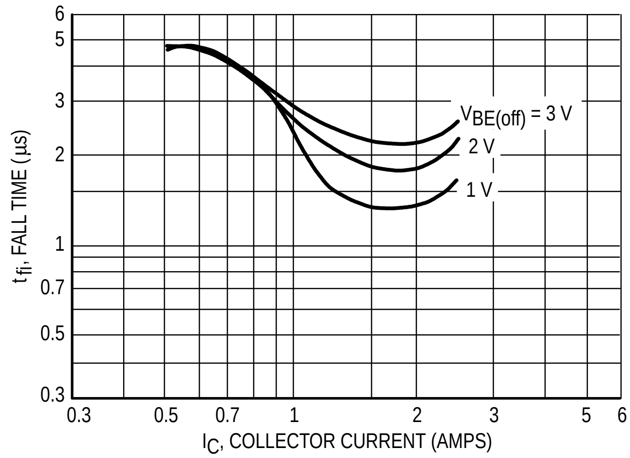
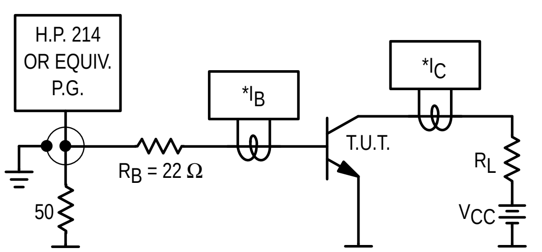
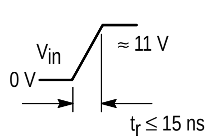


