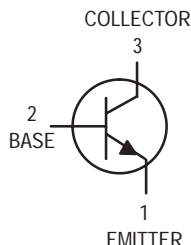


# General Purpose Transistors

## NPN Silicon

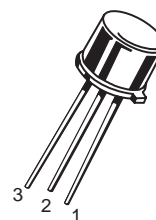


**2N2219**  
**2N2219A\***  
**2N2222**  
**2N2222A\***

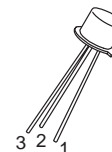
\*Motorola Preferred Devices

### 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)

### HERMAL 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
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### 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 ( $I_C = 10 \text{ }\mu\text{Adc}, I_E = 0$ )	Non–A Suffix A–Suffix	$V_{(BR)CBO}$	60 75	— —	Vdc
Emitter–Base Breakdown Voltage ( $I_E = 10 \text{ }\mu\text{Adc}, I_C = 0$ )	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)

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

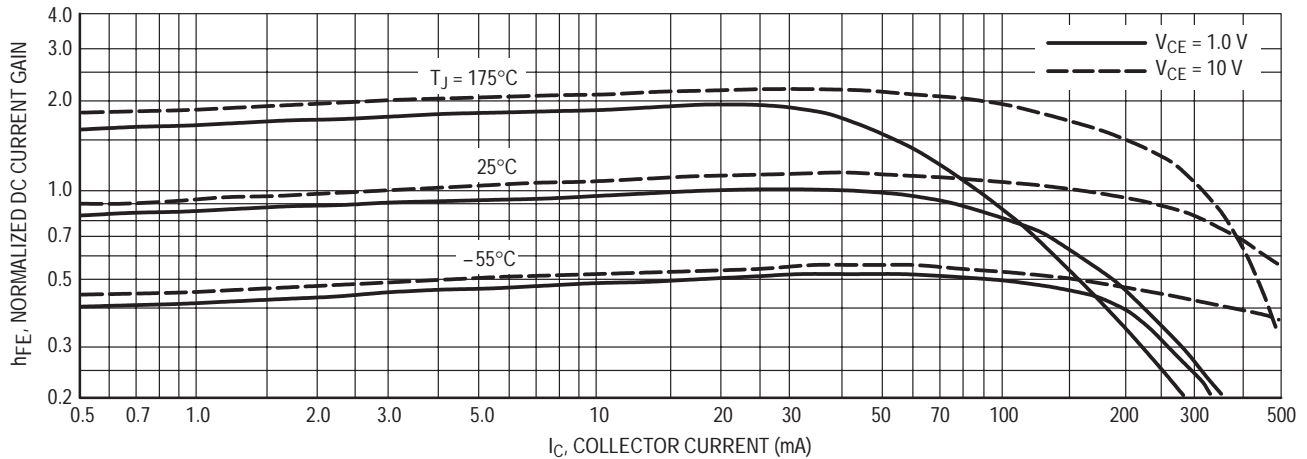
**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit	
<b>ON CHARACTERISTICS</b>					
DC Current Gain ( $I_C = 0.1\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) ( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) <sup>(1)</sup> ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $T_A = -55^\circ\text{C}$ ) <sup>(1)</sup> ( $I_C = 150\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) <sup>(1)</sup> ( $I_C = 150\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ ) <sup>(1)</sup> ( $I_C = 500\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) <sup>(1)</sup>	2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222,A 2N2219,A, 2N2222A 2N2219,A, 2N2222A 2N2219, 2N2222 2N2219A, 2N2222A	$h_{FE}$	35 50 75 35 100 50 30 40	— — — — 300 — — —	
Collector–Emitter Saturation Voltage <sup>(1)</sup> ( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )  ( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )	Non–A Suffix A–Suffix  Non–A Suffix A–Suffix	$V_{CE(sat)}$	— — — —	0.4 0.3 1.6 1.0	Vdc
Base–Emitter Saturation Voltage <sup>(1)</sup> ( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )  ( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )	Non–A Suffix A–Suffix  Non–A Suffix A–Suffix	$V_{BE(sat)}$	0.6 0.6 — —	1.3 1.2 2.6 2.0	Vdc
<b>MALL–SIGNAL CHARACTERISTICS</b>					
Current–Gain — Bandwidth Product <sup>(2)</sup> ( $I_C = 20\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ )	All Types, Except 2N2219A, 2N2222A	$f_T$	250 300	— —	MHz
Output Capacitance <sup>(3)</sup> ( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )		$C_{obo}$	—	8.0	pF
Input Capacitance <sup>(3)</sup> ( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )	Non–A Suffix A–Suffix	$C_{ibo}$	— —	30 25	pF
Input Impedance ( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	2N2219A, 2N2222A 2N2219A, 2N2222A	$h_{je}$	2.0 0.25	8.0 1.25	k $\Omega$
Voltage Feedback Ratio ( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	2N2219A, 2N2222A 2N2219A, 2N2222A	$h_{re}$	— —	8.0 4.0	$\times 10^{-4}$
Small–Signal Current Gain ( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	2N2219A, 2N2222A 2N2219A, 2N2222A	$h_{fe}$	50 75	300 375	—
Output Admittance ( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) ( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )	2N2219A, 2N2222A 2N2219A, 2N2222A	$h_{oe}$	5.0 15	35 200	$\mu\text{mhos}$
Collector Base Time Constant ( $I_E = 20\text{ mA}$ , $V_{CB} = 20\text{ Vdc}$ , $f = 31.8\text{ MHz}$ )	A–Suffix	$r_b'C_c$	—	150	ps
Noise Figure ( $I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 10\text{ Vdc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )	2N2222A	NF	—	4.0	dB
Real Part of Common–Emitter High Frequency Input Impedance ( $I_C = 20\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 300\text{ MHz}$ )	2N2219A, 2N2222A	$\text{Re}(h_{ie})$	—	60	$\Omega$

