

General Purpose Transistors

NPN Silicon

2N3903, 2N3904

Features

- Pb-Free Packages are Available*

MAXIMUM RATINGS

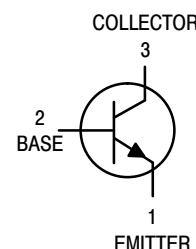
Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V_{CEO}	40	Vdc
Collector – Base Voltage	V_{CBO}	60	Vdc
Emitter – Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	625 5.0	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	1.5 12	W mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS (Note 1)

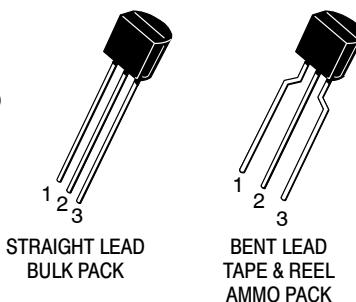
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	200	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	83.3	$^\circ\text{C}/\text{W}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

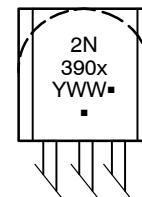
1. Indicates Data in addition to JEDEC Requirements.



TO-92
CASE 29
STYLE 1



MARKING DIAGRAMS



X = 3 or 4
Y = Year
WW = Work Week
■ = Pb-Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

*For additional information on our Pb-Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

2N3903, 2N3904

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector – Emitter Breakdown Voltage (Note 2) ($I_C = 1.0 \text{ mA}_\text{dc}$, $I_B = 0$)	$V_{(\text{BR})\text{CEO}}$	40	–	Vdc
Collector – Base Breakdown Voltage ($I_C = 10 \mu\text{A}_\text{dc}$, $I_E = 0$)	$V_{(\text{BR})\text{CBO}}$	60	–	Vdc
Emitter – Base Breakdown Voltage ($I_E = 10 \mu\text{A}_\text{dc}$, $I_C = 0$)	$V_{(\text{BR})\text{EBO}}$	6.0	–	Vdc
Base Cutoff Current ($V_{\text{CE}} = 30 \text{ Vdc}$, $V_{\text{EB}} = 3.0 \text{ Vdc}$)	I_{BL}	–	50	nAdc
Collector Cutoff Current ($V_{\text{CE}} = 30 \text{ Vdc}$, $V_{\text{EB}} = 3.0 \text{ Vdc}$)	I_{CEX}	–	50	nAdc

ON CHARACTERISTICS

DC Current Gain (Note 2) ($I_C = 0.1 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 1.0 \text{ Vdc}$) ($I_C = 1.0 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 1.0 \text{ Vdc}$) ($I_C = 50 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 1.0 \text{ Vdc}$) ($I_C = 100 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 1.0 \text{ Vdc}$)	2N3903 2N3904 2N3903 2N3904 2N3903 2N3904 2N3903 2N3904 2N3903 2N3904	h_{FE}	20 40 35 70 50 100 30 60 15 30	– – – – 150 300 – – – –	– – – – –
Collector – Emitter Saturation Voltage (Note 2) ($I_C = 10 \text{ mA}_\text{dc}$, $I_B = 1.0 \text{ mA}_\text{dc}$) ($I_C = 50 \text{ mA}_\text{dc}$, $I_B = 5.0 \text{ mA}_\text{dc}$)		$V_{\text{CE}(\text{sat})}$	– –	0.2 0.3	Vdc
Base – Emitter Saturation Voltage (Note 2) ($I_C = 10 \text{ mA}_\text{dc}$, $I_B = 1.0 \text{ mA}_\text{dc}$) ($I_C = 50 \text{ mA}_\text{dc}$, $I_B = 5.0 \text{ mA}_\text{dc}$)		$V_{\text{BE}(\text{sat})}$	0.65 –	0.85 0.95	Vdc

