

# High Voltage NPN Silicon Power Transistors

... designed for line operated audio output amplifier, Switchmode power supply drivers and other switching applications.

- 250 V to 400 V (Min) —  $V_{CEO(sus)}$
- 1 A Rated Collector Current
- Popular TO-220 Plastic Package

## MAXIMUM RATINGS

Rating	Symbol	TIP47	TIP48	TIP49	TIP50	Unit
Collector-Emitter Voltage	$V_{CEO}$	250	300	350	400	Vdc
Collector-Base Voltage	$V_{CB}$	350	400	450	500	Vdc
Emitter-Base Voltage	$V_{EB}$	5.0				Vdc
Collector Current — Continuous Peak	$I_C$	1.0 2.0				A <sub>dc</sub>
Base Current	$I_B$	0.6				A <sub>dc</sub>
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	40 0.32				Watts W/ $^\circ\text{C}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	2.0 0.016				Watts W/ $^\circ\text{C}$
Unclamped Inducting Load Energy (See Figure 8)	E	20				mJ
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-65 to +150				$^\circ\text{C}$

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C}/\text{W}$

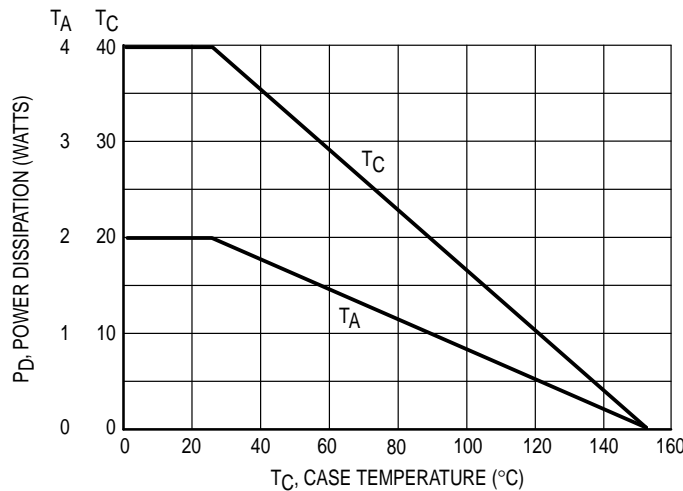


Figure 1. Power Derating

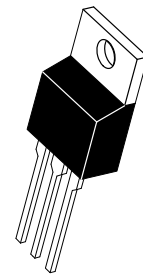
Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

**TIP47\***  
**TIP49\***  
**TIP48\***  
**TIP50\***

\*Motorola Preferred Device

**1.0 AMPERE  
POWER TRANSISTORS  
NPN SILICON  
250-300-350-400 VOLTS  
40 WATTS**



**CASE 221A-06  
TO-220AB**

**TIP47 TIP49 TIP48 TIP50**

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

Characteristic	Symbol	Min	Max	Unit	
<b>OFF CHARACTERISTICS</b>					
Collector–Emitter Sustaining Voltage (1) ( $I_C = 30\text{ mAdc}$ , $I_B = 0$ )	TIP47 TIP48 TIP49 TIP50	$V_{CE(sus)}$	250 300 350 400	— — — —	Vdc
Collector Cutoff Current ( $V_{CE} = 150\text{ Vdc}$ , $I_B = 0$ ) ( $V_{CE} = 200\text{ Vdc}$ , $I_B = 0$ ) ( $V_{CE} = 250\text{ Vdc}$ , $I_B = 0$ ) ( $V_{CE} = 300\text{ Vdc}$ , $I_B = 0$ )	TIP47 TIP48 TIP49 TIP50	$I_{CEO}$	— — — —	1.0 1.0 1.0 1.0	mAdc
Collector Cutoff Current ( $V_{CE} = 350\text{ Vdc}$ , $V_{BE} = 0$ ) ( $V_{CE} = 400\text{ Vdc}$ , $V_{BE} = 0$ ) ( $V_{CE} = 450\text{ Vdc}$ , $V_{BE} = 0$ ) ( $V_{CE} = 500\text{ Vdc}$ , $V_{BE} = 0$ )	TIP47 TIP48 TIP49 TIP50	$I_{CES}$	— — — —	1.0 1.0 1.0 1.0	mAdc
Emitter Cutoff Current ( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )		$I_{EBO}$	—	1.0	mAdc

