

2N3903, 2N3904

2N3903 is a Preferred Device

General Purpose Transistors

NPN Silicon

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	$^\circ\text{C}$

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

THERMAL CHARACTERISTICS (Note 1)

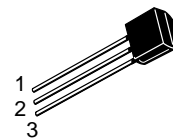
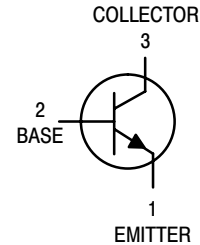
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	200	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	83.3	$^\circ\text{C}/\text{W}$

1. Indicates Data in addition to JEDEC Requirements.



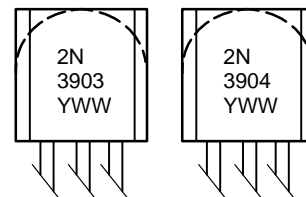
ON Semiconductor®

<http://onsemi.com>



TO-92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

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

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

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

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 2) (I _C = 1.0 mA _{dc} , I _B = 0)	V _{(BR)CEO}	40	–	Vdc
Collector–Base Breakdown Voltage (I _C = 10 μA _{dc} , I _E = 0)	V _{(BR)CBO}	60	–	Vdc
Emitter–Base Breakdown Voltage (I _E = 10 μA _{dc} , I _C = 0)	V _{(BR)EBO}	6.0	–	Vdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	I _{BL}	–	50	nA _{dc}
Collector Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	I _{CEX}	–	50	nA _{dc}

ON CHARACTERISTICS

DC Current Gain (Note 2)	2N3903 2N3904	h _{FE}	20 40	– –	– –
(I _C = 0.1 mA _{dc} , V _{CE} = 1.0 Vdc)					
	2N3903 2N3904		35 70	– –	
(I _C = 1.0 mA _{dc} , V _{CE} = 1.0 Vdc)					
	2N3903 2N3904		50 100	150 300	
(I _C = 10 mA _{dc} , V _{CE} = 1.0 Vdc)					
	2N3903 2N3904		30 60	– –	
(I _C = 50 mA _{dc} , V _{CE} = 1.0 Vdc)					
	2N3903 2N3904		15 30	– –	
(I _C = 100 mA _{dc} , V _{CE} = 1.0 Vdc)					
Collector–Emitter Saturation Voltage (Note 2)		V _{CE(sat)}	– –	0.2 0.3	Vdc
(I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc}) (I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc})					
Base–Emitter Saturation Voltage (Note 2)		V _{BE(sat)}	0.65 –	0.85 0.95	Vdc
(I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc}) (I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc})					

SMALL–SIGNAL CHARACTERISTICS

Current–Gain – Bandwidth Product	2N3903 2N3904	f _T	250 300	– –	MHz
(I _C = 10 mA _{dc} , V _{CE} = 20 Vdc, f = 100 MHz)					
Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)		C _{obo}	–	4.0	pF
Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)		C _{ibo}	–	8.0	pF
Input Impedance	2N3903 2N3904	h _{ie}	1.0 1.0	8.0 10	k Ω
(I _C = 1.0 mA _{dc} , V _{CE} = 10 Vdc, f = 1.0 kHz)					
Voltage Feedback Ratio	2N3903 2N3904	h _{re}	0.1 0.5	5.0 8.0	X 10 ^{–4}
(I _C = 1.0 mA _{dc} , V _{CE} = 10 Vdc, f = 1.0 kHz)					
Small–Signal Current Gain	2N3903 2N3904	h _{fe}	50 100	200 400	–
(I _C = 1.0 mA _{dc} , V _{CE} = 10 Vdc, f = 1.0 kHz)					
Output Admittance (I _C = 1.0 mA _{dc} , V _{CE} = 10 Vdc, f = 1.0 kHz)		h _{oe}	1.0	40	μmhos
Noise Figure	2N3903 2N3904	NF	– –	6.0 5.0	dB
(I _C = 100 μA _{dc} , V _{CE} = 5.0 Vdc, R _S = 1.0 k Ω, f = 1.0 kHz)					

SWITCHING CHARACTERISTICS

Delay Time	(V _{CC} = 3.0 Vdc, V _{BE} = 0.5 Vdc, I _C = 10 mA _{dc} , I _{B1} = 1.0 mA _{dc})		t _d	–	35	ns
Rise Time			t _r	–	35	ns
Storage Time	(V _{CC} = 3.0 Vdc, I _C = 10 mA _{dc} , I _{B1} = I _{B2} = 1.0 mA _{dc})	2N3903 2N3904	t _s	–	175 200	ns
Fall Time			t _f	–	50	ns