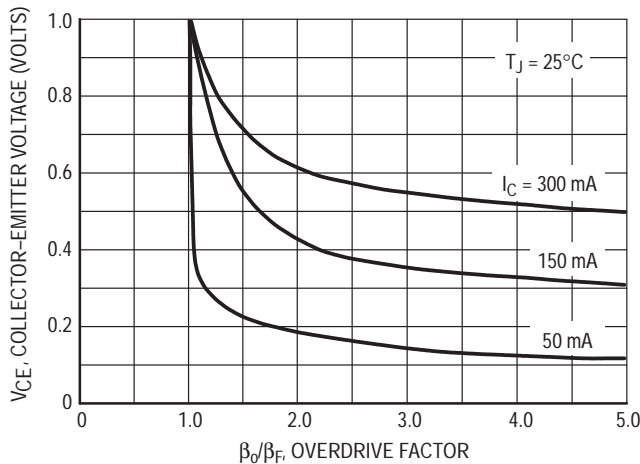
1. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .
2.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.
3. 2N5581 and 2N5582 are listed  $C_{cb}$  and  $C_{eb}$  for these conditions and values.

**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:

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

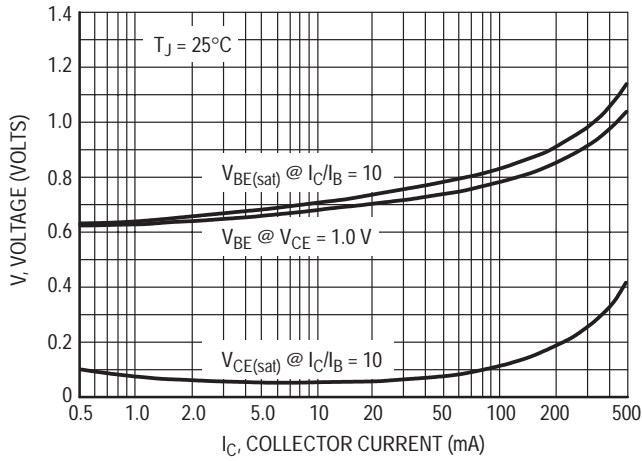


Figure 3. "On" Voltages

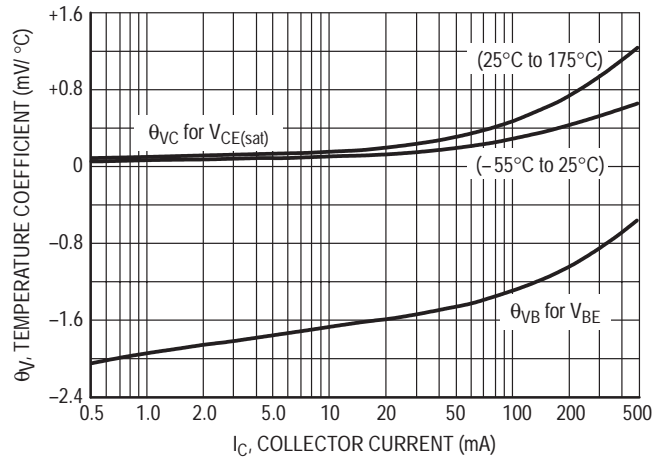


Figure 4. Temperature Coefficients

**h PARAMETERS**

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

This group of graphs illustrates the relationship between  $h_{re}$  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.