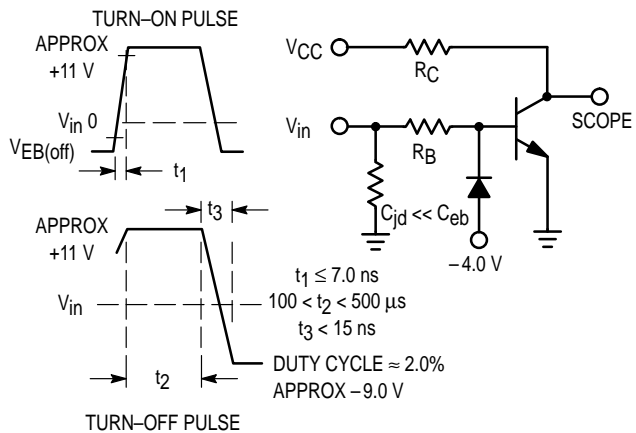
**ON CHARACTERISTICS (1)**

DC Current Gain ( $I_C = 0.3\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ ) ( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ )	$h_{FE}$	30 10	150 —	—
Collector–Emitter Saturation Voltage ( $I_C = 1.0\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	$V_{CE(sat)}$	—	1.0	Vdc
Base–Emitter On Voltage ( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ )	$V_{BE(on)}$	—	1.5	Vdc

**DYNAMIC CHARACTERISTICS**

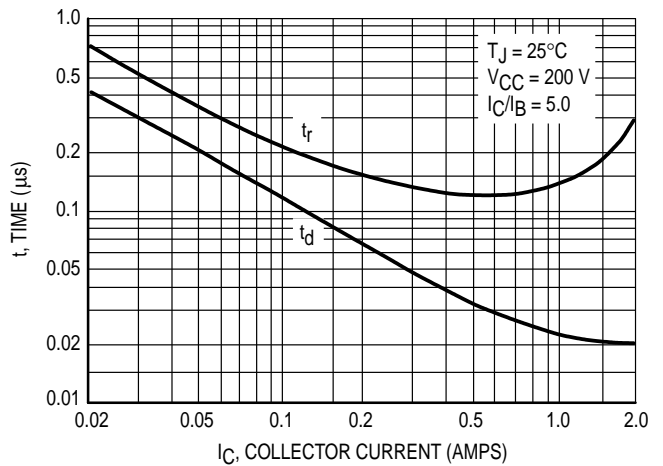
Current–Gain — Bandwidth Product ( $I_C = 0.1\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 2.0\text{ MHz}$ )	$f_T$	10	—	MHz
Small–Signal Current Gain ( $I_C = 0.2\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	$h_{fe}$	25	—	—

(1) Pulse Test: Pulse width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .



$R_B$  and  $R_C$  VARIED TO OBTAIN DESIRED CURRENT LEVELS.

