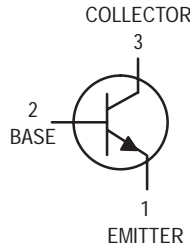


# General Purpose Transistors

## NPN Silicon

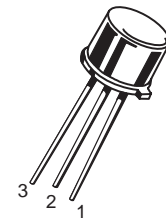


**2N2219**  
**2N2219A\***  
**2N2222**  
**2N2222A\***

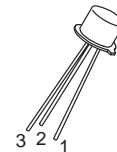
\*Motorola Preferred Devices

### MAXIMUM RATINGS

Rating	Symbol	2N2219 2N2222	2N2219A 2N2222A	Unit
Collector–Emitter Voltage	$V_{CEO}$	30	40	Vdc
Collector–Base Voltage	$V_{CBO}$	60	75	Vdc
Emitter–Base Voltage	$V_{EBO}$	5.0	6.0	Vdc
Collector Current — Continuous	$I_C$	800	800	mAdc
		<b>2N2219,A</b>	<b>2N2222,A</b>	
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	0.8 4.57	0.4 2.28	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	3.0 17.1	1.2 6.85	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	–65 to +200		$^\circ\text{C}$



**2N2219,A**  
CASE 79–04, STYLE 1  
TO–39 (TO–205AD)



**2N2222,A**  
CASE 22–03, STYLE 1  
TO–18 (TO–206AA)

### THERMAL CHARACTERISTICS

Characteristic	Symbol	2N2219,A	2N2222,A	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	437.5	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	58	145.8	$^\circ\text{C}/\text{W}$

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

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

### OFF CHARACTERISTICS

Collector–Emitter Breakdown Voltage ( $I_C = 10 \text{ mAdc}, I_B = 0$ )	Non–A Suffix A–Suffix	$V_{(BR)CEO}$	30 40	— —	Vdc
Collector–Base Breakdown Voltage ( $I_C = 10 \mu\text{Adc}, I_E = 0$ )	Non–A Suffix A–Suffix	$V_{(BR)CBO}$	60 75	— —	Vdc
Emitter–Base Breakdown Voltage ( $I_E = 10 \mu\text{Adc}, I_C = 0$ )	Non–A Suffix A–Suffix	$V_{(BR)EBO}$	5.0 6.0	— —	Vdc
Collector Cutoff Current ( $V_{CE} = 60 \text{ Vdc}, V_{EB(off)} = 3.0 \text{ Vdc}$ )	A–Suffix	$I_{CEX}$	—	10	nAdc
Collector Cutoff Current ( $V_{CB} = 50 \text{ Vdc}, I_E = 0$ ) ( $V_{CB} = 60 \text{ Vdc}, I_E = 0$ ) ( $V_{CB} = 50 \text{ Vdc}, I_E = 0, T_A = 150^\circ\text{C}$ ) ( $V_{CB} = 60 \text{ Vdc}, I_E = 0, T_A = 150^\circ\text{C}$ )	Non–A Suffix A–Suffix Non–A Suffix A–Suffix	$I_{CBO}$	— — — —	0.01 0.01 10 10	$\mu\text{Adc}$
Emitter Cutoff Current ( $V_{EB} = 3.0 \text{ Vdc}, I_C = 0$ )	A–Suffix	$I_{EBO}$	—	10	nAdc
Base Cutoff Current ( $V_{CE} = 60 \text{ Vdc}, V_{EB(off)} = 3.0 \text{ Vdc}$ )	A–Suffix	$I_{BL}$	—	20	nAdc

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

(Replaces 2N2218A/D)