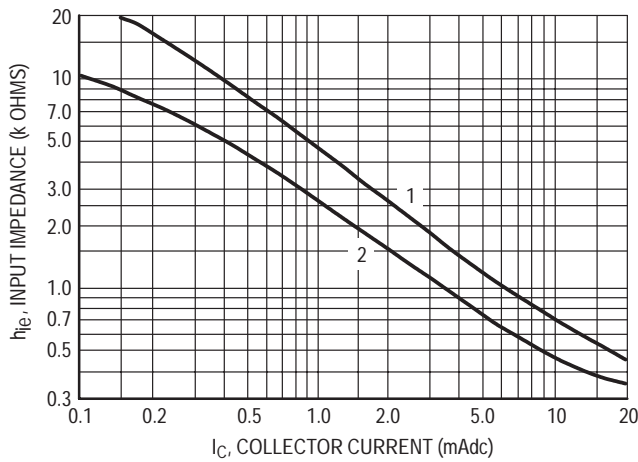


Figure 5. Input Impedance

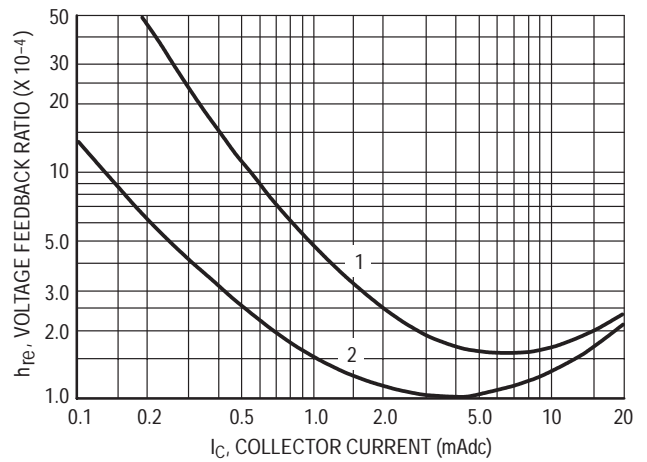


Figure 6. Voltage Feedback Ratio

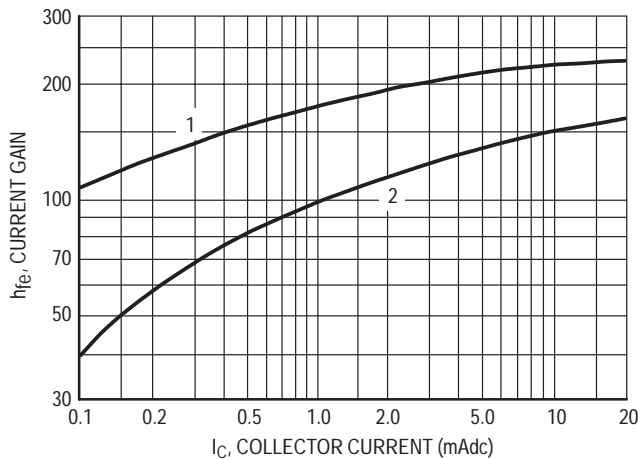


Figure 7. Current Gain

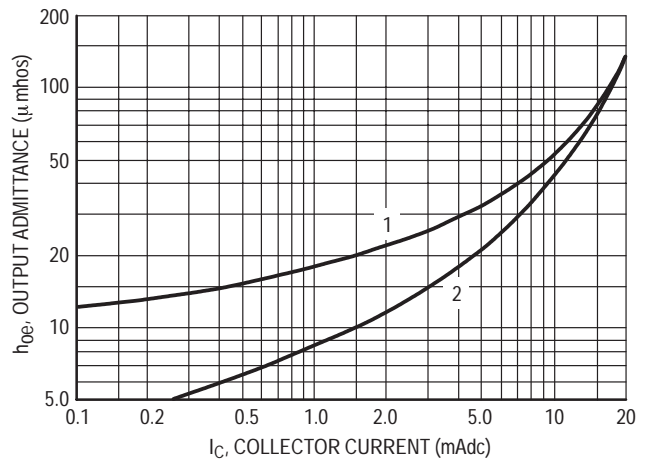


Figure 8. Output Admittance

