

2N3903, 2N3904

2N3903 is a Preferred Device

General Purpose Transistors

NPN Silicon



ON Semiconductor™

<http://onsemi.com>

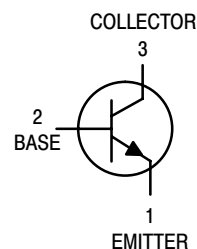
MAXIMUM RATINGS

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	mA dc
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	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$

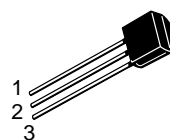
THERMAL CHARACTERISTICS (Note 1.)

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

1. Indicates Data in addition to JEDEC Requirements.

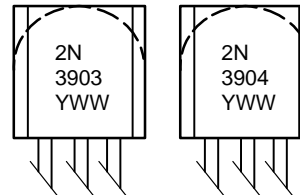


STYLE 1



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
2N3904RLRP	TO-92	2000/Ammo Pack
2N3904RL1	TO-92	2000/Tape & Reel
2N3904ZL1	TO-92	2000/Ammo Pack

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

2N3903, 2N3904

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

ON CHARACTERISTICS

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

SMALL–SIGNAL CHARACTERISTICS

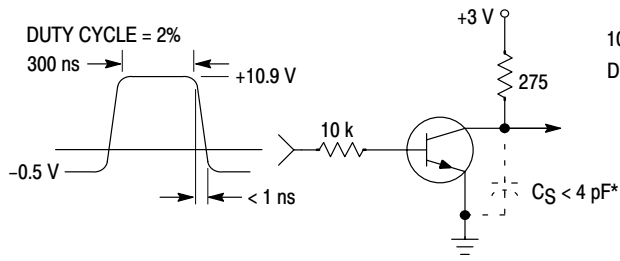
Current–Gain – Bandwidth Product ($I_C = 10\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$)	2N3903 2N3904	f_T	250 300	–	MHz
Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)		C_{obo}	–	4.0	pF
Input Capacitance ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{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

SWITCHING CHARACTERISTICS

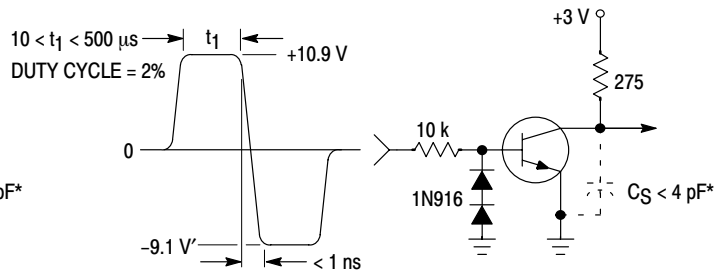
Delay Time	$(V_{CC} = 3.0\text{ Vdc}$, $V_{BE} = 0.5\text{ Vdc}$, $I_C = 10\text{ mA}$, $I_{B1} = 1.0\text{ mA}$)	t_d	–	35	ns
Rise Time		t_r	–	35	ns
Storage Time	$(V_{CC} = 3.0\text{ Vdc}$, $I_C = 10\text{ mA}$, $I_{B1} = I_{B2} = 1.0\text{ mA}$)	t_s	–	175 200	ns
Fall Time		t_f	–	50	ns

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

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**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