LIFETIME BUY

LAST SHIP 21/03/00  
LAST ORDER 23/09/99

ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS</b>				
DC Current Gain (I <sub>C</sub> = 0.1 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) <sup>(1)</sup> (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , T <sub>A</sub> = -55°C) <sup>(1)</sup> (I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) <sup>(1)</sup> (I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) <sup>(1)</sup> (I <sub>C</sub> = 500 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) <sup>(1)</sup>	2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219, 2N2222 2N2219A, 2N2222A	h <sub>FE</sub>	35 50 75 35 100 50 30 40	— — — — 300 — — —
Collector–Emitter Saturation Voltage <sup>(1)</sup> (I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )  (I <sub>C</sub> = 500 mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )	Non–A Suffix A–Suffix  Non–A Suffix A–Suffix	V <sub>CE(sat)</sub>	— — — —	0.4 0.3 1.6 1.0
Base–Emitter Saturation Voltage <sup>(1)</sup> (I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )  (I <sub>C</sub> = 500 mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )	Non–A Suffix A–Suffix  Non–A Suffix A–Suffix	V <sub>BE(sat)</sub>	0.6 0.6 — —	1.3 1.2 2.6 2.0
<b>SMALL–SIGNAL CHARACTERISTICS</b>				
Current–Gain — Bandwidth Product <sup>(2)</sup> (I <sub>C</sub> = 20 mA <sub>dc</sub> , V <sub>CE</sub> = 20 V <sub>dc</sub> , f = 100 MHz)	All Types, Except 2N2219A, 2N2222A	f <sub>T</sub>	250 300	— —
Output Capacitance <sup>(3)</sup> (V <sub>CB</sub> = 10 V <sub>dc</sub> , I <sub>E</sub> = 0, f = 1.0 MHz)		C <sub>obo</sub>	—	8.0
Input Capacitance <sup>(3)</sup> (V <sub>EB</sub> = 0.5 V <sub>dc</sub> , I <sub>C</sub> = 0, f = 1.0 MHz)	Non–A Suffix A–Suffix	C <sub>ibo</sub>	— —	30 25
Input Impedance (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)	2N2219A, 2N2222A 2N2219A, 2N2222A	h <sub>je</sub>	2.0 0.25	8.0 1.25
Voltage Feedback Ratio (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)	2N2219A, 2N2222A 2N2219A, 2N2222A	h <sub>re</sub>	— —	8.0 4.0
Small–Signal Current Gain (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)	2N2219A, 2N2222A 2N2219A, 2N2222A	h <sub>fe</sub>	50 75	300 375
Output Admittance (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)	2N2219A, 2N2222A 2N2219A, 2N2222A	h <sub>oe</sub>	5.0 15	35 200
Collector Base Time Constant (I <sub>E</sub> = 20 mA <sub>dc</sub> , V <sub>CB</sub> = 20 V <sub>dc</sub> , f = 31.8 MHz)	A–Suffix	rb'C <sub>C</sub>	—	150
Noise Figure (I <sub>C</sub> = 100 μA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , R <sub>S</sub> = 1.0 kΩ, f = 1.0 kHz)	2N2222A	NF	—	4.0
Real Part of Common–Emitter High Frequency Input Impedance (I <sub>C</sub> = 20 mA <sub>dc</sub> , V <sub>CE</sub> = 20 V <sub>dc</sub> , f = 300 MHz)	2N2219A, 2N2222A	Re(h <sub>je</sub> )	—	60

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f<sub>T</sub> is defined as the frequency at which |h<sub>fe</sub>| extrapolates to unity.
3. 2N5581 and 2N5582 are listed C<sub>cb</sub> and C<sub>eb</sub> for these conditions and values.

LIFETIME BUY

LAST SHIP 21/03/00  
LAST ORDER 23/09/99

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

Characteristic		Symbol	Min	Max	Unit
<b>SWITCHING CHARACTERISTICS</b>					
Delay Time	$(V_{CC} = 30\text{ Vdc}, V_{BE(\text{off})} = -0.5\text{ Vdc}, I_C = 150\text{ mA}, I_{B1} = 15\text{ mA})$ (Figure 12)	$t_d$	—	10	ns
Rise Time		$t_r$	—	25	ns
Storage Time	$(V_{CC} = 30\text{ Vdc}, I_C = 150\text{ mA}, I_{B1} = I_{B2} = 15\text{ mA})$ (Figure 13)	$t_s$	—	225	ns
Fall Time		$t_f$	—	60	ns
Active Region Time Constant ( $I_C = 150\text{ mA}, V_{CE} = 30\text{ Vdc}$ ) (See Figure 11 for 2N2219A, 2N2222A)		$T_A$	—	2.5	ns