SWITCHING TIME CHARACTERISTICS

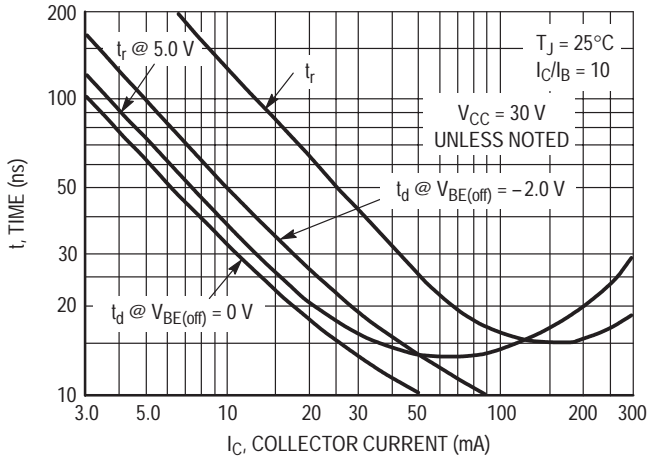


Figure 9. Turn-On Time

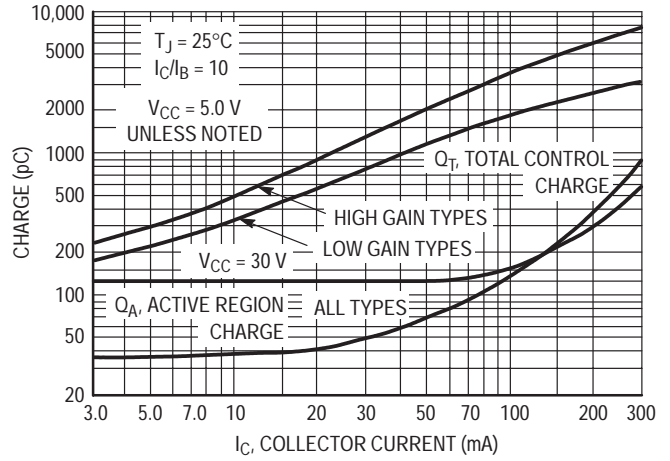


Figure 10. Charge Data

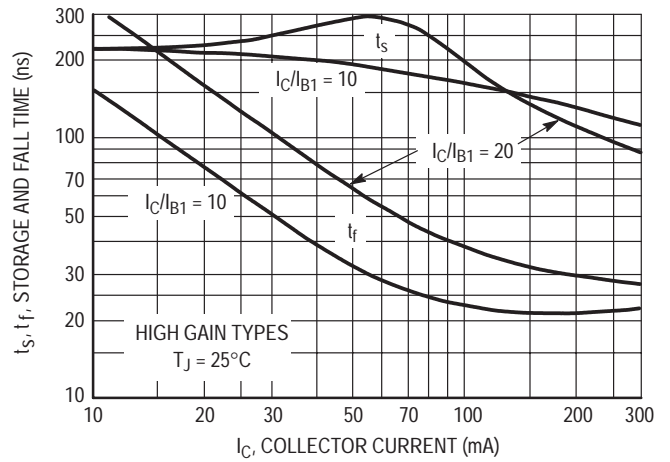
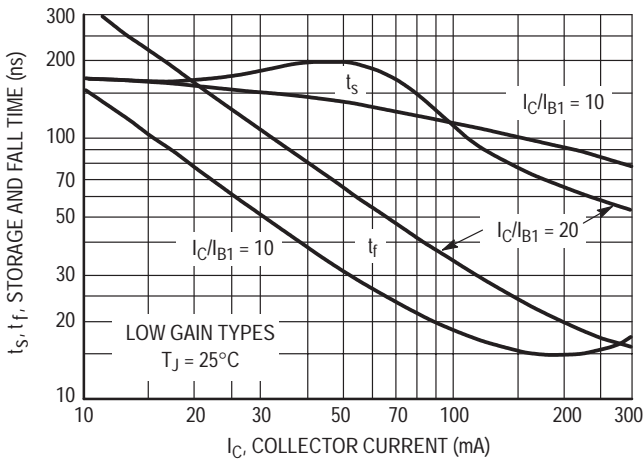


Figure 11. Turn-Off Behavior

