

2N3903, 2N3904

2N3903 is a Preferred Device

General Purpose Transistors

NPN Silicon

Features

- Pb-Free Package May be Available. The G-Suffix Denotes a Pb-Free Lead Finish

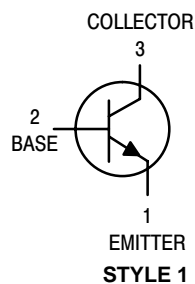
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CE0}	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)

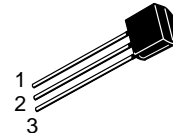
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	200	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	83.3	$^\circ\text{C}/\text{W}$

1. Indicates Data in addition to JEDEC Requirements.



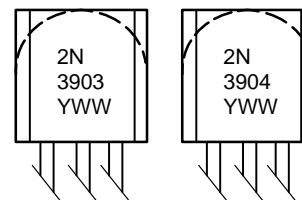
ON Semiconductor®

<http://onsemi.com>



TO-92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping†
2N3903	TO-92	5000 Units/Box
2N3903RLRM	TO-92	2000/Ammo Pack
2N3904	TO-92	5000 Units/Box
2N3904RLRA	TO-92	2000/Tape & Reel
2N3904RLRE	TO-92	2000/Tape & Reel
2N3904RLRM	TO-92	2000/Ammo Pack
2N3904RLRMG	TO-92	2000/Ammo Pack
2N3904RLRP	TO-92	2000/Ammo Pack
2N3904RL1	TO-92	2000/Tape & Reel
2N3904ZL1	TO-92	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.

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

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

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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	–	V _{dc}
Collector–Base Breakdown Voltage (I _C = 10 μA _{dc} , I _E = 0)	V _{(BR)CBO}	60	–	V _{dc}
Emitter–Base Breakdown Voltage (I _E = 10 μA _{dc} , I _C = 0)	V _{(BR)EBO}	6.0	–	V _{dc}
Base Cutoff Current (V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc})	I _{BL}	–	50	nA _{dc}
Collector Cutoff Current (V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc})	I _{CEX}	–	50	nA _{dc}

ON CHARACTERISTICS

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

SMALL–SIGNAL CHARACTERISTICS

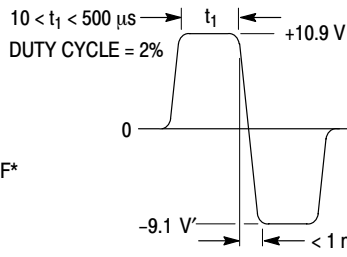
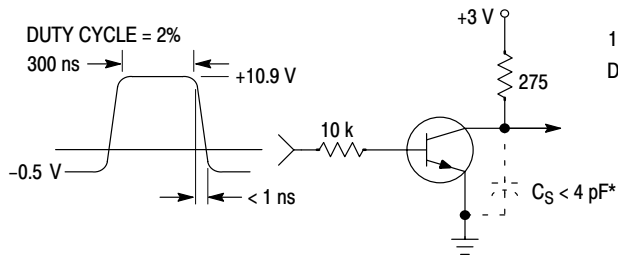
Current–Gain – Bandwidth Product	2N3903	f _T	250	–	MHz
(I _C = 10 mA _{dc} , V _{CE} = 20 V _{dc} , f = 100 MHz)					
	2N3904		300	–	
(I _C = 10 mA _{dc} , V _{CE} = 20 V _{dc} , f = 100 MHz)					
Output Capacitance (V _{CB} = 5.0 V _{dc} , I _E = 0, f = 1.0 MHz)		C _{obo}	–	4.0	pF
Input Capacitance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

SWITCHING CHARACTERISTICS

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

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

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* Total shunt capacitance of test jig and connectors