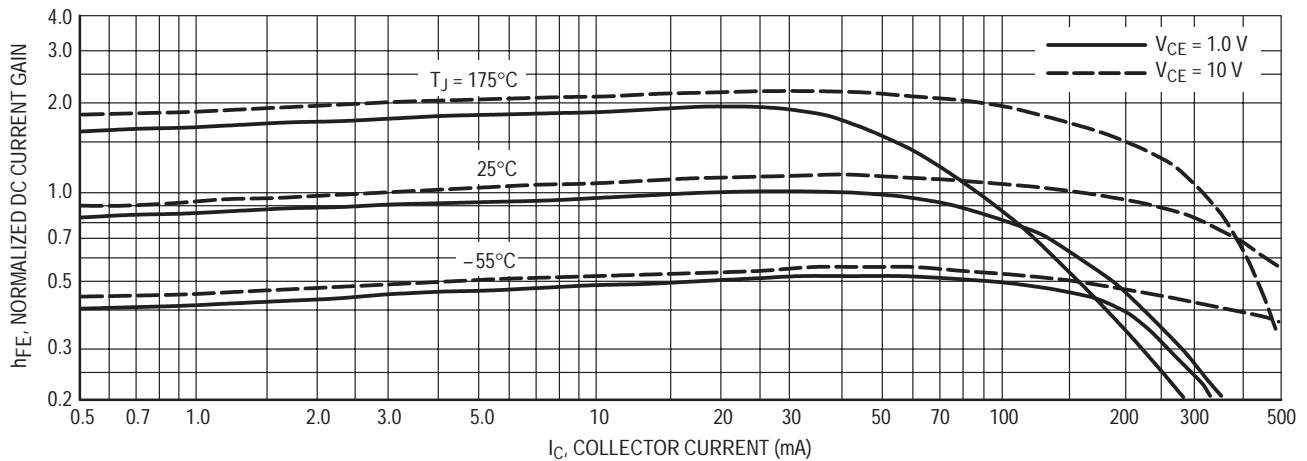


Figure 1. Normalized DC Current Gain

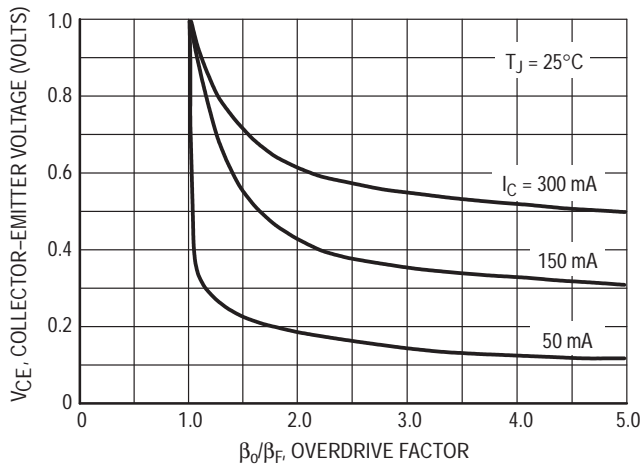


Figure 2. Collector Characteristics in Saturation Region

This graph shows the effect of base current on collector current.  $\beta_o$  (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and  $\beta_F$  (forced gain) is the ratio of  $I_C/I_{BF}$  in a circuit.

EXAMPLE: For type 2N2219, estimate a base current ( $I_{BF}$ ) to insure saturation at a temperature of  $25^\circ\text{C}$  and a collector current of 150 mA.