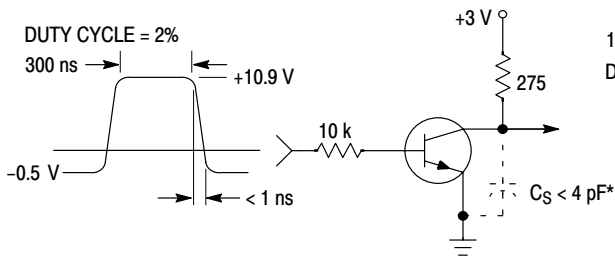
2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.

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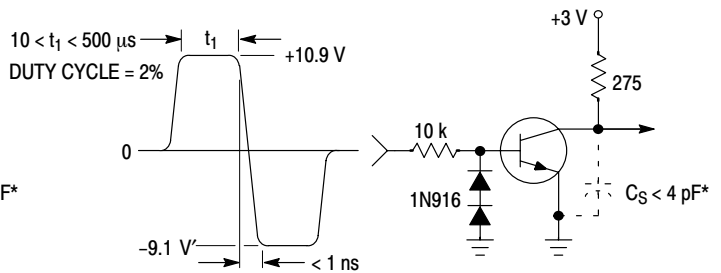
ORDERING INFORMATION

Device	Package	Shipping†
2N3903	TO-92	5,000 Units / Box
2N3903RLRM	TO-92	2,000 / Ammo Pack
2N3904	TO-92	5,000 Units / Box
2N3904G	TO-92 (Pb-Free)	5,000 Units / Box
2N3904RLRA	TO-92	2,000 / Tape & Reel
2N3904RLRAG	TO-92 (Pb-Free)	2,000 / Tape & Reel
2N3904RLRE	TO-92	2,000 / Tape & Reel
2N3904RLRM	TO-92	2,000 / Ammo Pack
2N3904RLRMG	TO-92 (Pb-Free)	2,000 / Ammo Pack
2N3904RLRP	TO-92	2,000 / Ammo Pack
2N3904RLRPG	TO-92 (Pb-Free)	2,000 / Ammo Pack
2N3904RL1	TO-92	2,000 / Tape & Reel
2N3904ZL1	TO-92	2,000 / 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.