SMALL-SIGNAL CHARACTERISTICS

Current-Gain – Bandwidth Product ($I_C = 10 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 20 \text{ Vdc}$, $f = 100 \text{ MHz}$)	2N3903 2N3904	f_T	250 300	– –	MHz
Output Capacitance ($V_{\text{CB}} = 5.0 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)		C_{obo}	–	4.0	pF
Input Capacitance ($V_{\text{EB}} = 0.5 \text{ Vdc}$, $I_C = 0$, $f = 1.0 \text{ MHz}$)		C_{ibo}	–	8.0	pF
Input Impedance ($I_C = 1.0 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	2N3903 2N3904	h_{ie}	1.0 1.0	8.0 10	k Ω
Voltage Feedback Ratio ($I_C = 1.0 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	2N3903 2N3904	h_{re}	0.1 0.5	5.0 8.0	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	2N3903 2N3904	h_{fe}	50 100	200 400	–
Output Admittance ($I_C = 1.0 \text{ mA}_\text{dc}$, $V_{\text{CE}} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)		h_{oe}	1.0	40	μmhos
Noise Figure ($I_C = 100 \mu\text{A}_\text{dc}$, $V_{\text{CE}} = 5.0 \text{ Vdc}$, $R_S = 1.0 \text{ k } \Omega$, $f = 1.0 \text{ kHz}$)	2N3903 2N3904	NF	– –	6.0 5.0	dB

SWITCHING CHARACTERISTICS

Delay Time	($V_{\text{CC}} = 3.0 \text{ Vdc}$, $V_{\text{BE}} = 0.5 \text{ Vdc}$, $I_C = 10 \text{ mA}_\text{dc}$, $I_{B1} = 1.0 \text{ mA}_\text{dc}$)	t_d	–	35	ns
Rise Time		t_r	–	35	ns
Storage Time	($V_{\text{CC}} = 3.0 \text{ Vdc}$, $I_C = 10 \text{ mA}_\text{dc}$, $I_{B1} = I_{B2} = 1.0 \text{ mA}_\text{dc}$)	t_s	– –	175 200	ns
Fall Time		t_f	–	50	ns

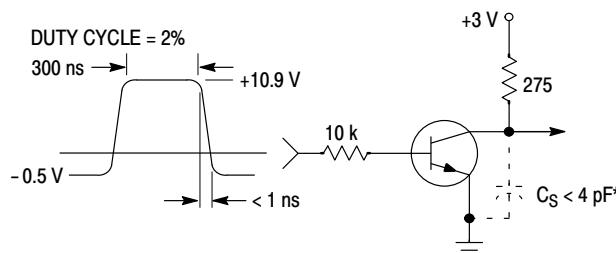
2. Pulse Test: Pulse Width $\leq 300 \mu\text{s}$; Duty Cycle $\leq 2\%$.

2N3903, 2N3904

ORDERING INFORMATION

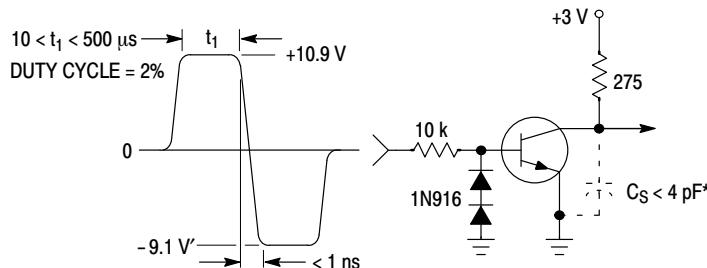
Device	Package	Shipping [†]
2N3903RLRM	TO-92	2000 / Ammo Pack
2N3904	TO-92	5000 Units / Bulk
2N3904G	TO-92 (Pb-Free)	5000 Units / Bulk
2N3904RLRA	TO-92	2000 / Tape & Reel
2N3904RLRAG	TO-92 (Pb-Free)	2000 / Tape & Reel
2N3904RLRM	TO-92	2000 / Ammo Pack
2N3904RLRMG	TO-92 (Pb-Free)	2000 / Ammo Pack
2N3904RLRP	TO-92	2000 / Ammo Pack
2N3904RLRPG	TO-92 (Pb-Free)	2000 / Ammo Pack
2N3904RL1G	TO-92 (Pb-Free)	2000 / Tape & Reel
2N3904ZL1	TO-92	2000 / Ammo Pack
2N3904ZL1G	TO-92 (Pb-Free)	2000 / Ammo Pack