Observe that at  $I_C = 150\text{ mA}$  an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that  $h_{FE} @ 1\text{ volt}$  is approximately 0.62 of  $h_{FE} @ 10\text{ volts}$ . Using the guaranteed minimum gain of 100 @ 150 mA and 10 V,  $\beta_o = 62$  and substituting values in the overdrive equation, we find:

$$\frac{\beta_o}{\beta_F} = \frac{h_{FE} @ 1.0\text{ V}}{I_C/I_{BF}} \quad 2.5 = \frac{62}{150/I_{BF}} \quad I_{BF} \approx 6.0\text{ mA}$$

LIFETIME BUY

LAST SHIP 21/03/00  
LAST ORDER 23/09/99

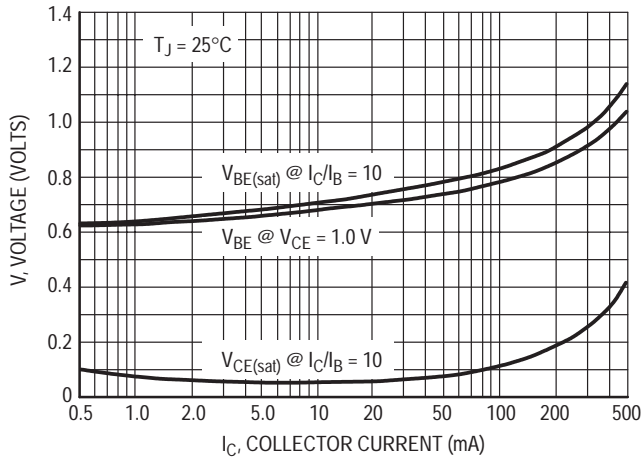


Figure 3. "On" Voltages

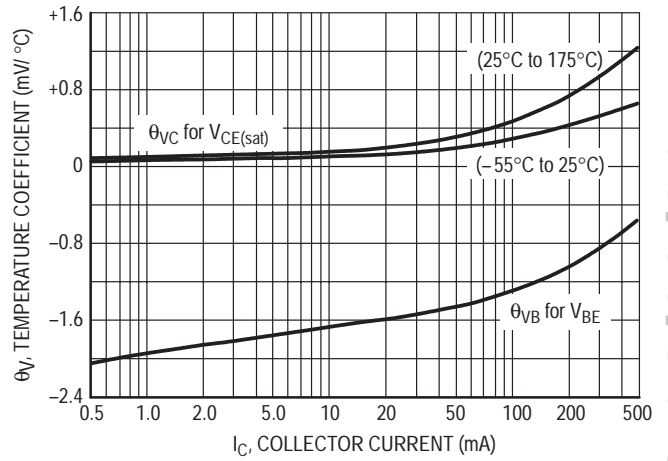


Figure 4. Temperature Coefficients

**h PARAMETERS**

$V_{CE} = 10$  Vdc,  $f = 1.0$  kHz,  $T_A = 25^\circ\text{C}$

This group of graphs illustrates the relationship between  $h_{fe}$  and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