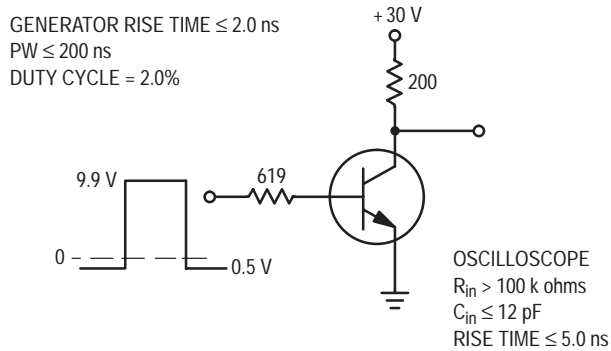


Figure 12. Delay and Rise Time Equivalent Test Circuit

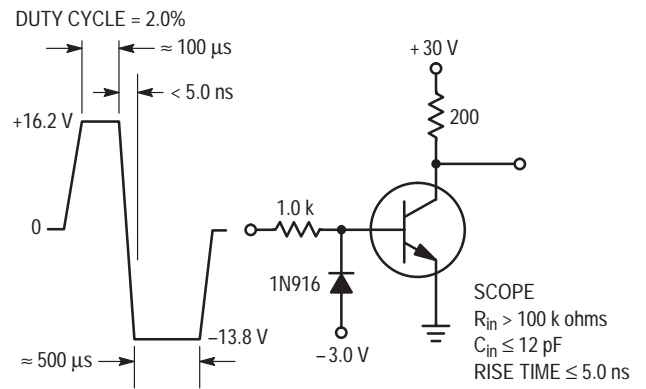


Figure 13. Storage Time and Fall Time Equivalent Test Circuit

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**

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