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

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

TYPICAL TRANSIENT CHARACTERISTICS

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

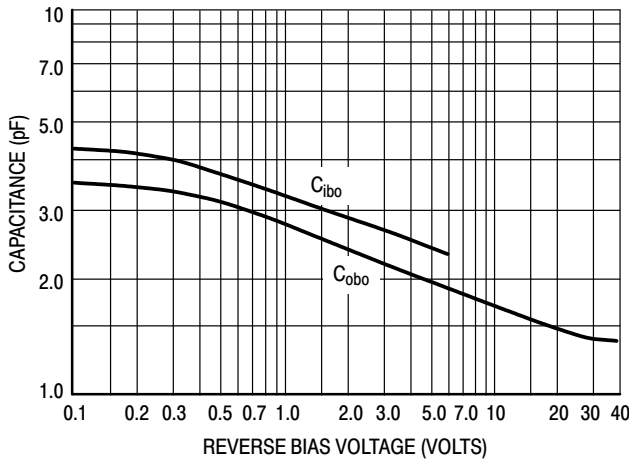


Figure 3. Capacitance

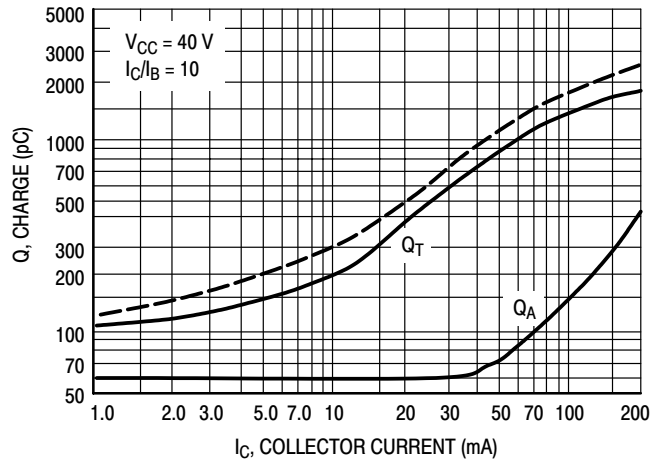


Figure 4. Charge Data

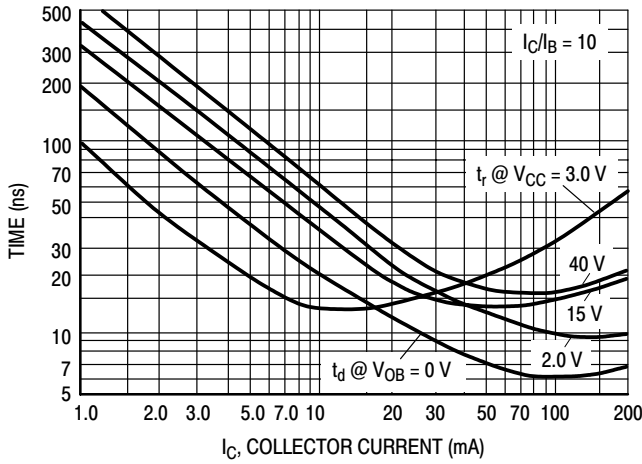