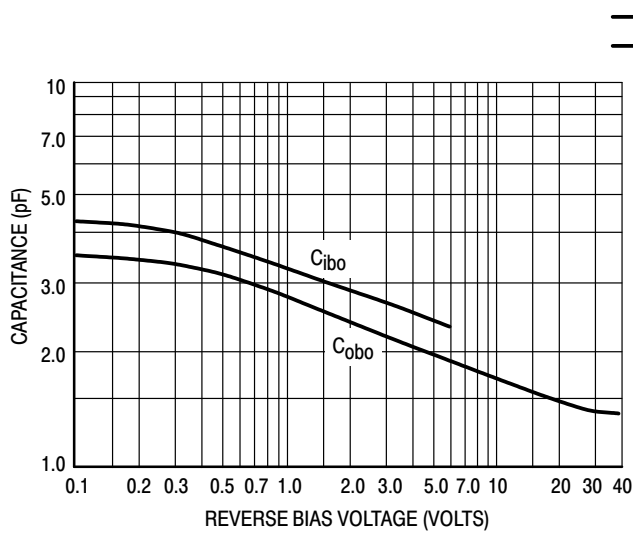


Figure 3. Capacitance

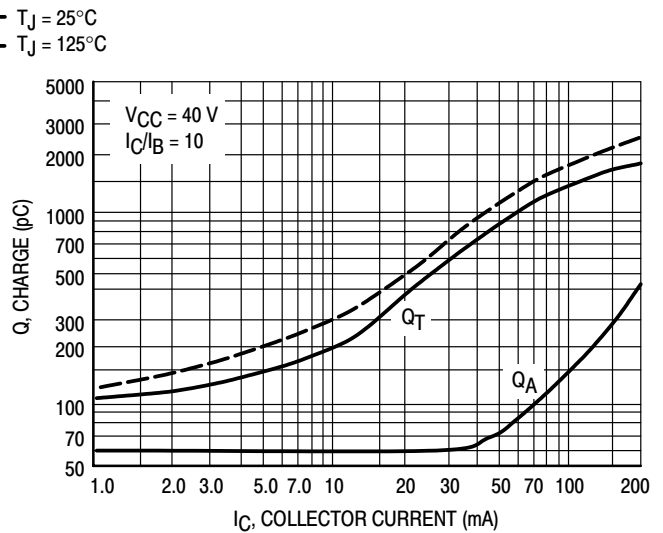


Figure 4. Charge Data

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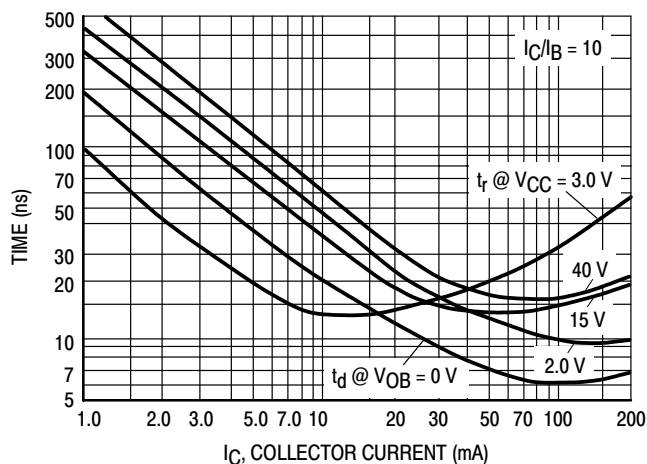