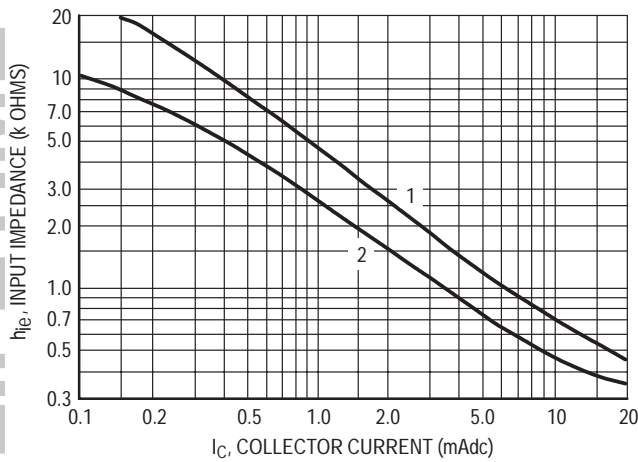


Figure 5. Input Impedance

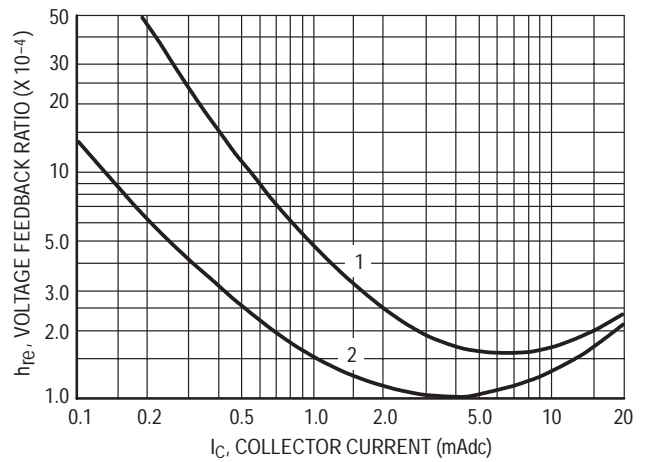


Figure 6. Voltage Feedback Ratio

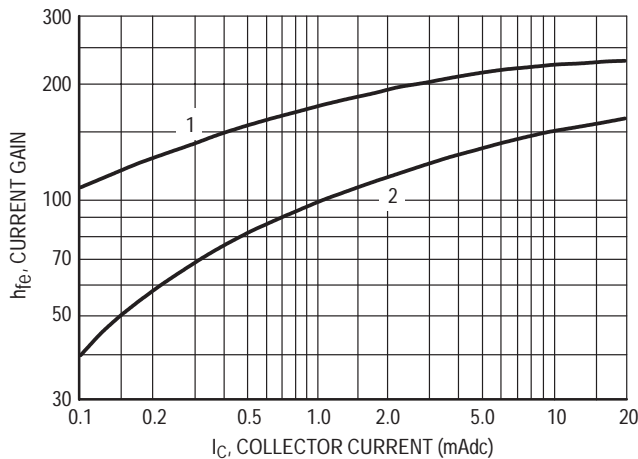


Figure 7. Current Gain

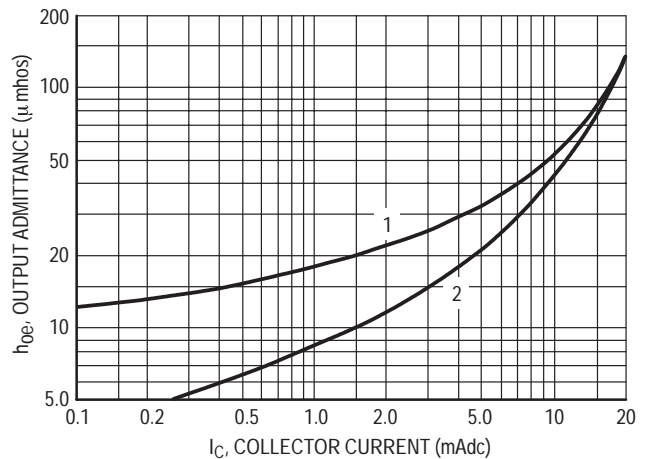


Figure 8. Output Admittance

LIFETIME BUY