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit



* Total shunt capacitance of test jig and connectors

Figure 2. Storage and Fall Time Equivalent Test Circuit

2N3903, 2N3904

TYPICAL TRANSIENT CHARACTERISTICS

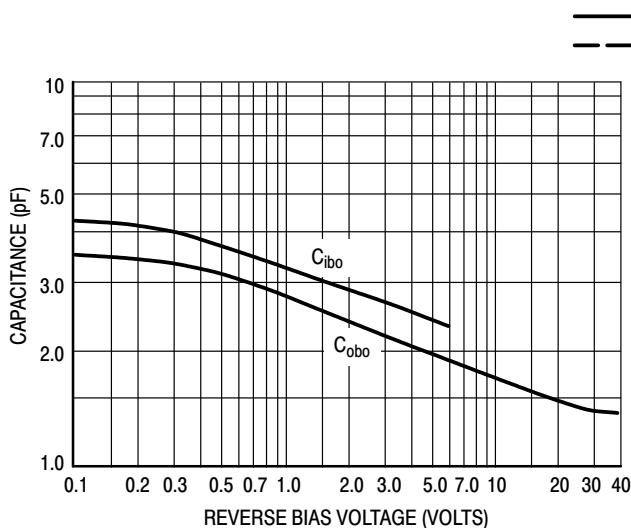


Figure 3. Capacitance

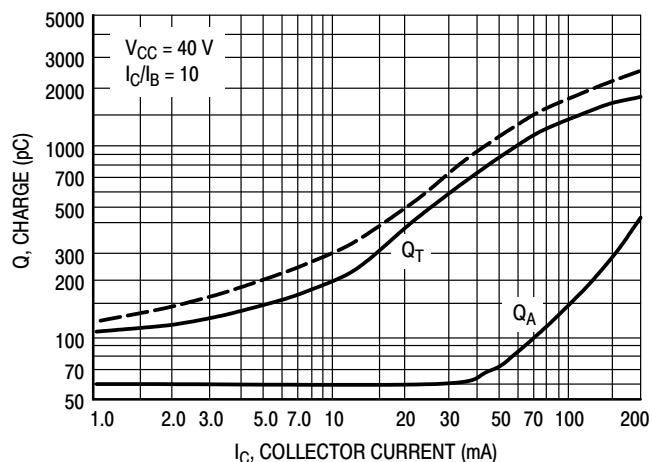


Figure 4. Charge Data

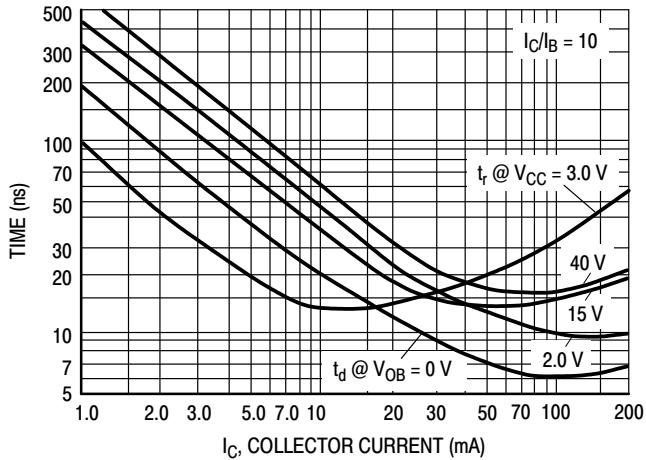


