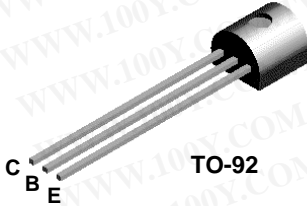




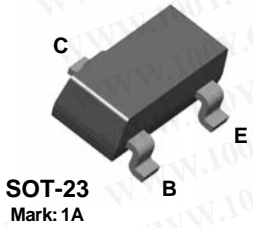
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2N3904 / MMBT3904 / PZT3904

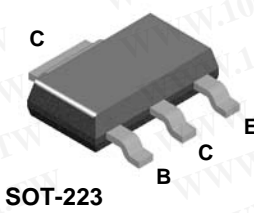
2N3904



MMBT3904



PZT3904



NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

Absolute Maximum Ratings* T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V _{CEO}	Collector-Emitter Voltage	40	V
V _{CBO}	Collector-Base Voltage	60	V
V _{EBO}	Emitter-Base Voltage	6.0	V
I _C	Collector Current - Continuous	200	mA
T _J , T _{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

- NOTES:**
 1) These ratings are based on a maximum junction temperature of 150 degrees C.
 2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		2N3904	*MMBT3904	**PZT3904	
P _D	Total Device Dissipation Derate above 25°C	625	350	1,000	mW
		5.0	2.8	8.0	mW/°C
R _{θJC}	Thermal Resistance, Junction to Case	83.3			°C/W
R _{θJA}	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."
 ** Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm².

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NPN General Purpose Amplifier
 (continued)

2N3904 / MMBT3904 / PZT3904

Electrical Characteristics

$T_A = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
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OFF CHARACTERISTICS

$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = 1.0 \text{ mA}, I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10 \mu\text{A}, I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10 \mu\text{A}, I_C = 0$	6.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 30 \text{ V}, V_{EB} = 3 \text{ V}$		50	nA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 30 \text{ V}, V_{EB} = 3 \text{ V}$		50	nA

ON CHARACTERISTICS*

h_{FE}	DC Current Gain	$I_C = 0.1 \text{ mA}, V_{CE} = 1.0 \text{ V}$	40	300	
		$I_C = 1.0 \text{ mA}, V_{CE} = 1.0 \text{ V}$	70		
		$I_C = 10 \text{ mA}, V_{CE} = 1.0 \text{ V}$	100		
		$I_C = 50 \text{ mA}, V_{CE} = 1.0 \text{ V}$	60		
		$I_C = 100 \text{ mA}, V_{CE} = 1.0 \text{ V}$	30		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10 \text{ mA}, I_B = 1.0 \text{ mA}$		0.2	V
		$I_C = 50 \text{ mA}, I_B = 5.0 \text{ mA}$		0.3	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10 \text{ mA}, I_B = 1.0 \text{ mA}$	0.65	0.85	V
		$I_C = 50 \text{ mA}, I_B = 5.0 \text{ mA}$		0.95	V

SMALL SIGNAL CHARACTERISTICS

f_T	Current Gain - Bandwidth Product	$I_C = 10 \text{ mA}, V_{CE} = 20 \text{ V}, f = 100 \text{ MHz}$	300		MHz
C_{obo}	Output Capacitance	$V_{CB} = 5.0 \text{ V}, I_E = 0, f = 1.0 \text{ MHz}$		4.0	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5 \text{ V}, I_C = 0, f = 1.0 \text{ MHz}$		8.0	pF
NF	Noise Figure	$I_C = 100 \mu\text{A}, V_{CE} = 5.0 \text{ V}, R_S = 1.0 \text{ k}\Omega, f = 10 \text{ Hz to } 15.7 \text{ kHz}$		5.0	dB

SWITCHING CHARACTERISTICS

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

*Pulse Test: Pulse Width $\leq 300 \mu\text{s}$, Duty Cycle $\leq 2.0\%$

Spice Model

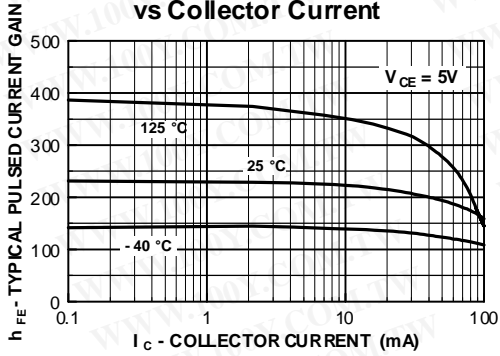
NPN (Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259 Ise=6.734 Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75 Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)

NPN General Purpose Amplifier
 (continued)

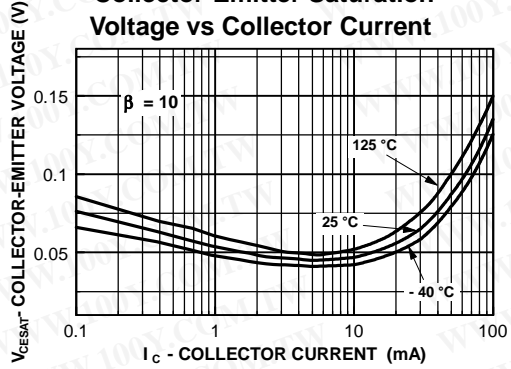
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Typical Characteristics

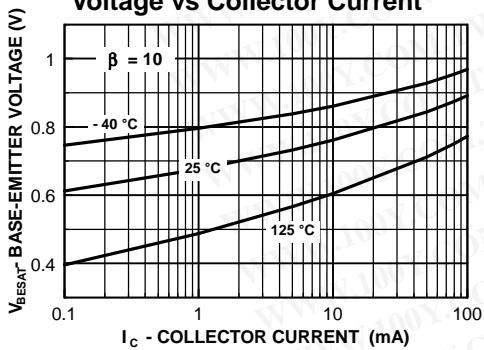
Typical Pulsed Current Gain vs Collector Current



