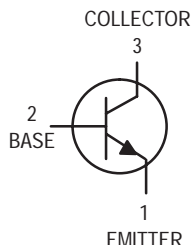


General Purpose Transistors

NPN Silicon

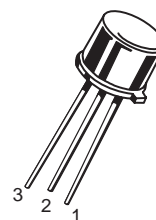


2N2219
2N2219A*
2N2222
2N2222A*

*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
		2N2219,A	2N2222,A	
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°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°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	μAdc
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)

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.1\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ($I_C = 1.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ($I_C = 10\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ⁽¹⁾ ($I_C = 10\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $T_A = -55^\circ\text{C}$) ⁽¹⁾ ($I_C = 150\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ⁽¹⁾ ($I_C = 150\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ⁽¹⁾ ($I_C = 500\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ⁽¹⁾	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_{FE}	35 50 75 35 100 50 30 40	— — — — 300 — — —
Collector–Emitter Saturation Voltage ⁽¹⁾ ($I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$) ($I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$)	Non–A Suffix A–Suffix Non–A Suffix A–Suffix	$V_{CE(sat)}$	— — — —	0.4 0.3 1.6 1.0
Base–Emitter Saturation Voltage ⁽¹⁾ ($I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$) ($I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$)	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
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product ⁽²⁾ ($I_C = 20\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$)	All Types, Except 2N2219A, 2N2222A	f_T	250 300	— —
Output Capacitance ⁽³⁾ ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)		C_{obo}	—	8.0
Input Capacitance ⁽³⁾ ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$)	Non–A Suffix A–Suffix	C_{ibo}	— —	30 25
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
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
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
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
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
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	$\text{Re}(h_{je})$	—	60

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.

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
SWITCHING CHARACTERISTICS					
Delay Time	$(V_{CC} = 30\text{ Vdc}, V_{BE(off)} = -0.5\text{ Vdc}, I_C = 150\text{ mA}, I_{B1} = 15\text{ mA})$ (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

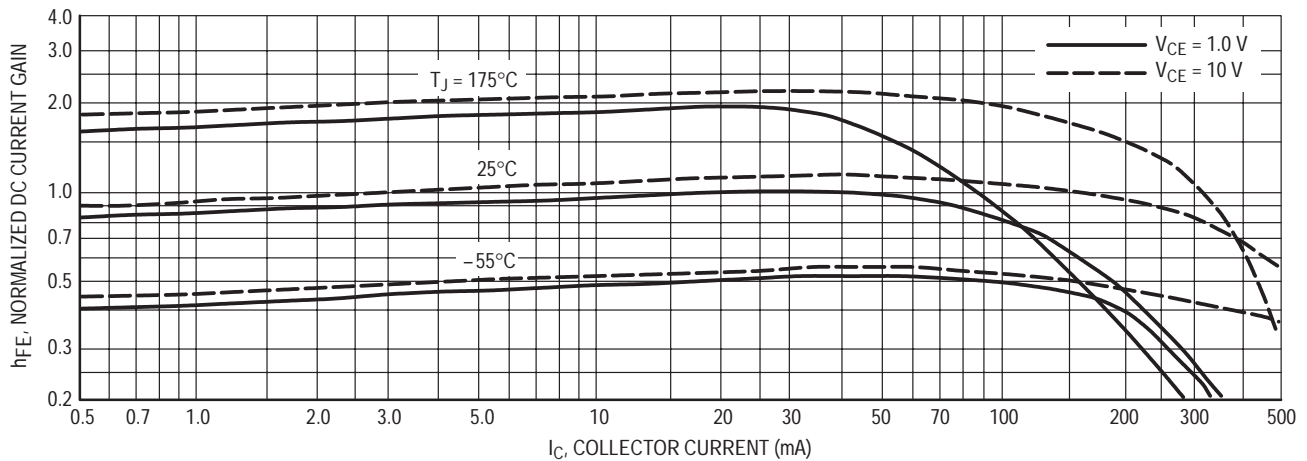


Figure 1. Normalized DC Current Gain

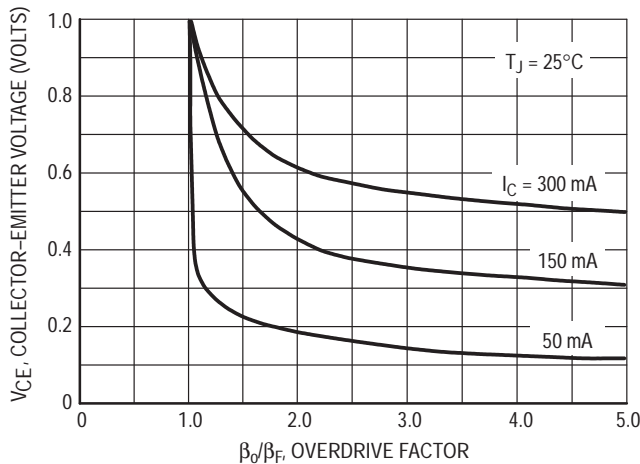


Figure 2. Collector Characteristics in Saturation Region

This graph shows the effect of base current on collector current. β_o (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_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°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