**Figure 1. Delay and Rise Time
Equivalent Test Circuit**



**Figure 2. Storage and Fall Time
Equivalent Test Circuit**

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

— $T_J = 25^\circ\text{C}$
 - - - $T_J = 125^\circ\text{C}$

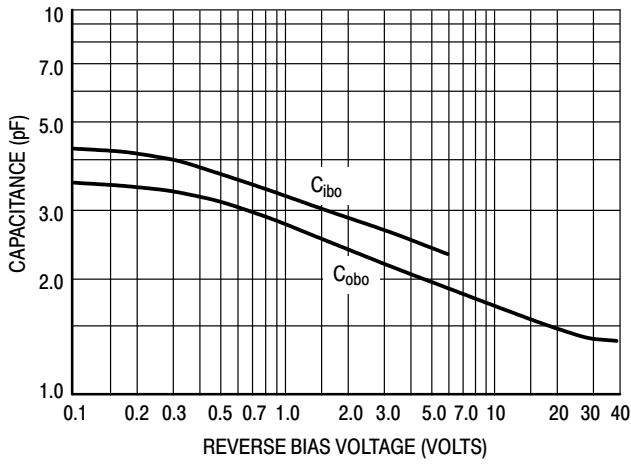


Figure 3. Capacitance

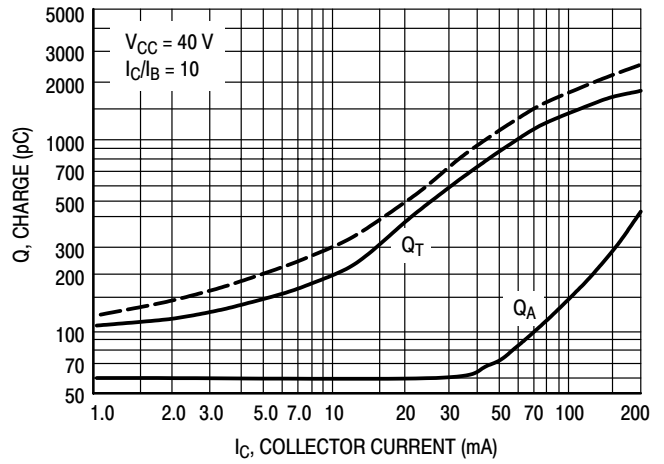


Figure 4. Charge Data

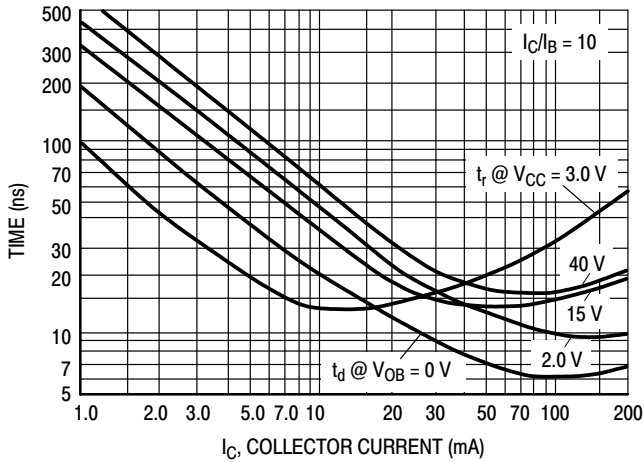


Figure 5. Turn-On Time

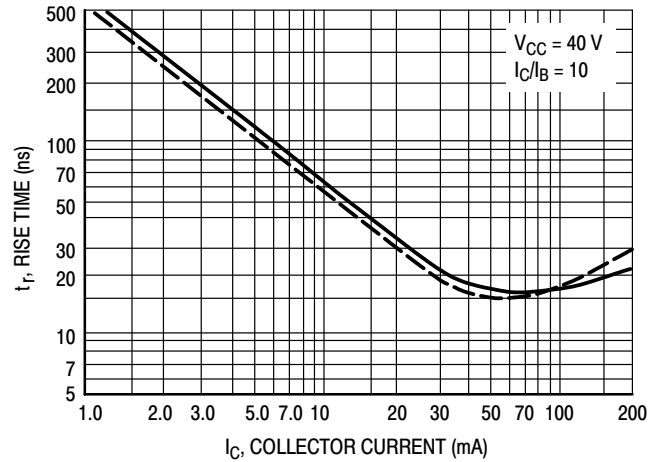


Figure 6. Rise Time

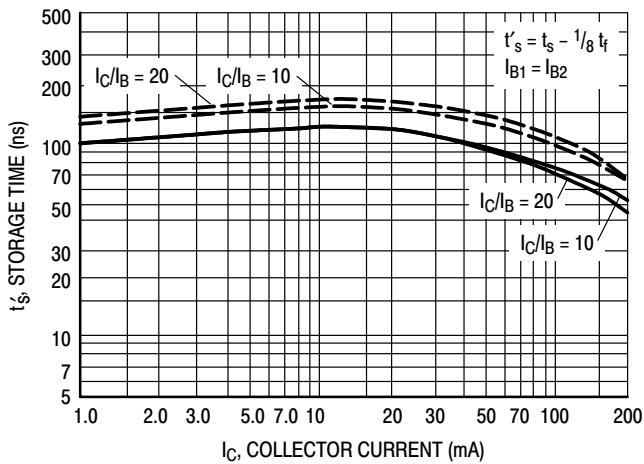


Figure 7. Storage Time

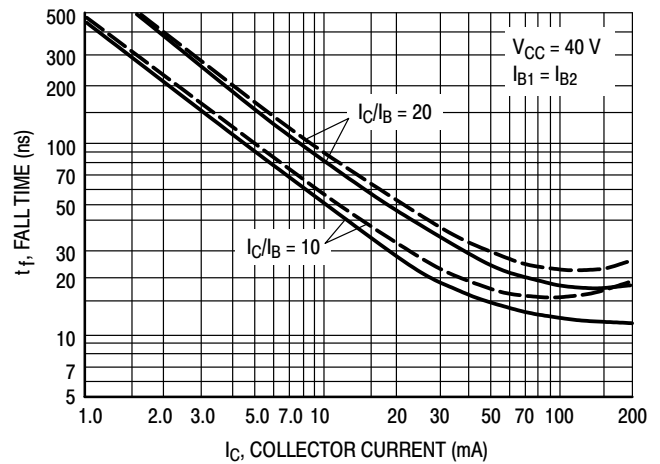


Figure 8. Fall Time

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TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