Figure 5. Turn-On Time

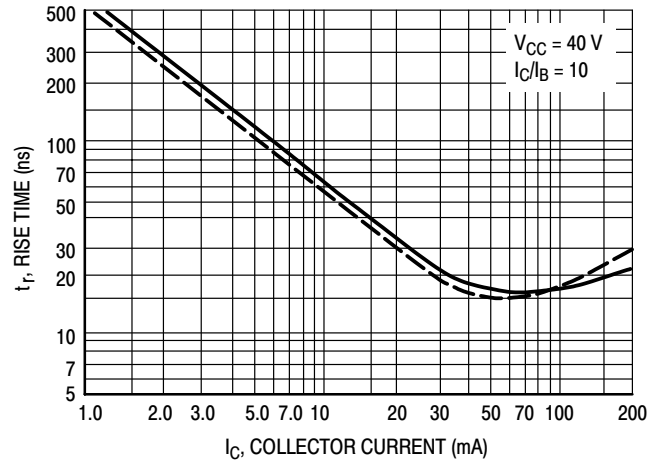


Figure 6. Rise Time

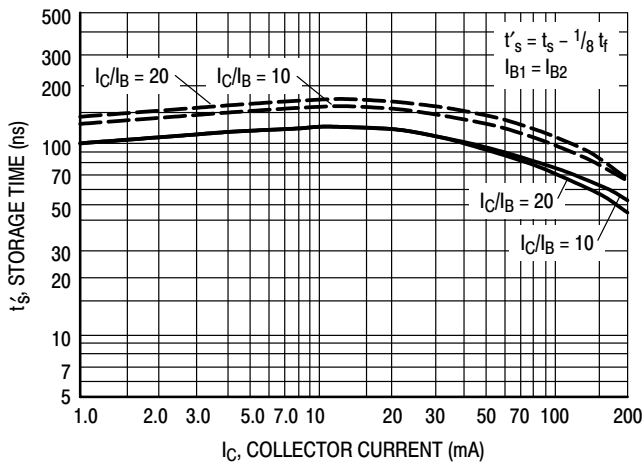


Figure 7. Storage Time

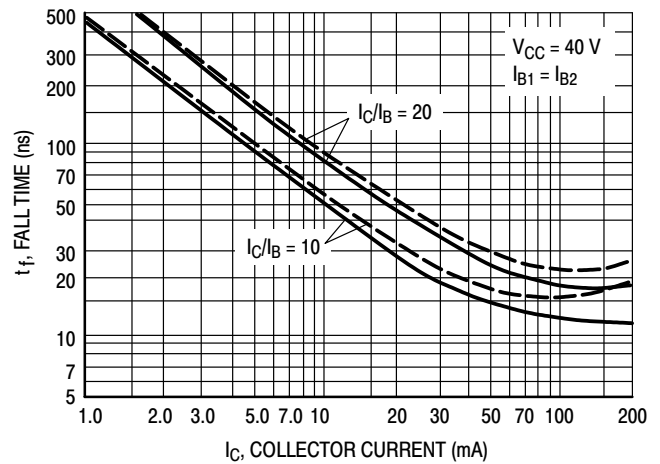


Figure 8. Fall Time

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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)

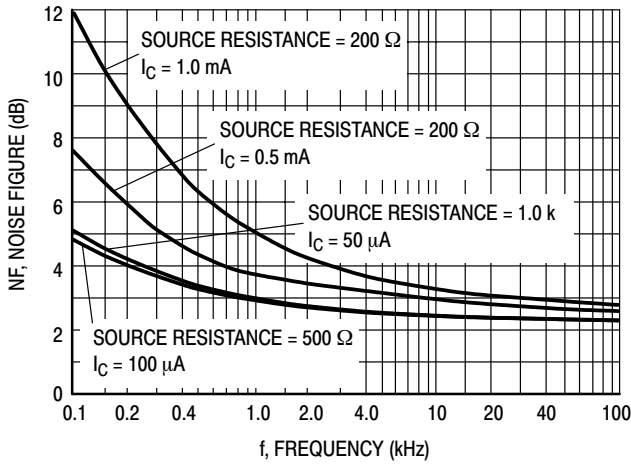


Figure 9.