LAST SHIP 21/03/00  
LAST ORDER 23/09/99

SWITCHING TIME CHARACTERISTICS

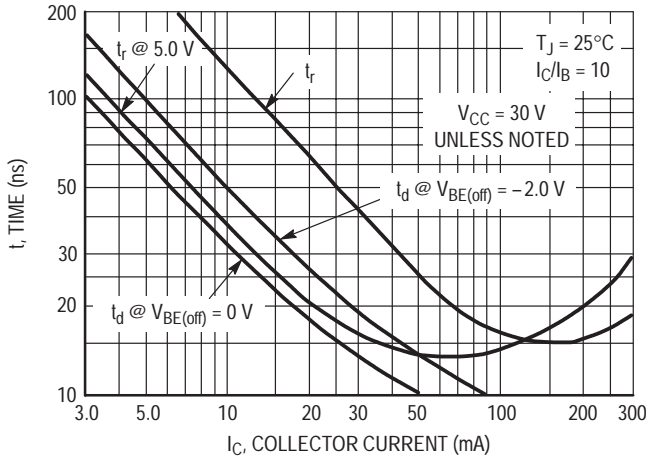


Figure 9. Turn-On Time

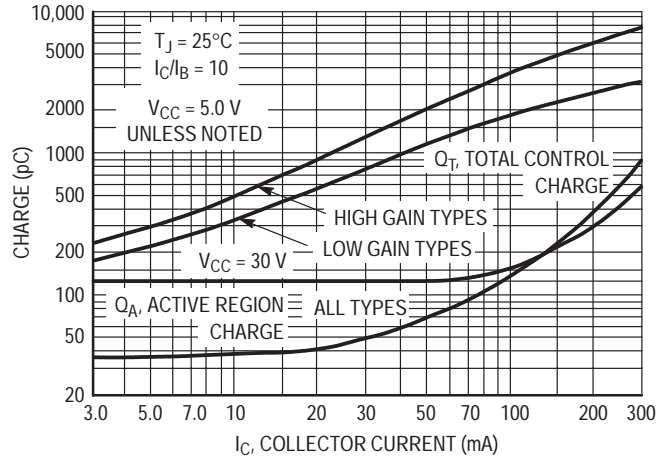


Figure 10. Charge Data

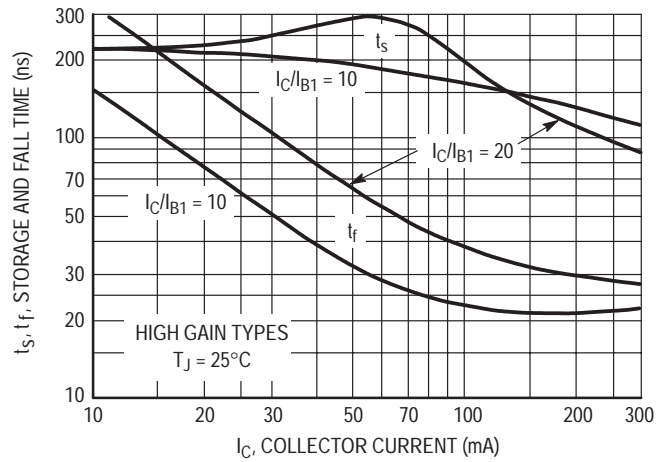
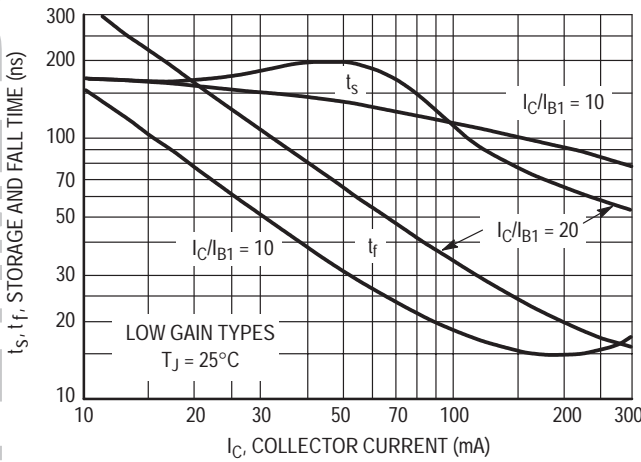