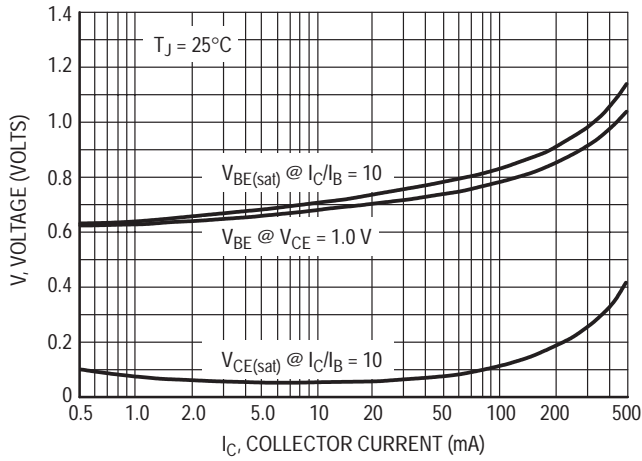


Figure 3. "On" Voltages

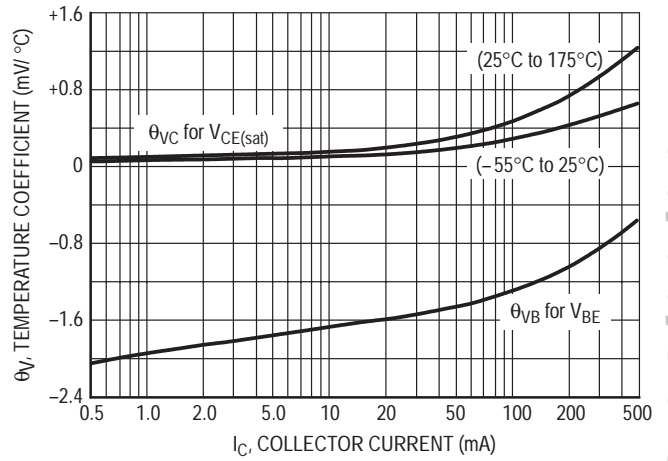


Figure 4. Temperature Coefficients

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.