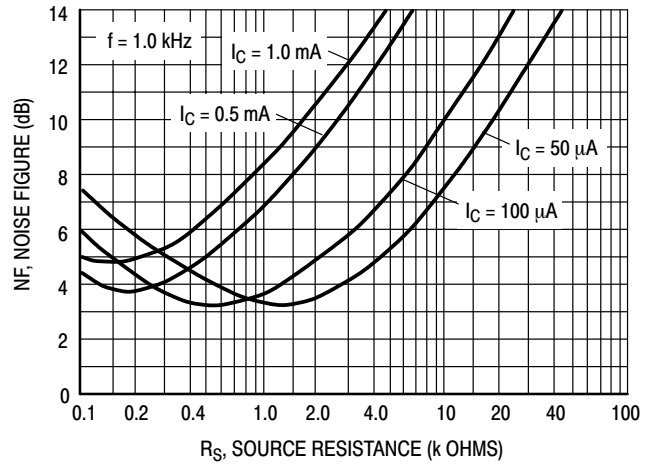


Figure 10.

h PARAMETERS

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

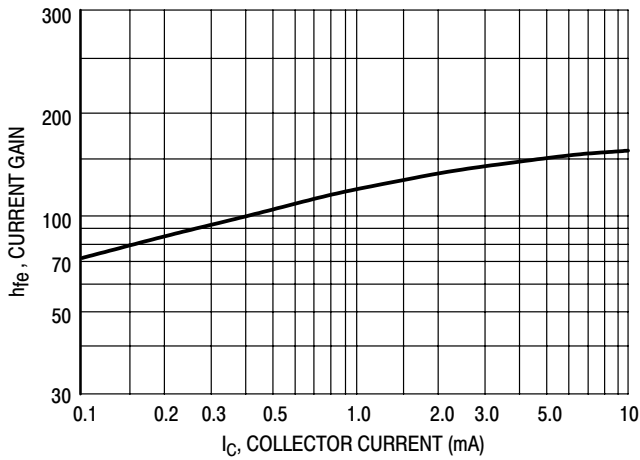


Figure 11. Current Gain

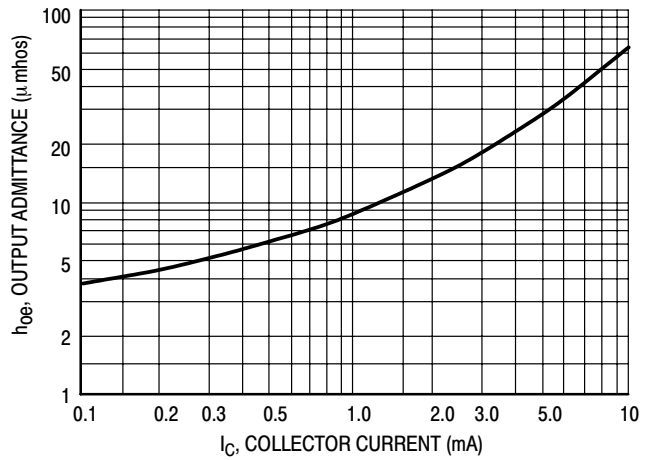


Figure 12. Output Admittance

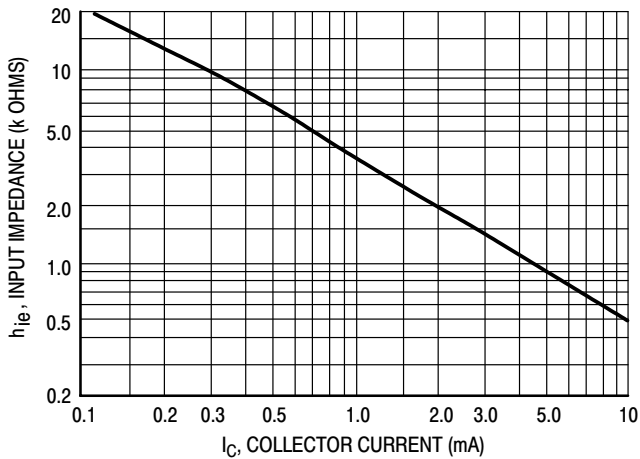


Figure 13. Input Impedance

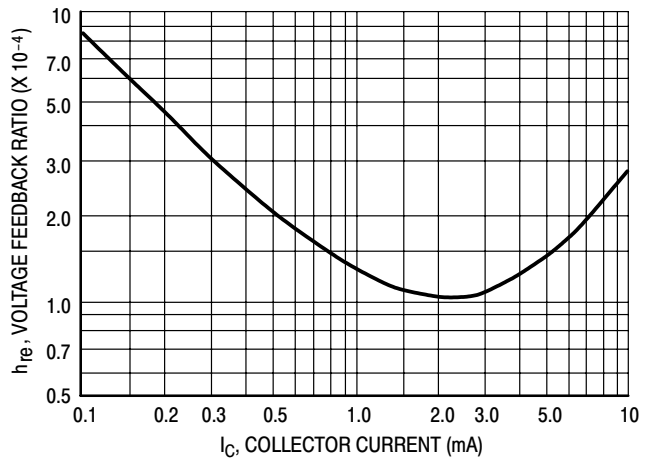


Figure 14. Voltage Feedback Ratio

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TYPICAL STATIC CHARACTERISTICS