Figure 5. Turn-On Time

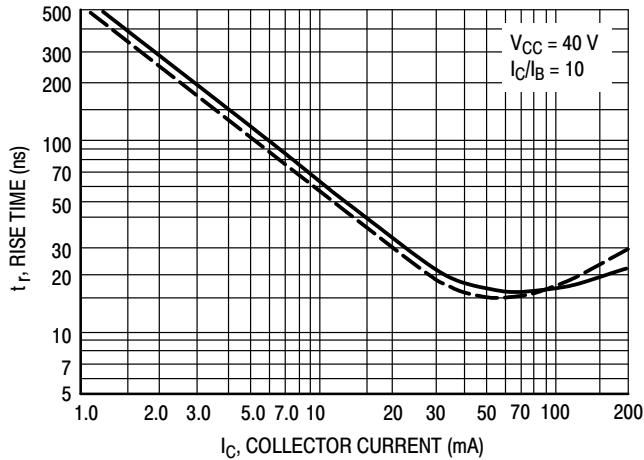


Figure 6. Rise Time

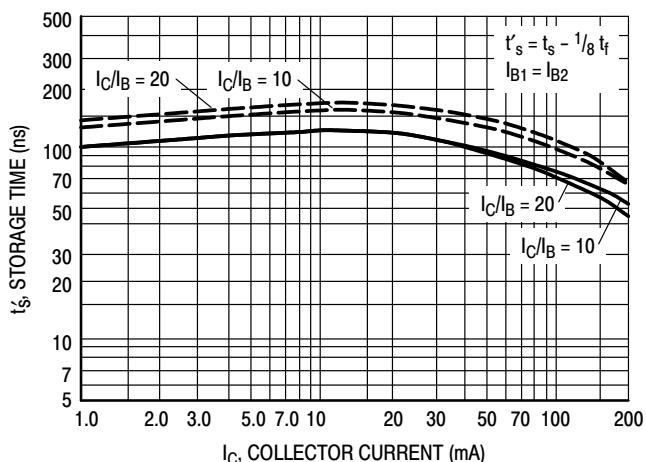


Figure 7. Storage Time

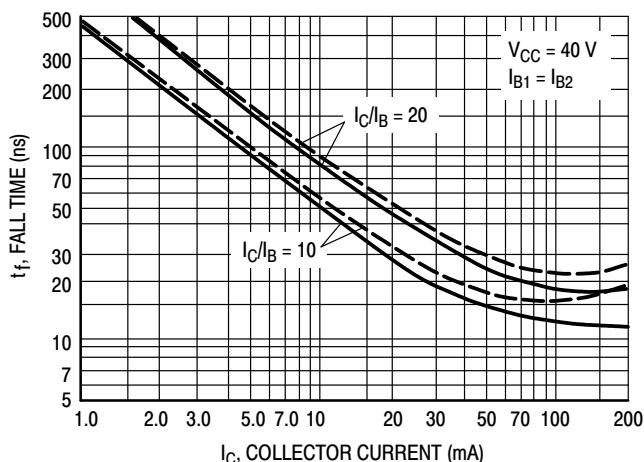


Figure 8. Fall Time

2N3903, 2N3904

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

($V_{CE} = 5.0$ Vdc, $T_A = 25^\circ\text{C}$, Bandwidth = 1.0 Hz)

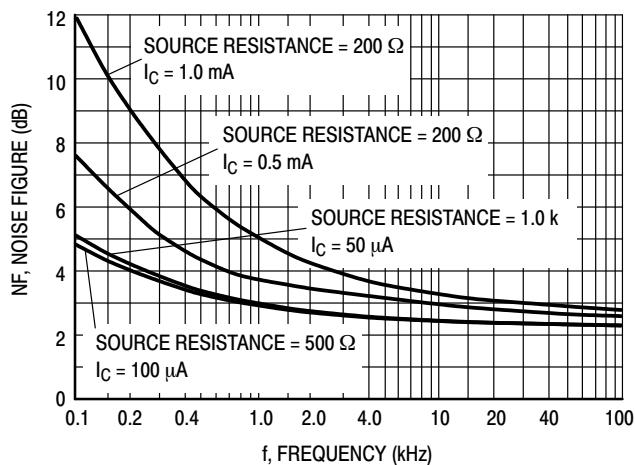


Figure 9.