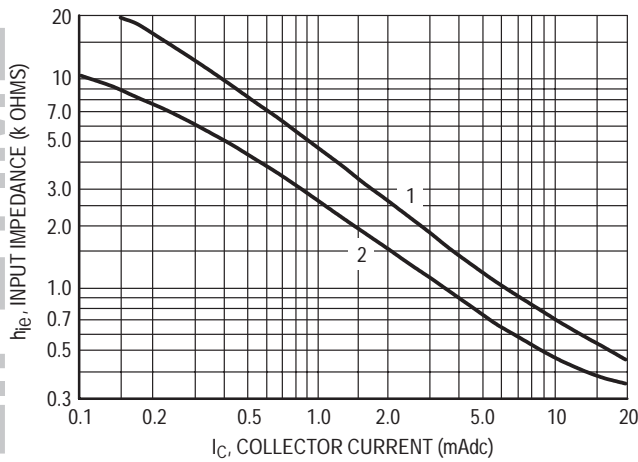


Figure 5. Input Impedance

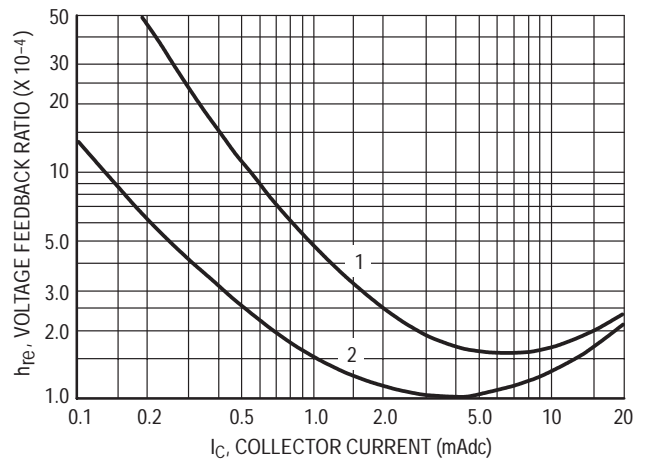


Figure 6. Voltage Feedback Ratio

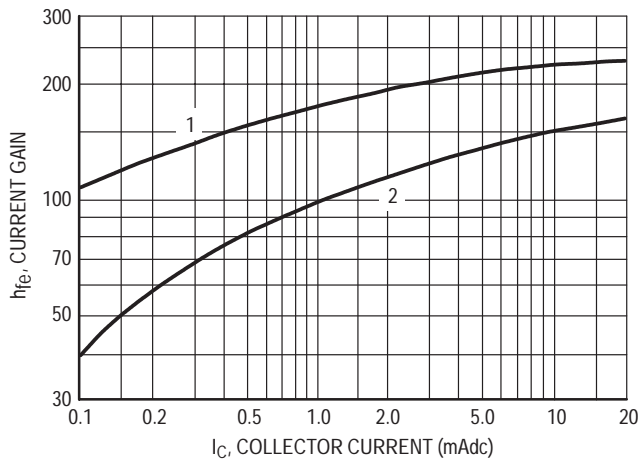


Figure 7. Current Gain

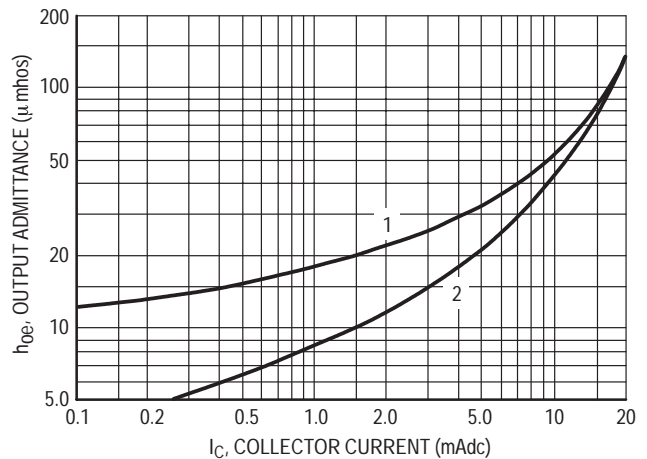


Figure 8. Output Admittance

LIFETIME BUY

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

SWITCHING TIME CHARACTERISTICS

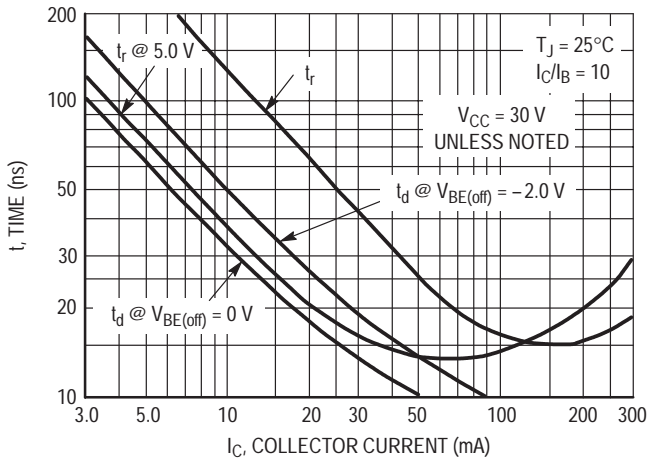


Figure 9. Turn-On Time

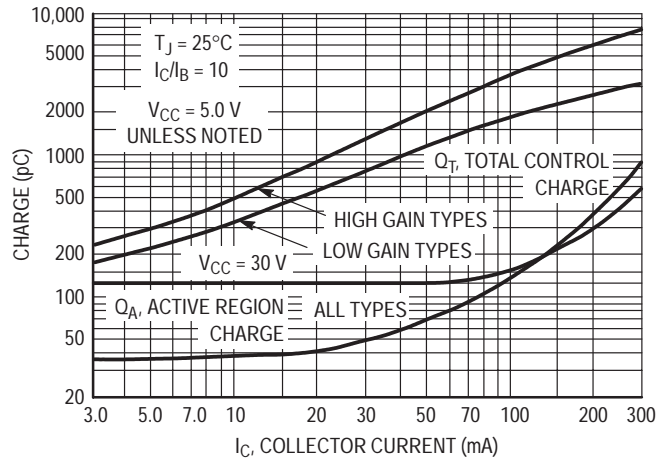


Figure 10. Charge Data

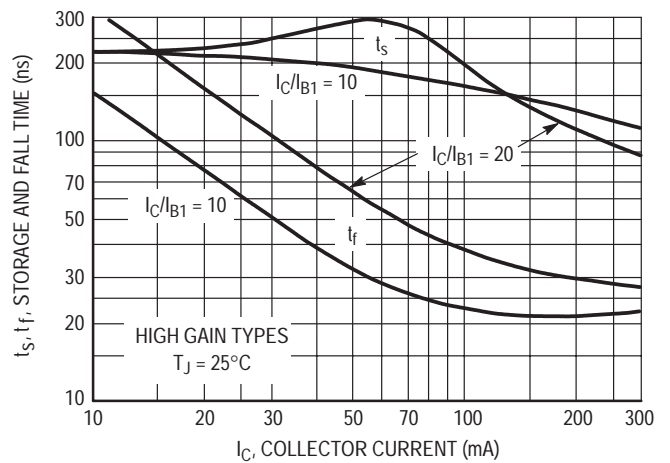