Figure 5. Turn-On Time

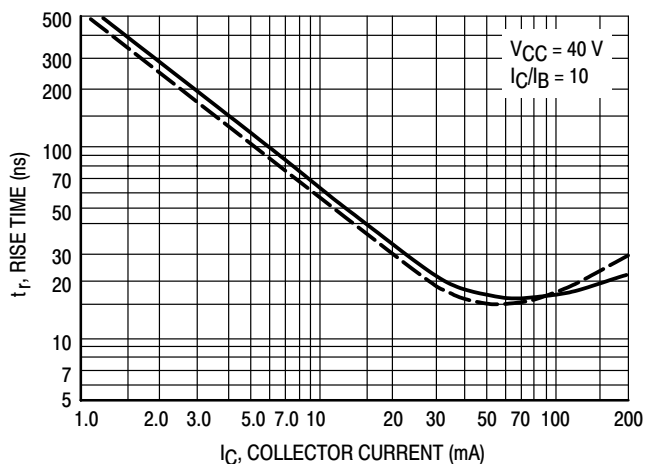


Figure 6. Rise Time

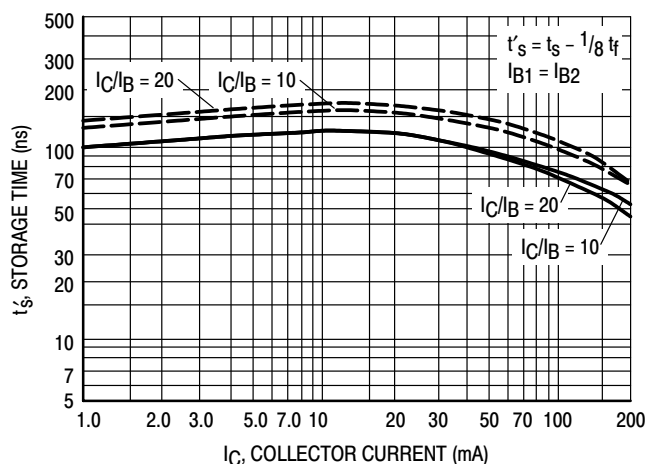


Figure 7. Storage Time

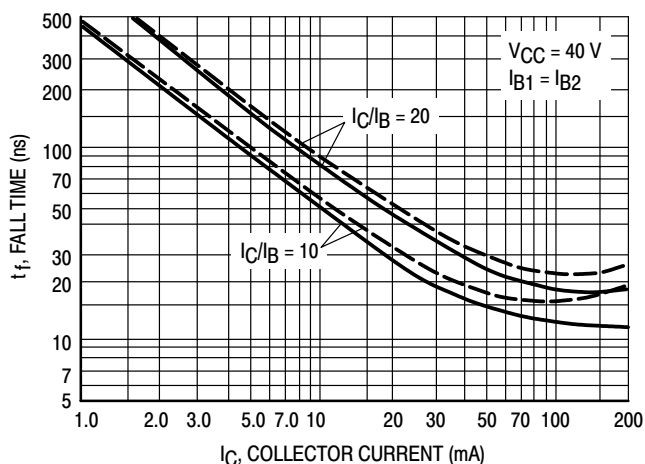


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

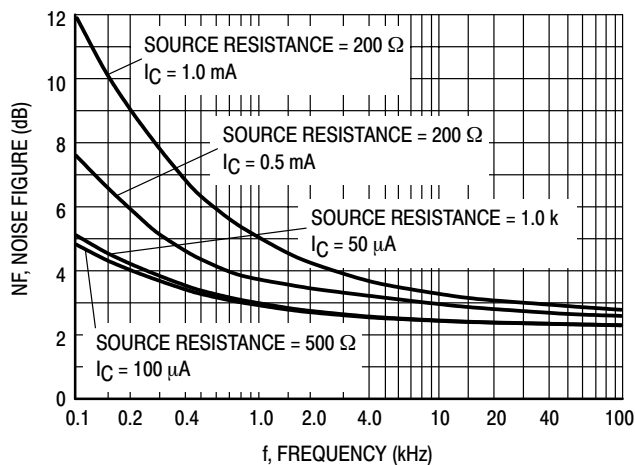


Figure 9.

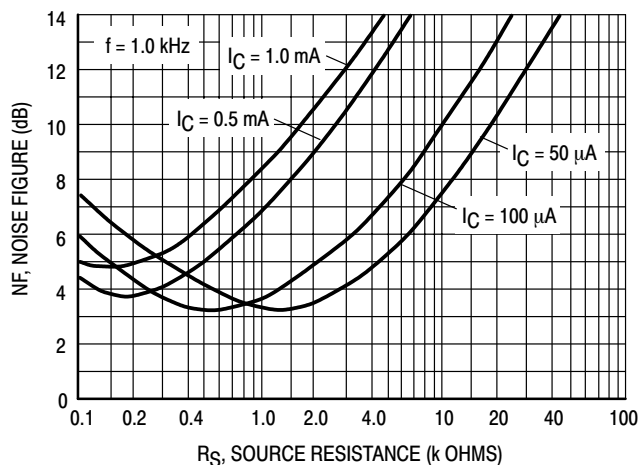


Figure 10.