Figure 10. Inductive Fall Time

Table 1. Resistive Load Switching

t_d and t_r

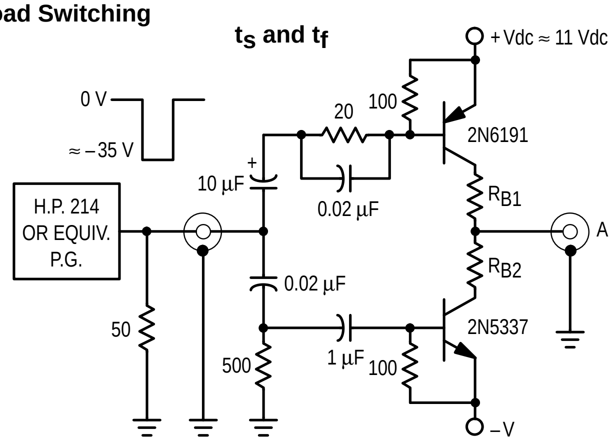


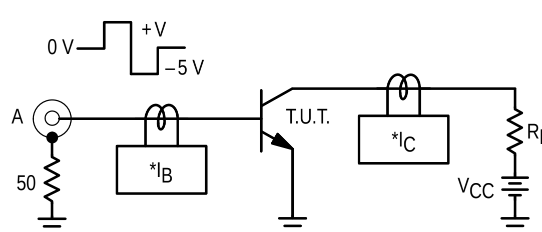


V_{CC} = 250 Vdc
R_L = 250 Ω
I_C = 1 Adc
I_B = 0.5 Adc

*Tektronix AM503
P6302 or Equivalent

t_s and t_f

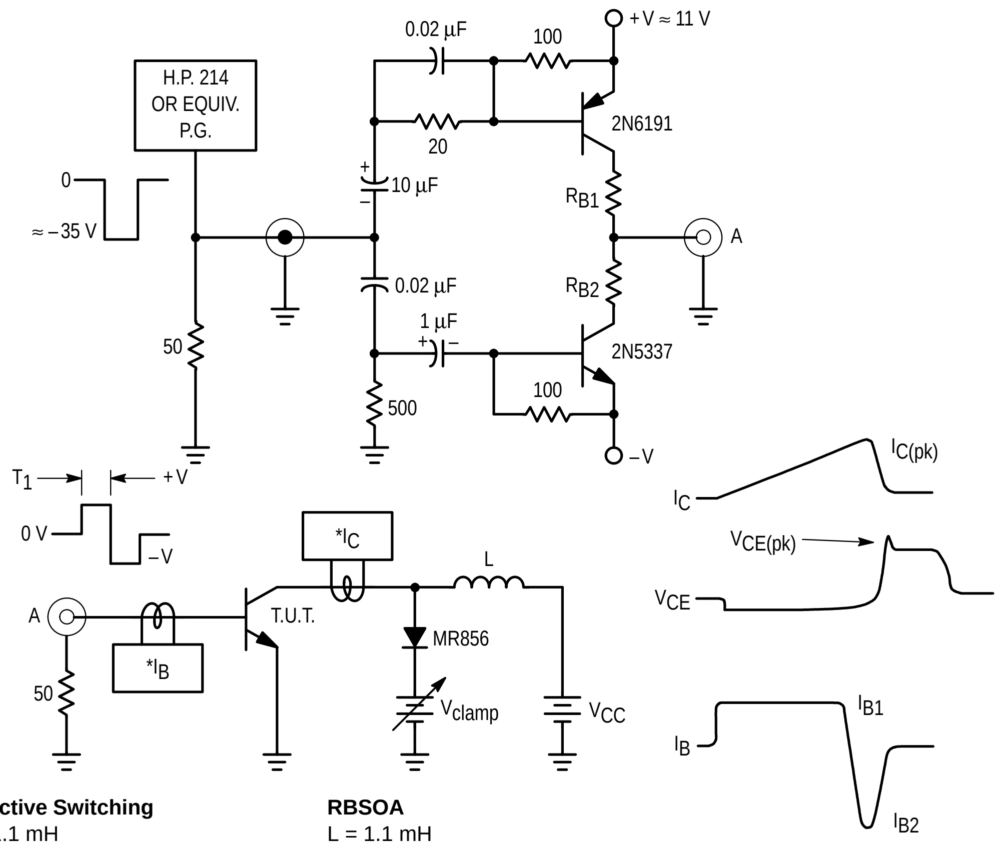




V_{CC} = 250 Vdc	I_{B1} = 0.5 Adc	R_{B1} = 22 Ω
R_L = 250 Ω	I_{B2} = 0.5 Adc	R_{B2} = 10 Ω
I_C = 1 Adc	For $V_{BE(off)}$ = 5 V	R_{B2} = 0 Ω

Note: Adjust – V to obtain desired $V_{BE(off)}$ at Point A.

Table 2. Inductive Load Switching



$T_1 \approx \frac{L_{coil}\,(I_{Cpk})}{V_{CC}}$

T_1 adjusted to obtain $I_{C(pk)}$

$V_{(BR)CEO}$	Inductive Switching	RBSOA
L = 10 mH	L = 1.1 mH	L = 1.1 mH
R_{B2} = ∞	R_{B2} = 0	R_{B2} = 0
V_{CC} = 20 Volts	V_{CC} = 20 Volts	V_{CC} = 20 Volts
	R_{B1} selected for desired I_{B1}	R_{B1} selected for desired I_{B1}

*Tektronix P–6042 or Equivalent

Scope — Tektronix 7403 or Equivalent

Note: Adjust –V to obtain desired $V_{BE(off)}$ at Point A.

SAFE OPERATING AREA INFORMATION

FORWARD BIAS

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 12 is based on T_C = 25°C; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when $T_C \geq 25°C$. Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 12 may be found at any case temperature by using the appropriate curve on Figure 11.

$T_{J(pk)}$ may be calculated from the data in Figure 14. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

REVERSE BIAS

For inductive loads, high voltage and high current must be sustained simultaneously during turn–off, in most cases, with the base–to–emitter junction reverse biased. Under these conditions the collector voltage must be held to a safe level at or below a specific value of collector current. This can be accomplished by several means such as active clamping, RC snubbing, load line shaping, etc. The safe level for these devices is specified as Reverse Bias Safe Operating Area and represents the voltage–current condition allowable during reverse biased turnoff. This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode. Figure 13 gives the RBSOA characteristics.