**Figure 2. Switching Time Equivalent Circuit**



**Figure 3. Turn–On Time**

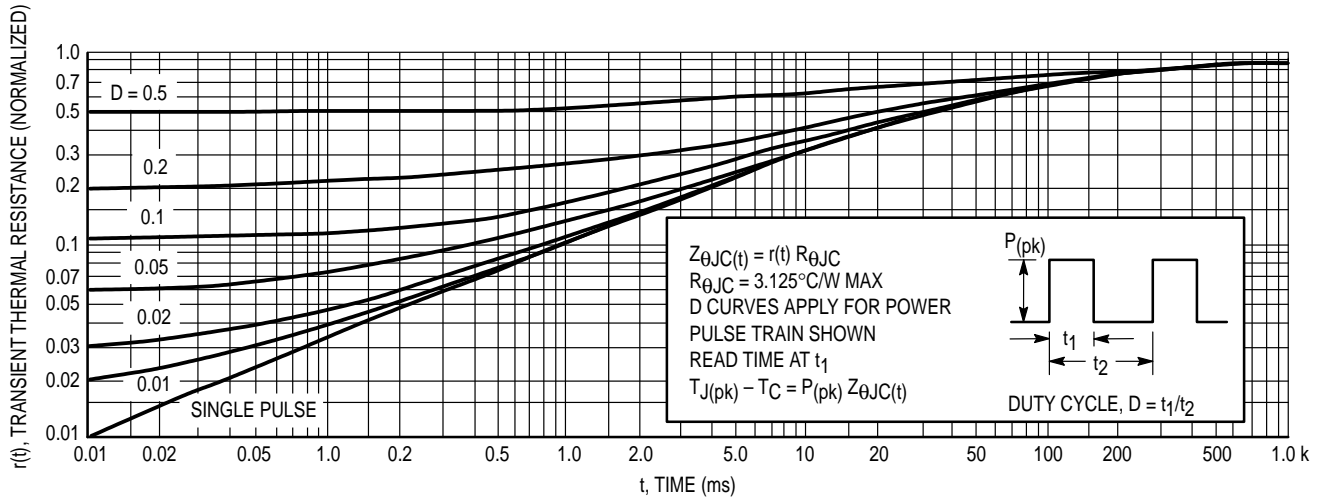


Figure 4. Thermal Response

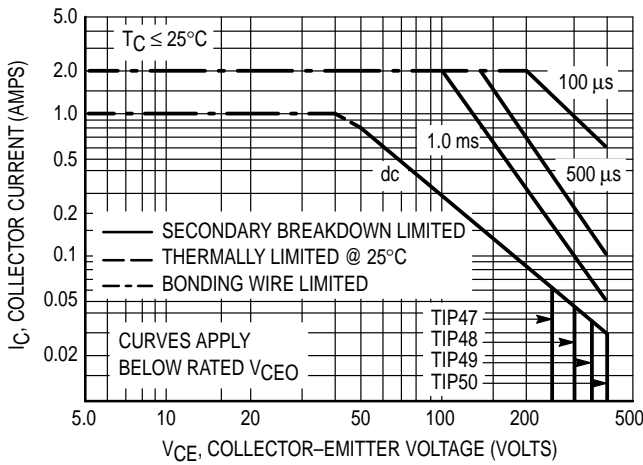


Figure 5. Active Region Safe Operating Area

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 5 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  $T_J(pk) \leq 150^\circ\text{C}$ .  $T_J(pk)$  may be calculated from the data in Figure 4. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

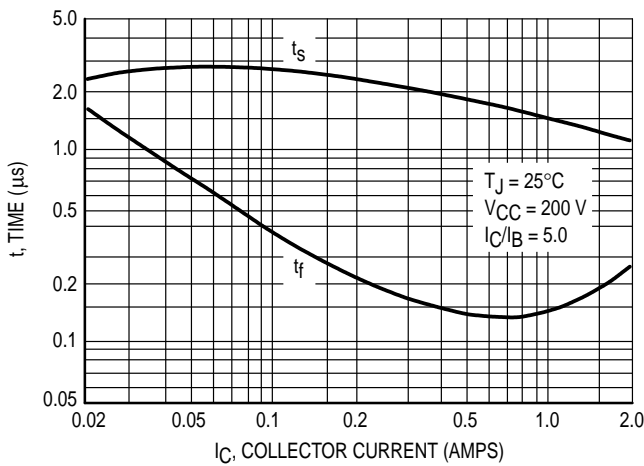


Figure 6. Turn-Off Time

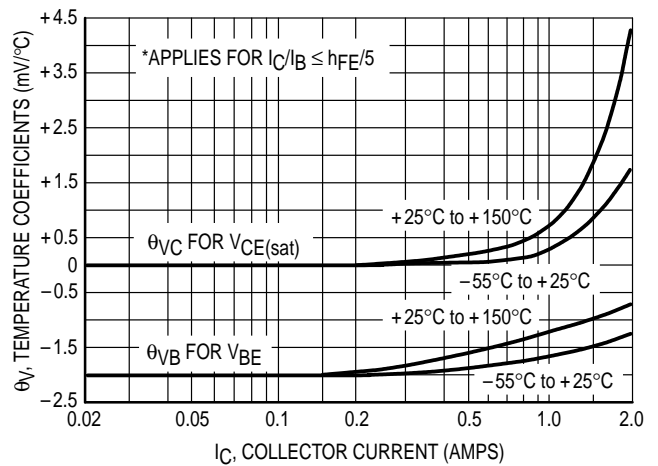
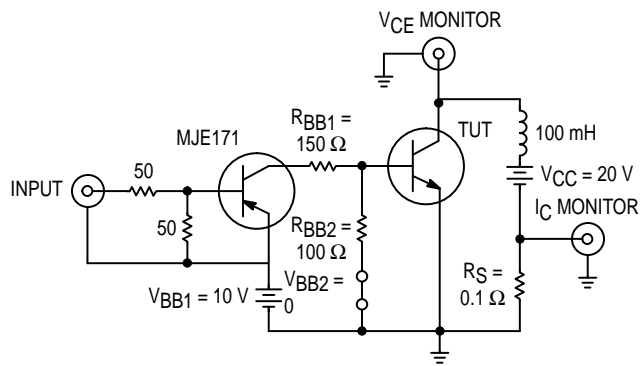


Figure 7. Temperature Coefficients



Note A: Input pulse width is increased until  $I_{CM} = 0.63$  A.