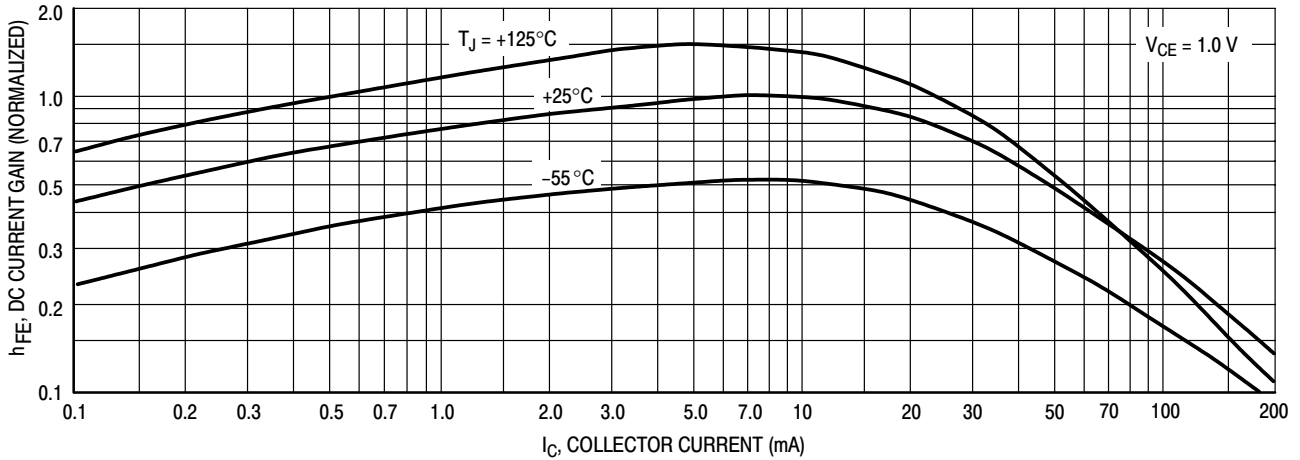


Figure 15. DC Current Gain

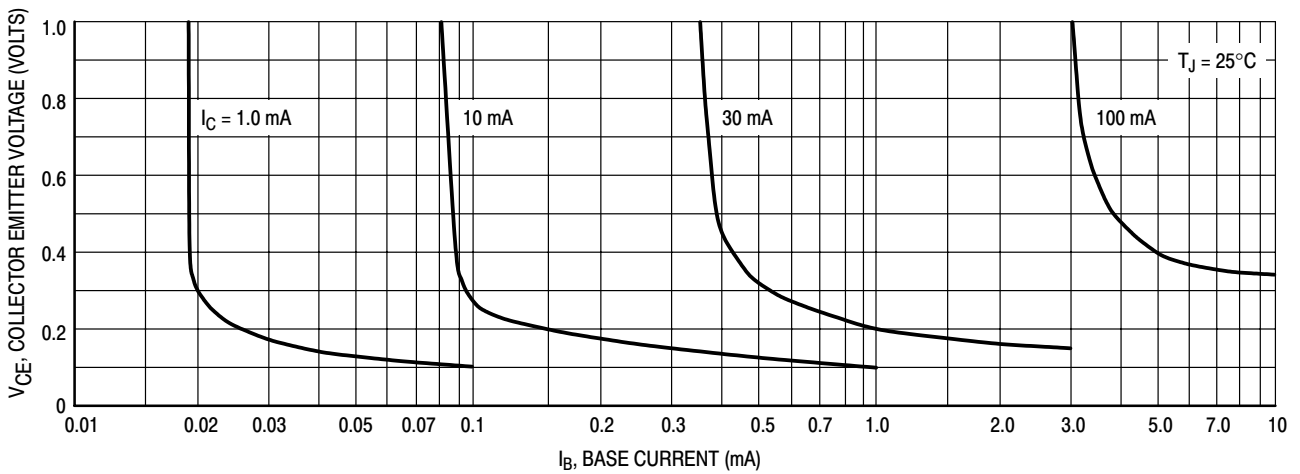


Figure 16. Collector Saturation Region

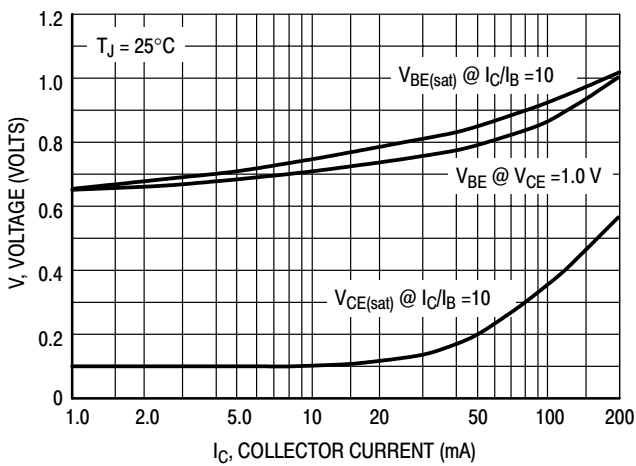


Figure 17. "ON" Voltages

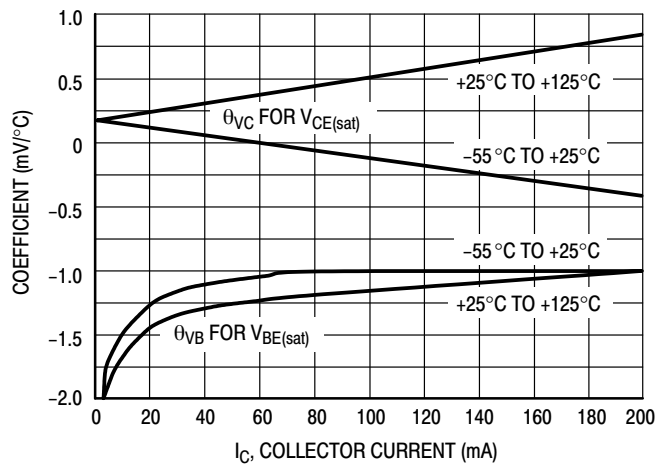
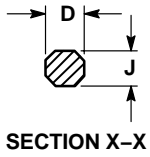
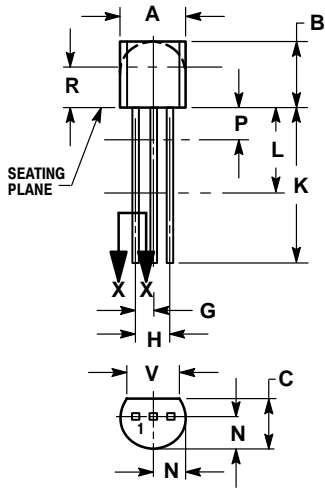


Figure 18. Temperature Coefficients

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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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