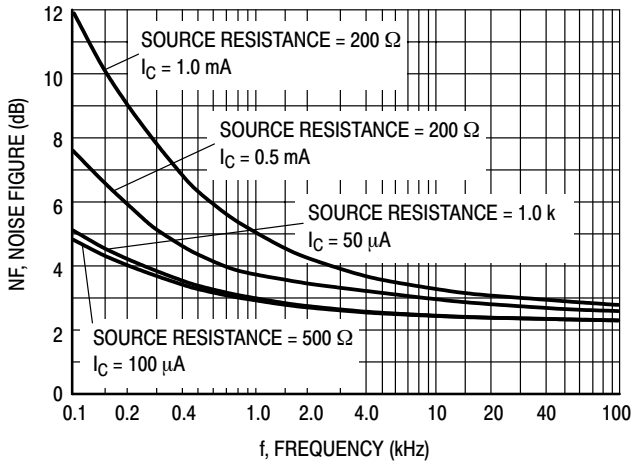


Figure 9.

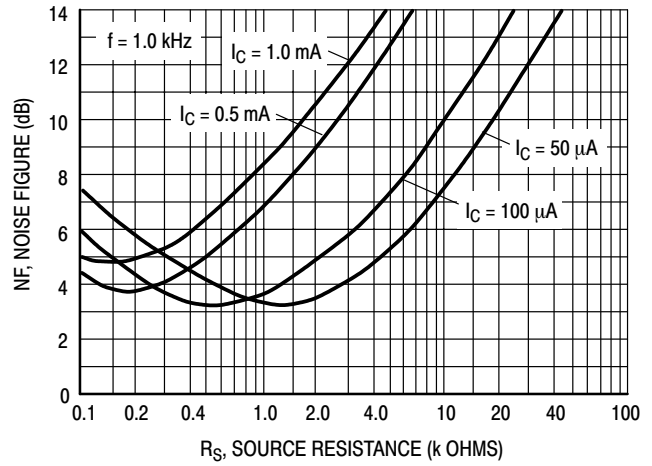


Figure 10.