2N3903, 2N3904

h PARAMETERS

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

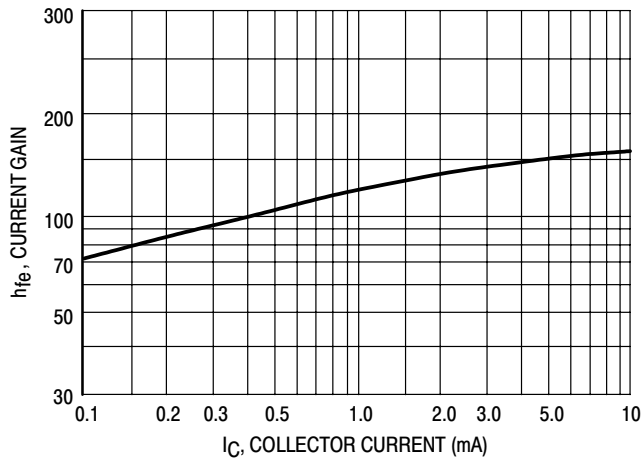


Figure 11. Current Gain

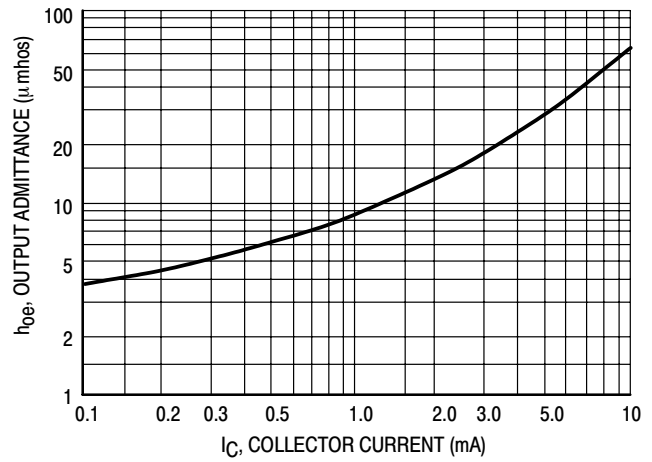


Figure 12. Output Admittance

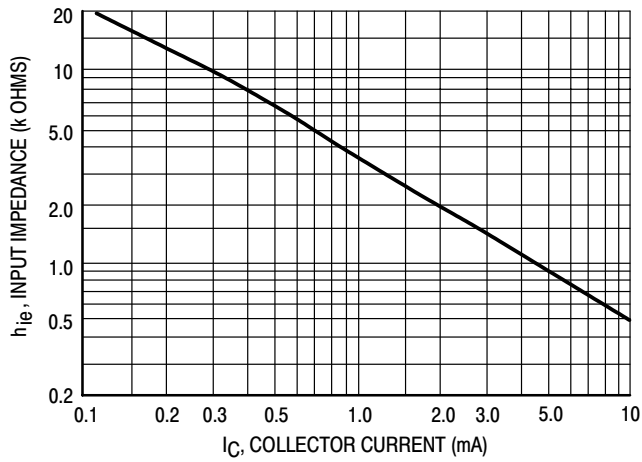


Figure 13. Input Impedance

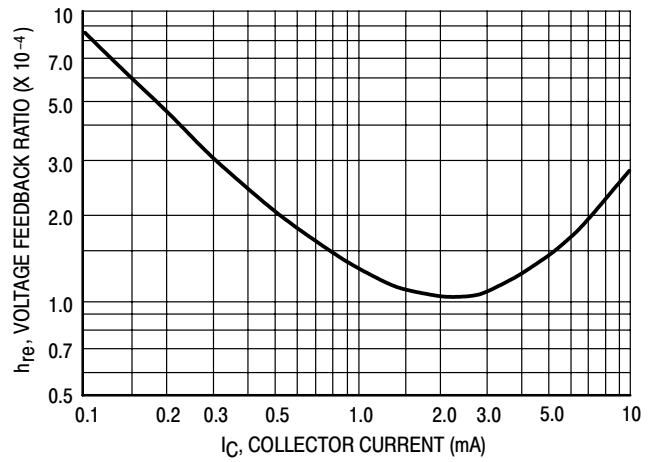


Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

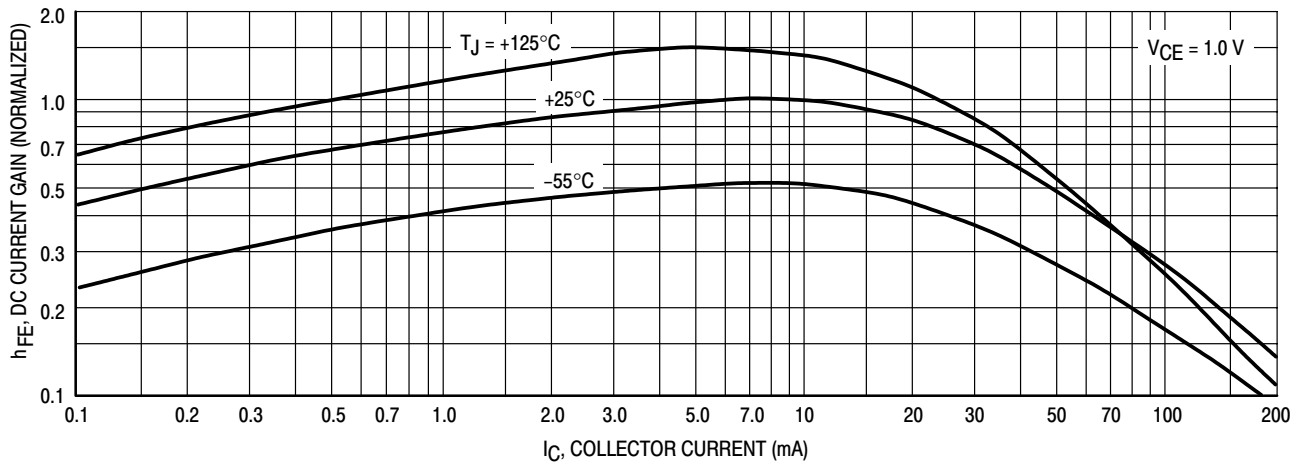


Figure 15. DC Current Gain

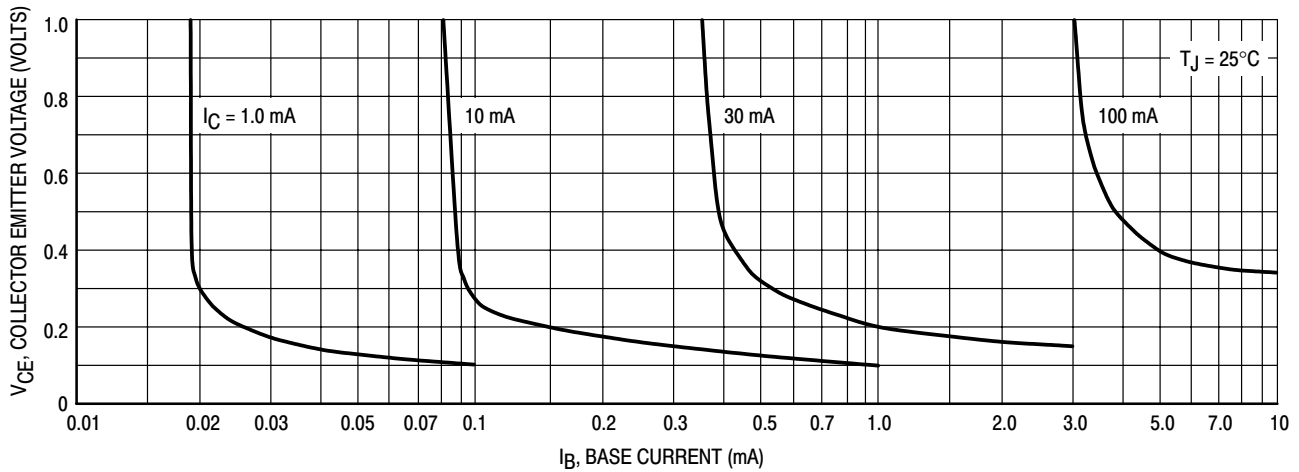


Figure 16. Collector Saturation Region

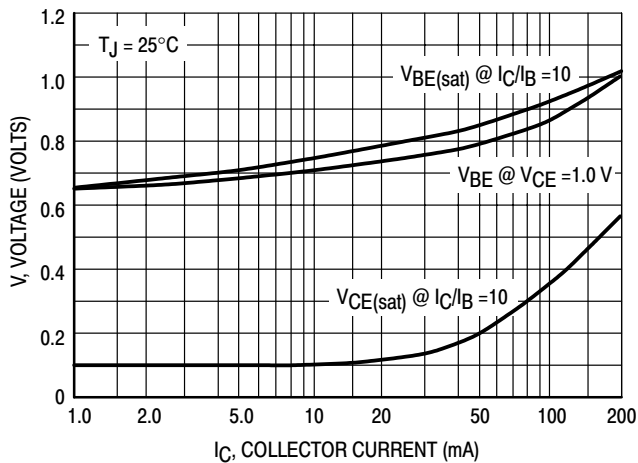


Figure 17. "ON" Voltages

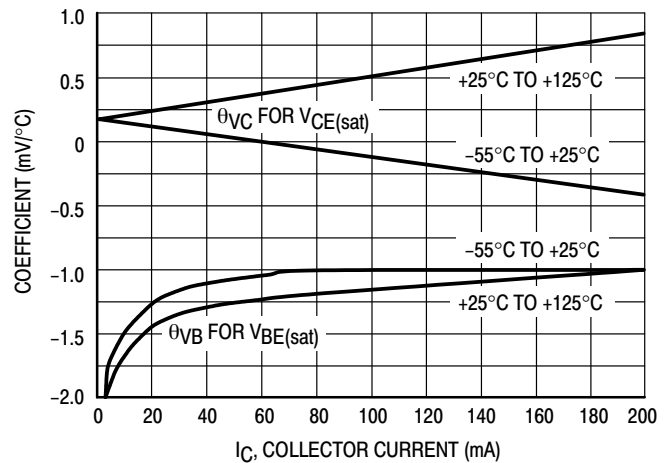
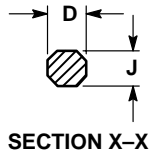
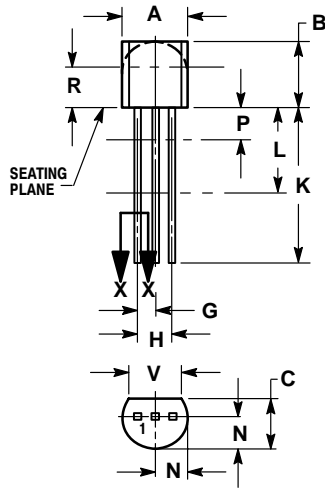


Figure 18. Temperature Coefficients

2N3903, 2N3904

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
2. BASE
3. COLLECTOR

STYLE 14:

- PIN 1. EMITTER
2. COLLECTOR
3. BASE

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