Figure 11. Turn-Off Behavior

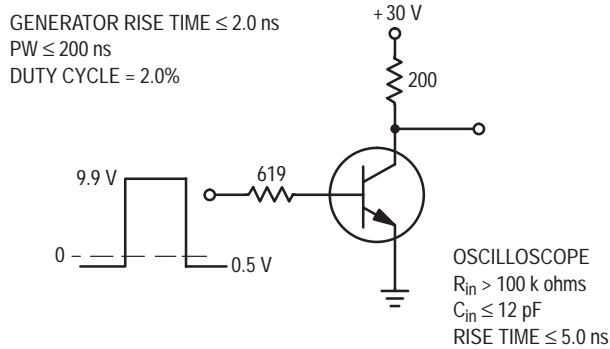


Figure 12. Delay and Rise Time Equivalent Test Circuit

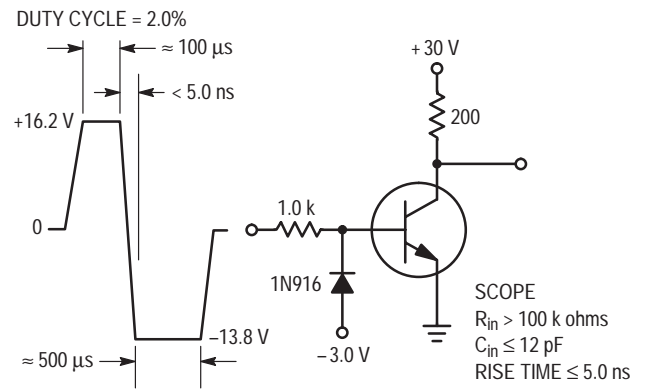
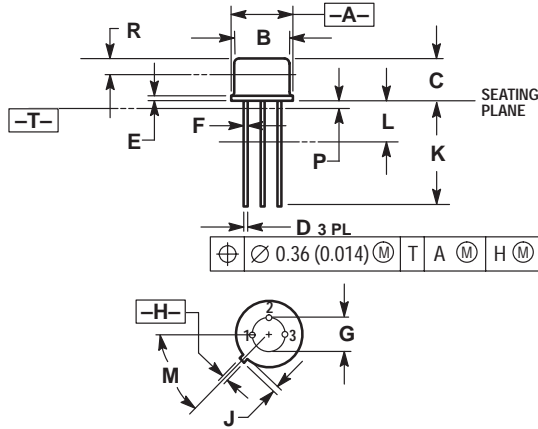


Figure 13. Storage Time and Fall Time Equivalent Test Circuit

LIFETIME BUY

LAST SHIP 21/03/00  
LAST ORDER 23/09/99

PACKAGE DIMENSIONS

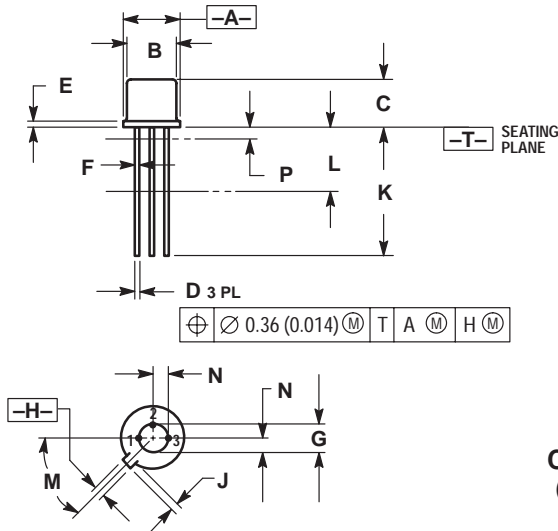


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
  4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
  5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.335	0.370	8.51	9.39
B	0.305	0.335	7.75	8.50
C	0.240	0.260	6.10	6.60
D	0.016	0.021	0.41	0.53
E	0.009	0.041	0.23	1.04
F	0.016	0.019	0.41	0.48
G	0.200 BSC		5.08 BSC	
H	0.028	0.034	0.72	0.86
J	0.029	0.045	0.74	1.14
K	0.500	0.750	12.70	19.05
L	0.250	---	6.35	---
M	45° BSC		45° BSC	
P	---	0.050	---	1.27
R	0.100	---	2.54	---

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

CASE 079-04  
 (TO-205AD)  
 ISSUE N



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
  4. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.
  5. DIMENSION E INCLUDES THE TAB THICKNESS. (TAB THICKNESS IS 0.51(0.002) MAXIMUM).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.170	0.210	4.32	5.33
D	0.016	0.021	0.406	0.533
E	---	0.030	---	0.762
F	0.016	0.019	0.406	0.483
G	0.100 BSC		2.54 BSC	
H	0.036	0.046	0.914	1.17
J	0.028	0.048	0.711	1.22
K	0.500	---	12.70	---
L	0.250	---	6.35	---
M	45° BSC		45° BSC	
N	0.050 BSC		1.27 BSC	
P	---	0.050	---	1.27

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

CASE 022-03  
 (TO-206AA)  
 ISSUE N

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 which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. 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/Locations Not Listed:** Motorola Literature Distribution;  
 P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

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

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



LIFETIME BUY

LAST SHIP 21/03/00  
 LAST ORDER 23/09/99