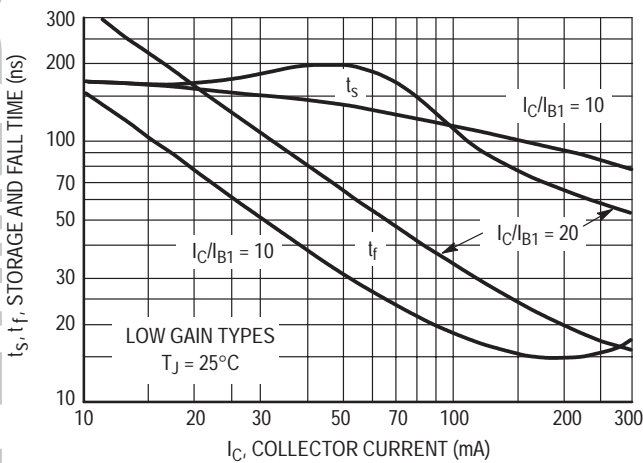


Figure 11. Turn-Off Behavior

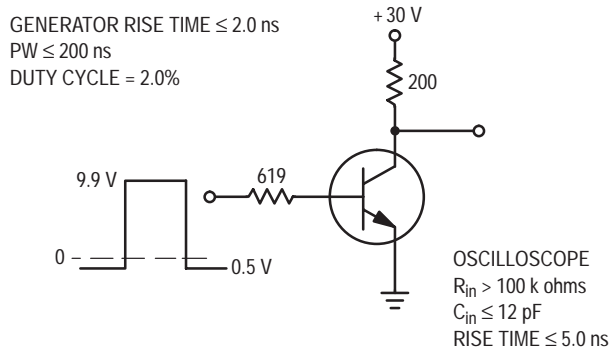


Figure 12. Delay and Rise Time Equivalent Test Circuit

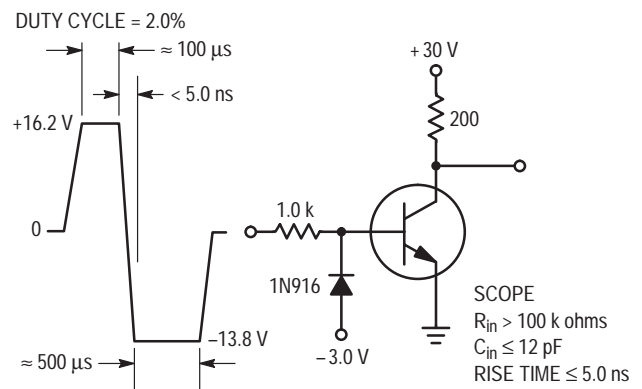
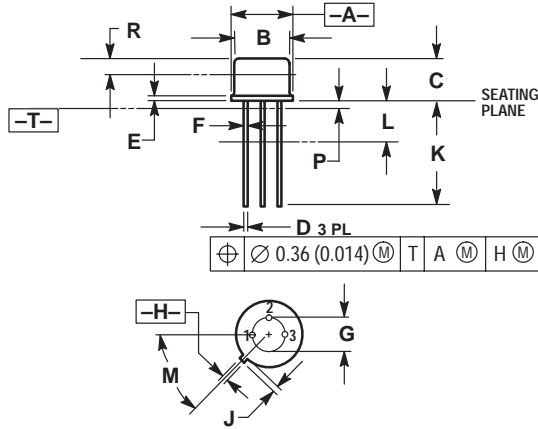


Figure 13. Storage Time and Fall Time Equivalent Test Circuit

LIFETIME BUY

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

PACKAGE DIMENSIONS

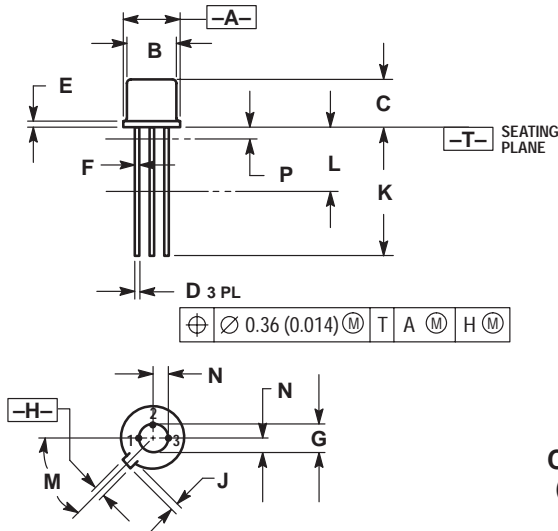


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P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