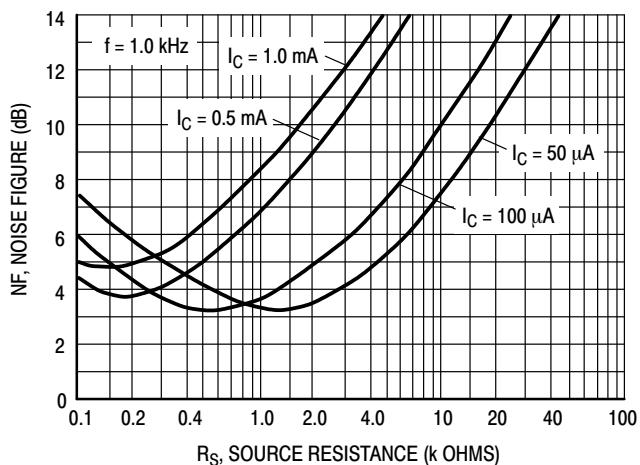


Figure 10.

h PARAMETERS

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

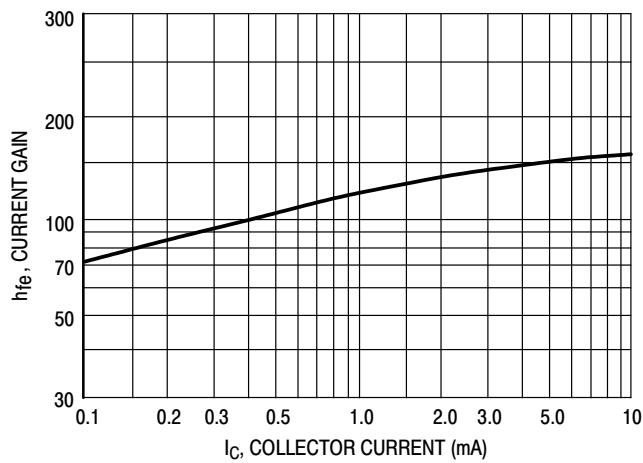


Figure 11. Current Gain

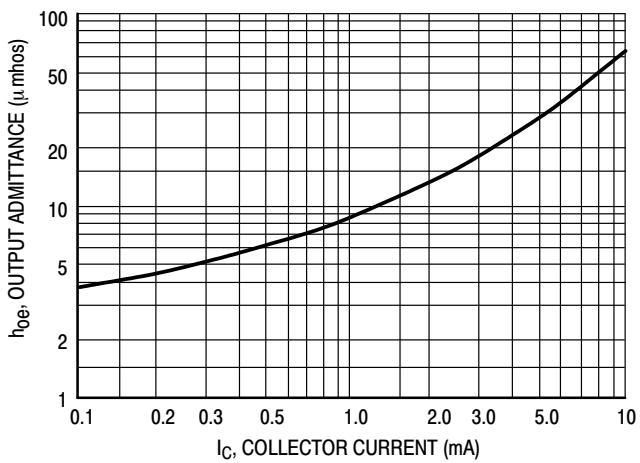


Figure 12. Output Admittance