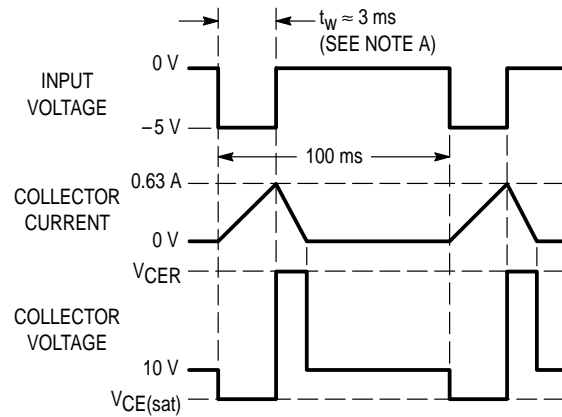


Figure 8. Inductive Load Switching

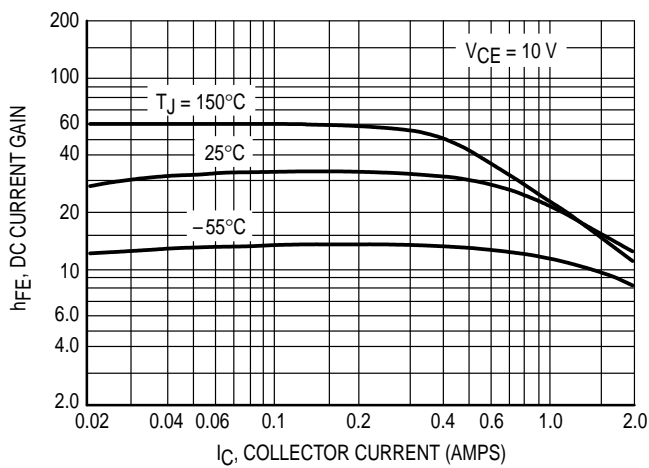


Figure 9. DC Current Gain

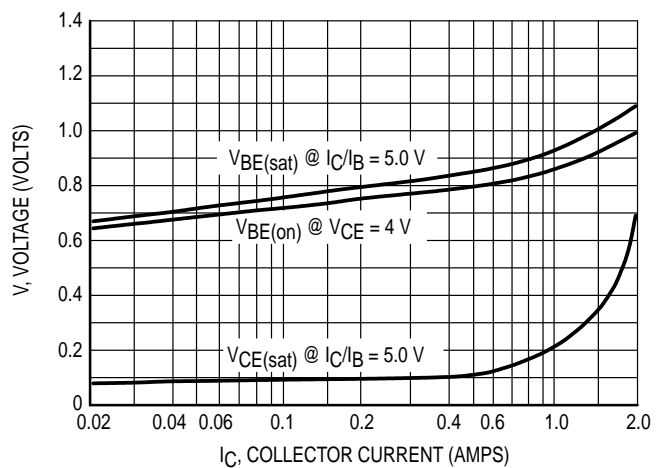
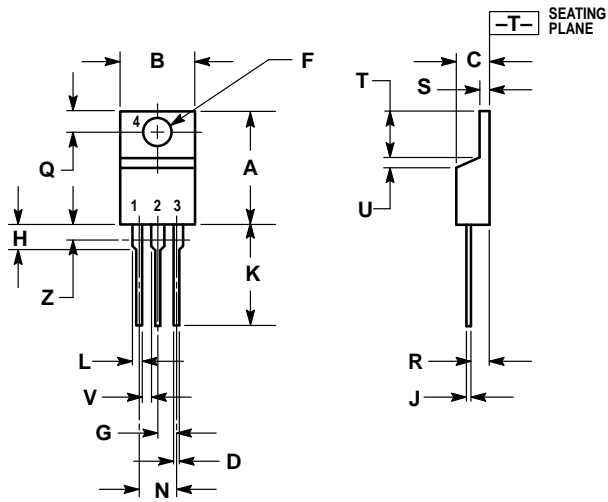


Figure 10. "On" Voltages

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.

DIM	INCHES		MILLIMETERS	
	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
  - COLLECTOR
  - EMITTER
  - COLLECTOR

CASE 221A-06  
TO-220AB  
ISSUE Y

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**How to reach us:**

**USA / EUROPE:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,  
6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE (602) 244-6609  
**INTERNET:** <http://Design-NET.com>

**HONG KONG:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