h PARAMETERS

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

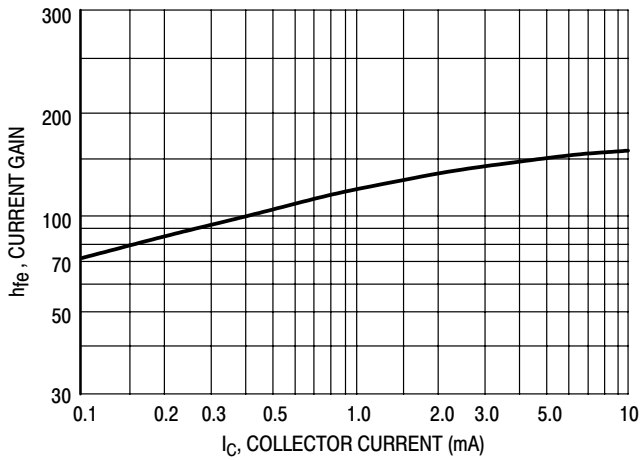


Figure 11. Current Gain

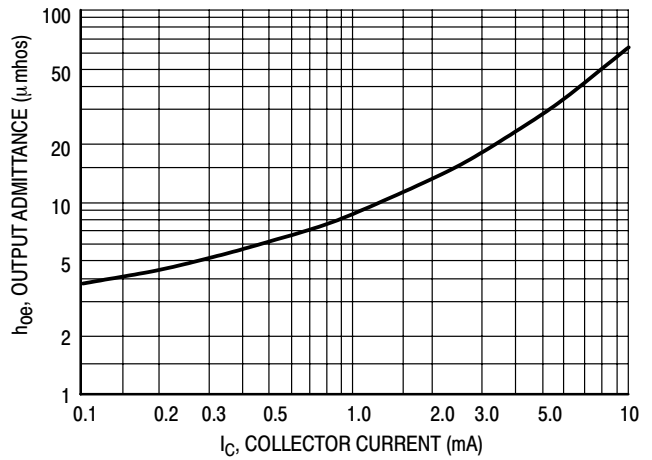


Figure 12. Output Admittance

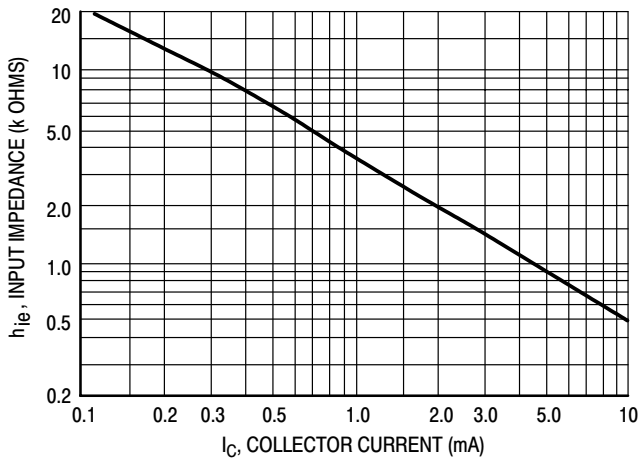


Figure 13. Input Impedance

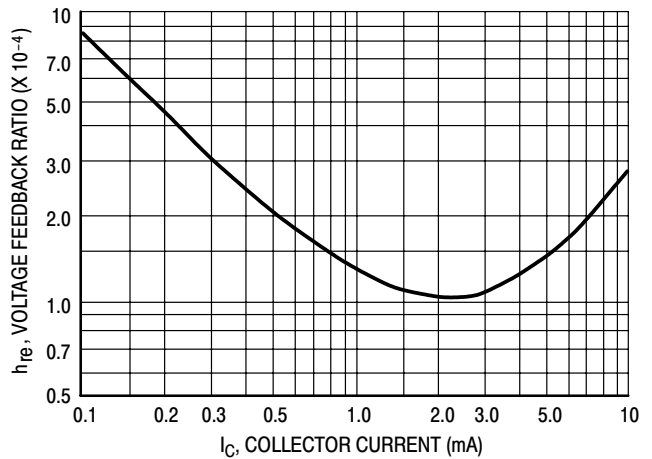


Figure 14. Voltage Feedback Ratio

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TYPICAL STATIC CHARACTERISTICS