GUARANTEED SAFE OPERATING AREA

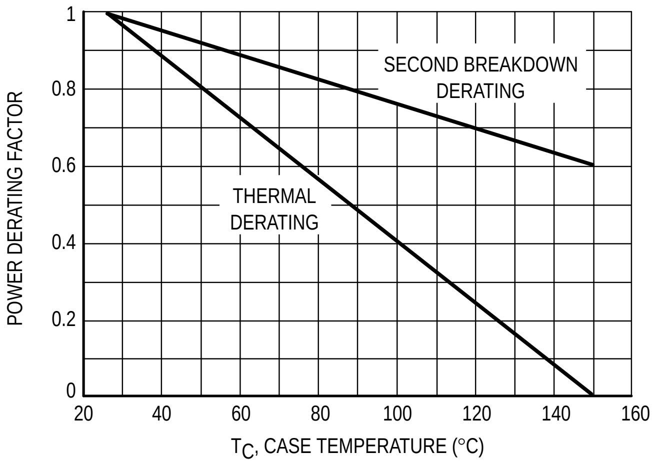


Figure 11. Power Derating

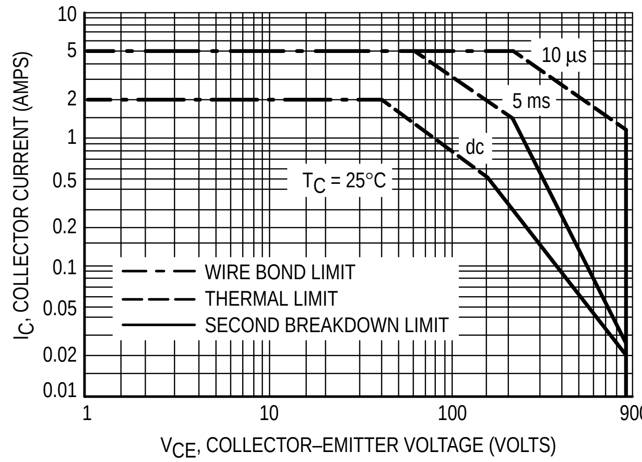


Figure 12. Maximum Rated Forward Bias Safe Operating Area

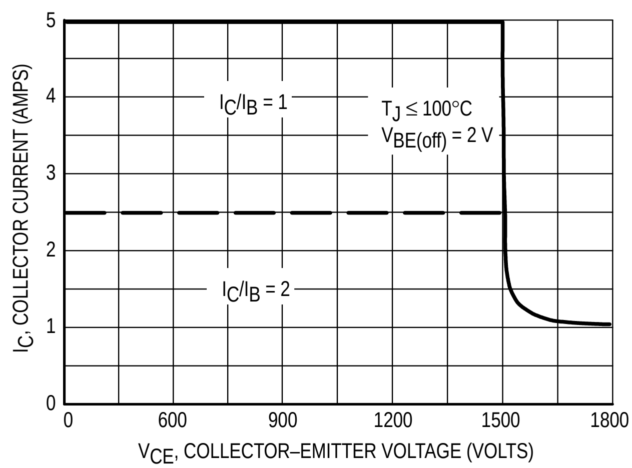


Figure 13. Maximum Rated Reverse Bias Safe Operating Area

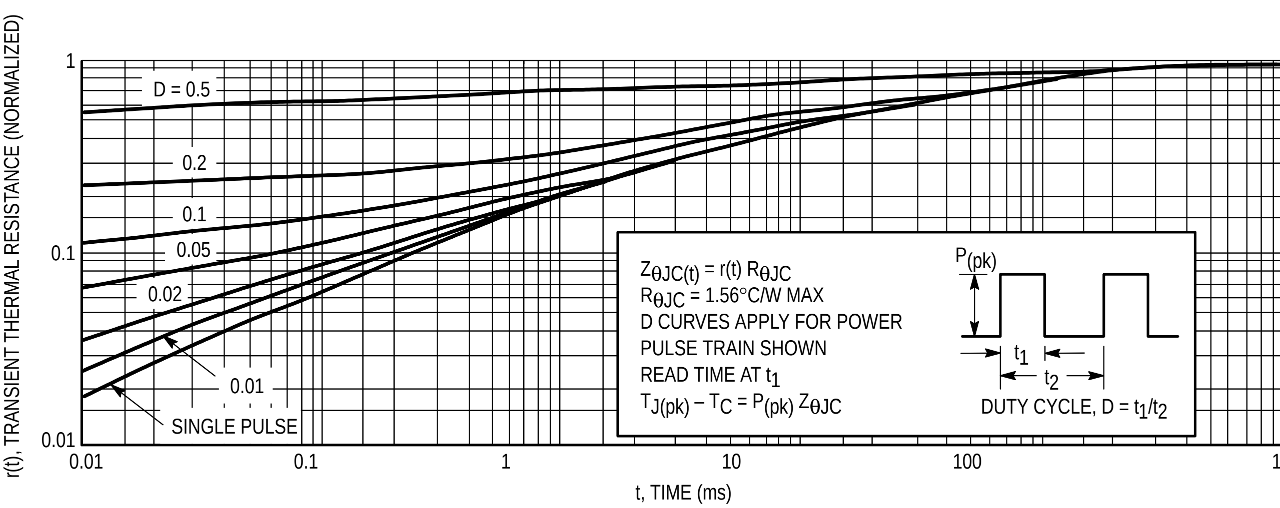
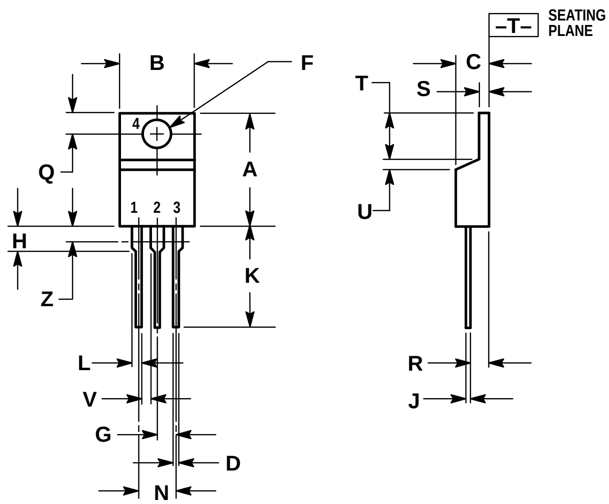


Figure 14. Thermal Response

PACKAGE DIMENSIONS



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	—–	1.15	—–
Z	—–	0.080	—–	2.04

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

CASE 221A–06
TO–220AB
ISSUE Y

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