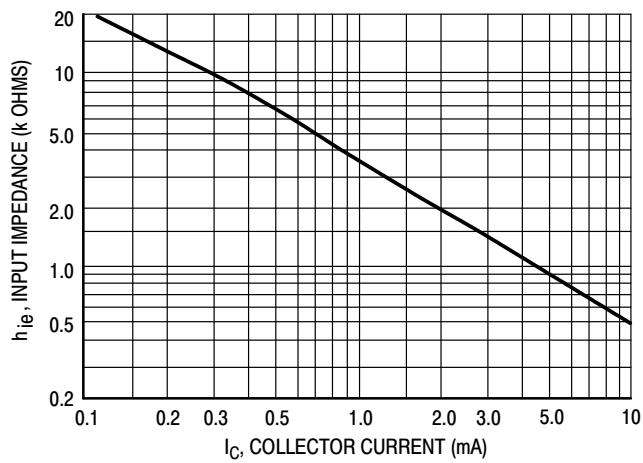


Figure 13. Input Impedance

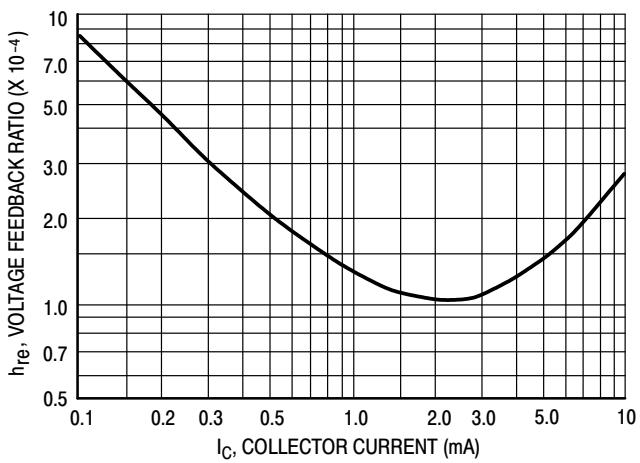


Figure 14. Voltage Feedback Ratio

2N3903, 2N3904

TYPICAL STATIC CHARACTERISTICS

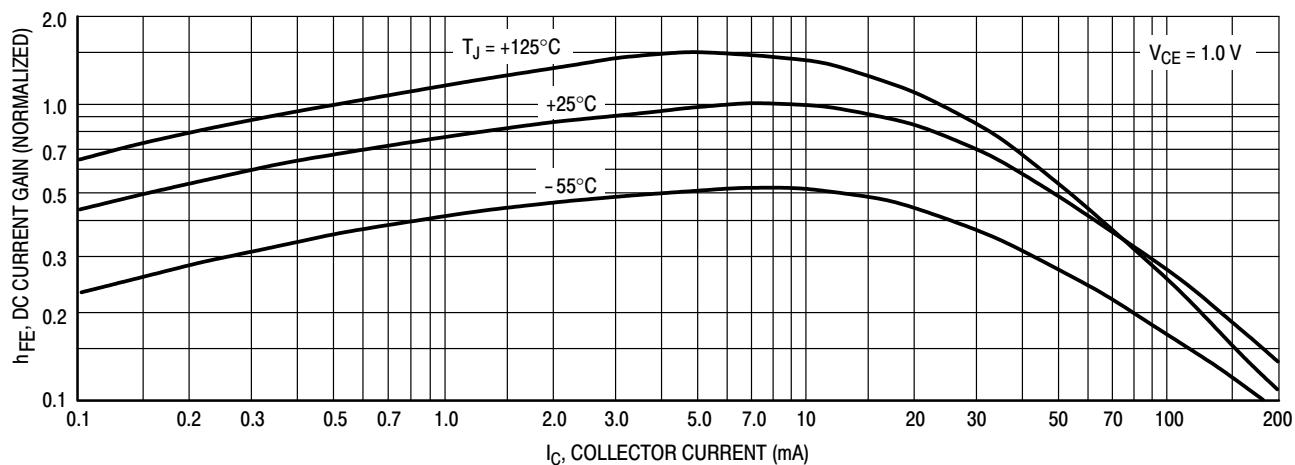


Figure 15. DC Current Gain