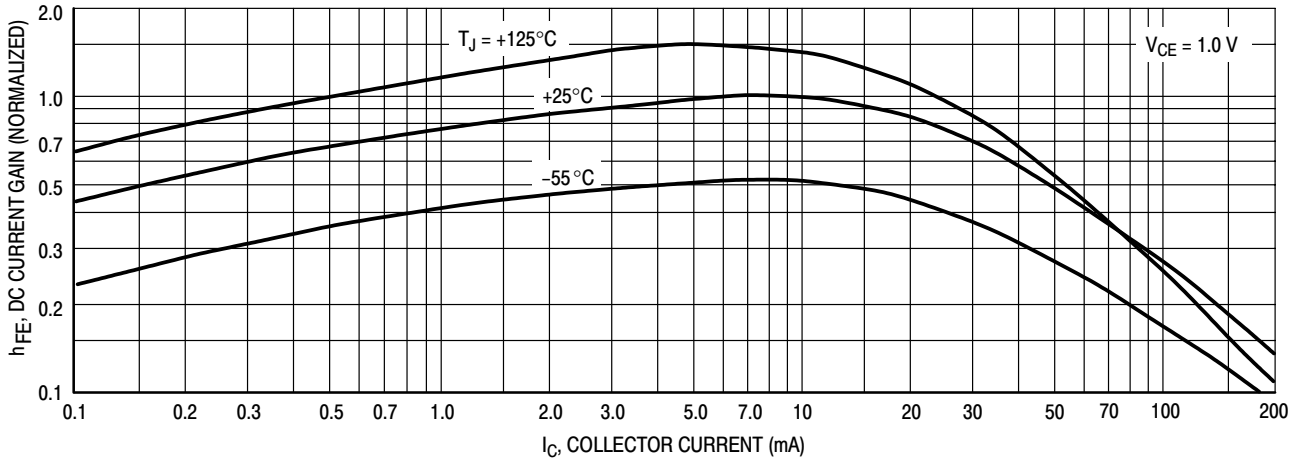


Figure 15. DC Current Gain

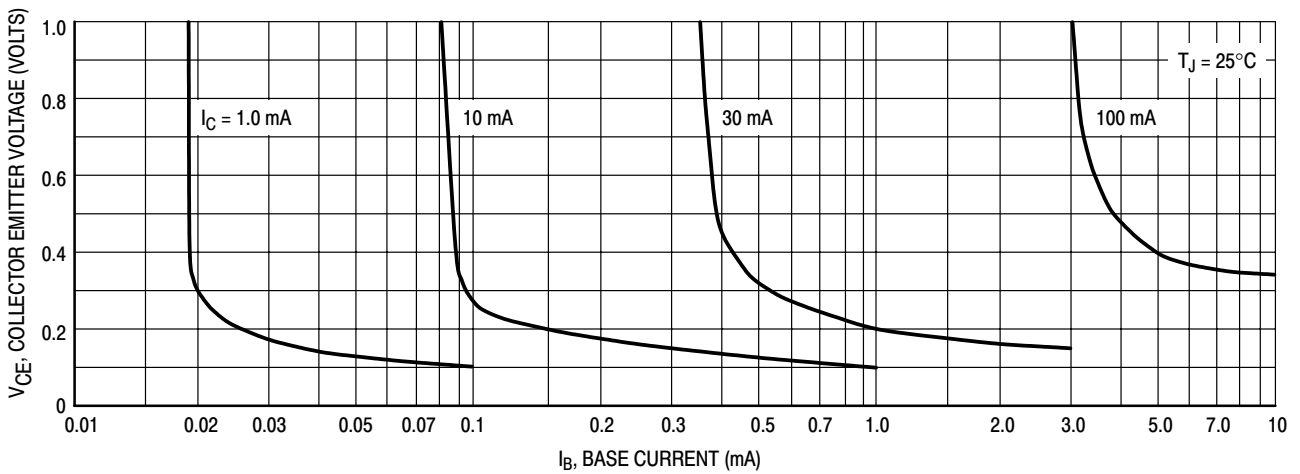


Figure 16. Collector Saturation Region

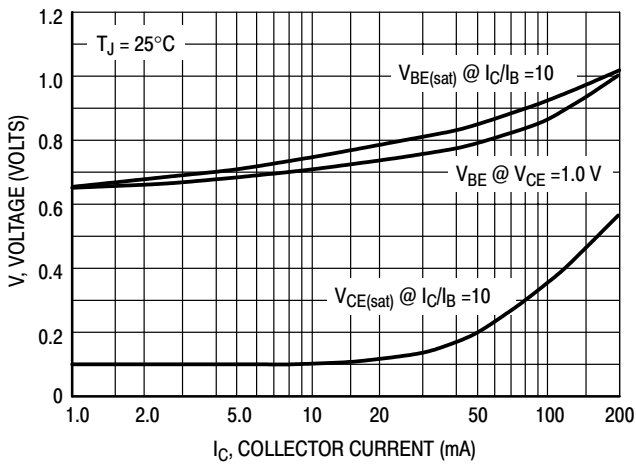


Figure 17. "ON" Voltages

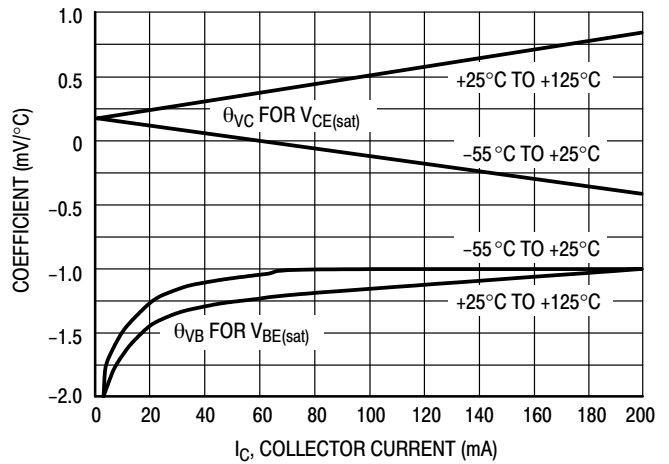
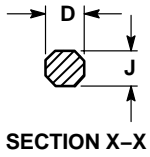
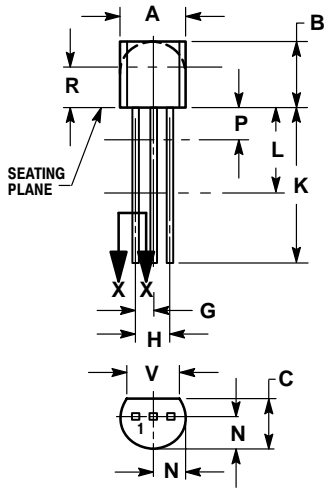


Figure 18. Temperature Coefficients

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PACKAGE DIMENSIONS

TO-92
TO-226AA
CASE 29-11
ISSUE AL



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	---

STYLE 1:

- PIN 1. EMITTER
- BASE
- COLLECTOR

STYLE 14:

- PIN 1. EMITTER
- COLLECTOR
- BASE

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