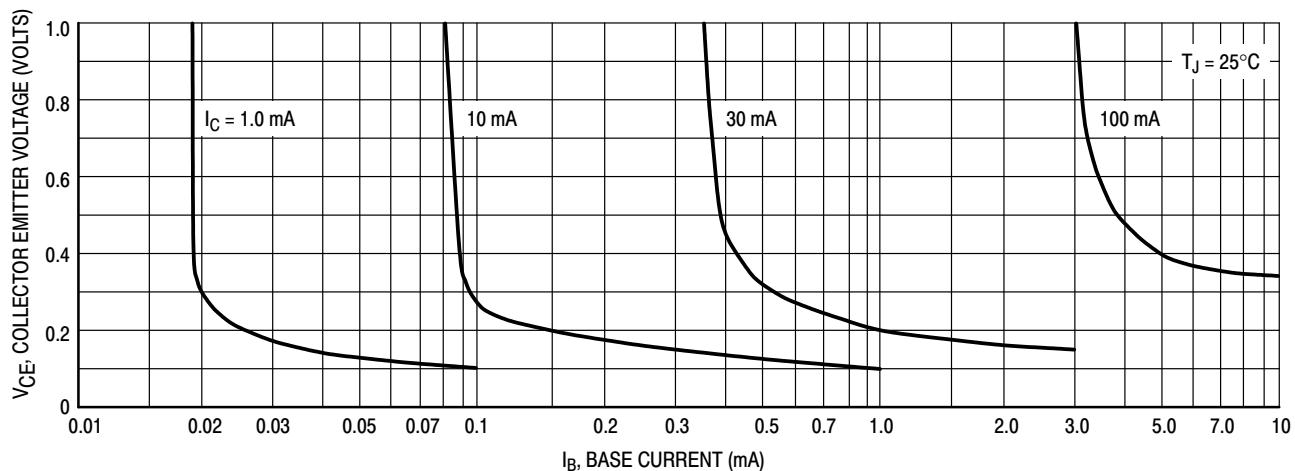


Figure 16. Collector Saturation Region

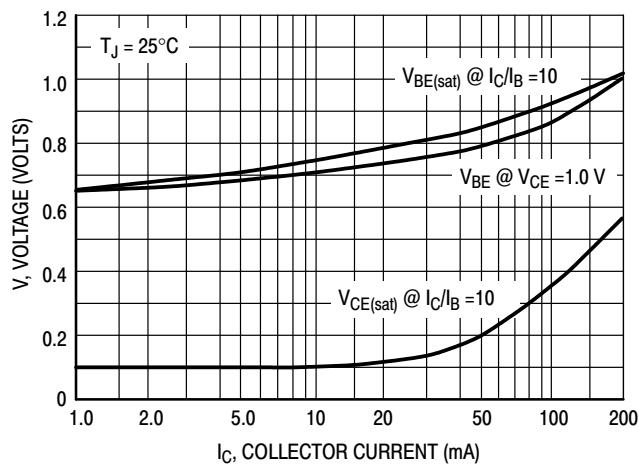


Figure 17. "ON" Voltages

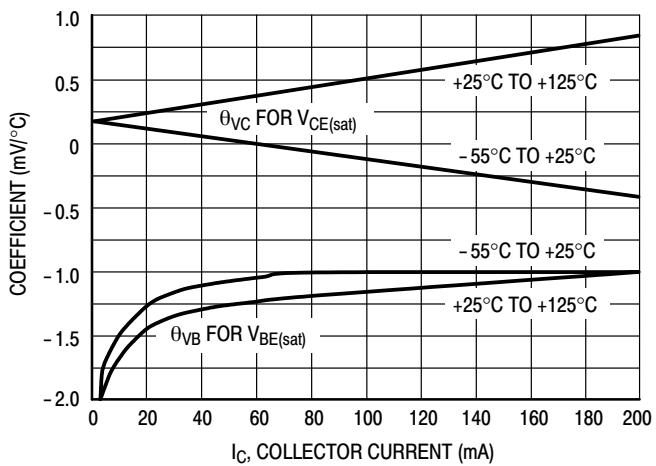
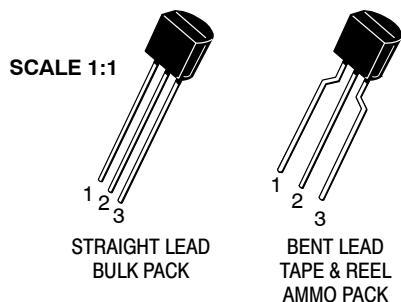
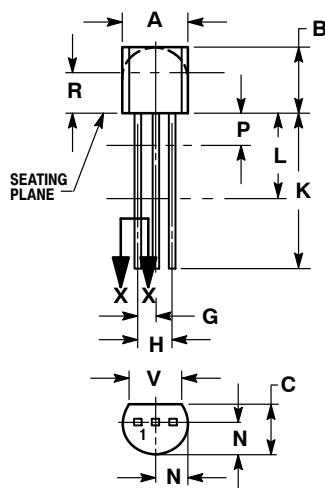


Figure 18. Temperature Coefficients

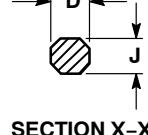


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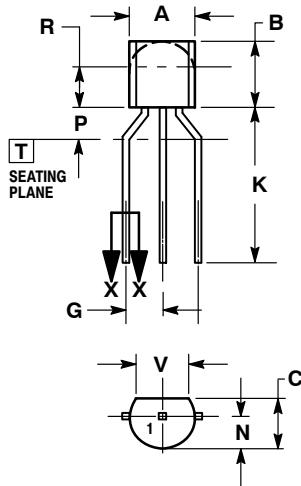


STRAIGHT LEAD
BULK PACK

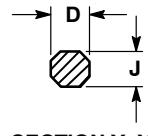


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
 4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
 2. CONTROLLING DIMENSION: MILLIMETERS.
 3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
 4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS	
	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLES ON PAGE 2

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CASE 29-11

ISSUE AM

DATE 09 MAR 2007

STYLE 1: PIN 1. Emitter 2. Base 3. Collector	STYLE 2: PIN 1. Base 2. Emitter 3. Collector	STYLE 3: PIN 1. Anode 2. Anode 3. Cathode	STYLE 4: PIN 1. Cathode 2. Cathode 3. Anode	STYLE 5: PIN 1. Drain 2. Source 3. Gate
STYLE 6: PIN 1. Gate 2. Source & Substrate 3. Drain	STYLE 7: PIN 1. Source 2. Drain 3. Gate	STYLE 8: PIN 1. Drain 2. Gate 3. Source & Substrate	STYLE 9: PIN 1. Base 1 2. Emitter 3. Base 2	STYLE 10: PIN 1. Cathode 2. Gate 3. Anode
STYLE 11: PIN 1. Anode 2. Cathode & Anode 3. Cathode	STYLE 12: PIN 1. Main Terminal 1 2. Gate 3. Main Terminal 2	STYLE 13: PIN 1. Anode 1 2. Gate 3. Cathode 2	STYLE 14: PIN 1. Emitter 2. Collector 3. Base	STYLE 15: PIN 1. Anode 1 2. Cathode 3. Anode 2
STYLE 16: PIN 1. Anode 2. Gate 3. Cathode	STYLE 17: PIN 1. Collector 2. Base 3. Emitter	STYLE 18: PIN 1. Anode 2. Cathode 3. Not Connected	STYLE 19: PIN 1. Gate 2. Anode 3. Cathode	STYLE 20: PIN 1. Not Connected 2. Cathode 3. Anode
STYLE 21: PIN 1. Collector 2. Emitter 3. Base	STYLE 22: PIN 1. Source 2. Gate 3. Drain	STYLE 23: PIN 1. Gate 2. Source 3. Drain	STYLE 24: PIN 1. Emitter 2. Collector/Anode 3. Cathode	STYLE 25: PIN 1. MT 1 2. Gate 3. MT 2
STYLE 26: PIN 1. V _{CC} 2. Ground 2 3. Output	STYLE 27: PIN 1. MT 2. Substrate 3. MT	STYLE 28: PIN 1. Cathode 2. Anode 3. Gate	STYLE 29: PIN 1. Not Connected 2. Anode 3. Cathode	STYLE 30: PIN 1. Drain 2. Gate 3. Source
STYLE 31: PIN 1. Gate 2. Drain 3. Source	STYLE 32: PIN 1. Base 2. Collector 3. Emitter	STYLE 33: PIN 1. Return 2. Input 3. Output	STYLE 34: PIN 1. Input 2. Ground 3. Logic	STYLE 35: PIN 1. Gate 2. Collector 3. Emitter

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