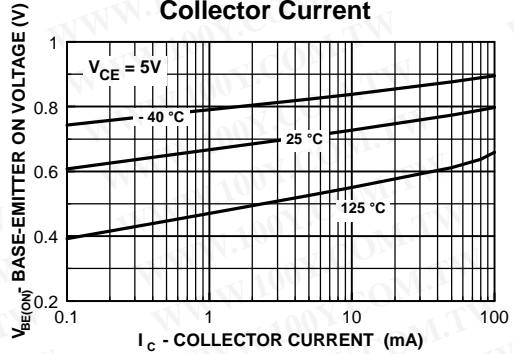
Collector-Emitter Saturation Voltage vs Collector Current



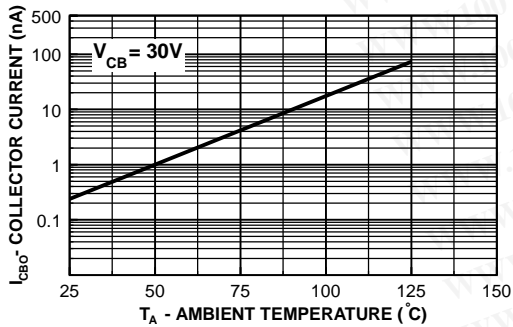
Base-Emitter Saturation Voltage vs Collector Current



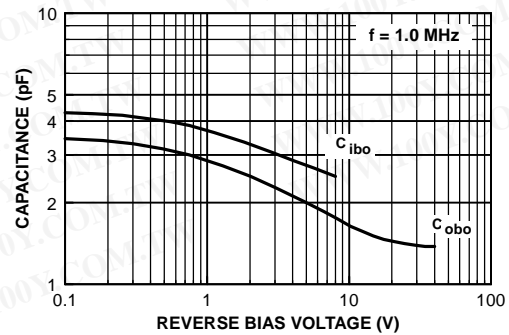
Base-Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature



Capacitance vs Reverse Bias Voltage

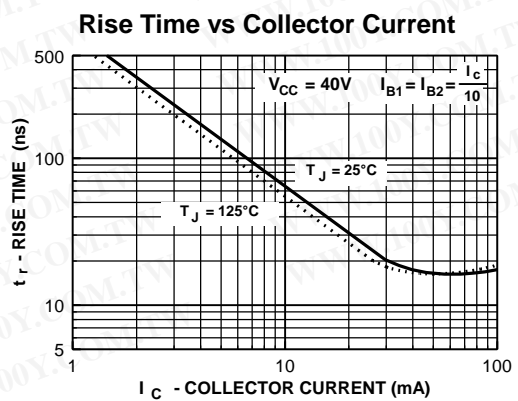
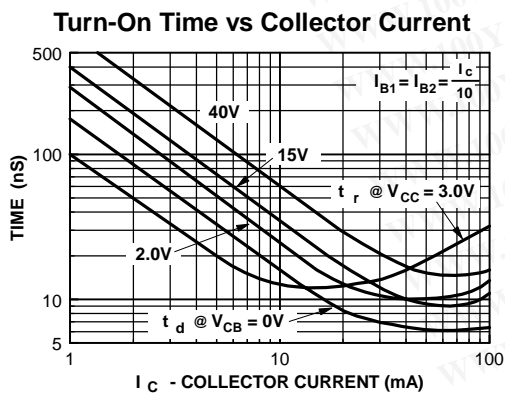
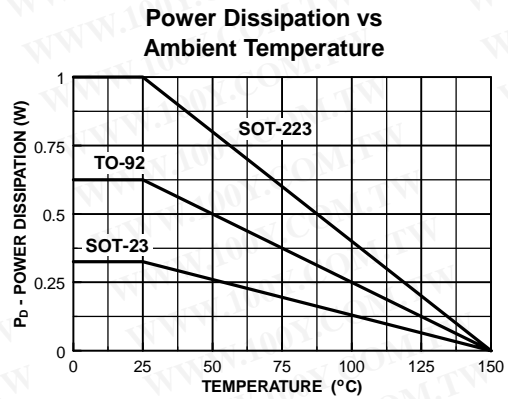
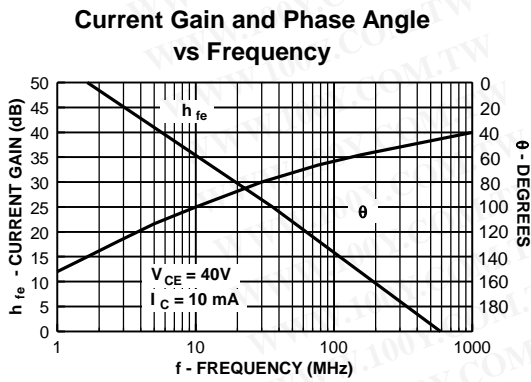
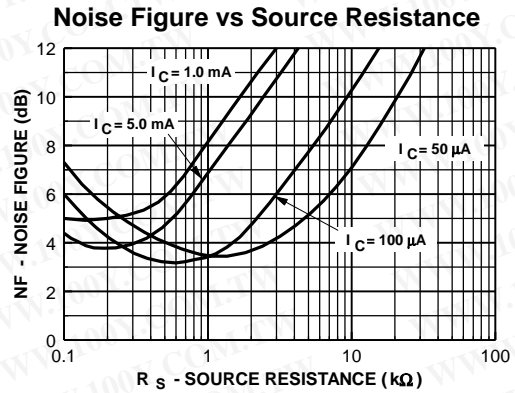
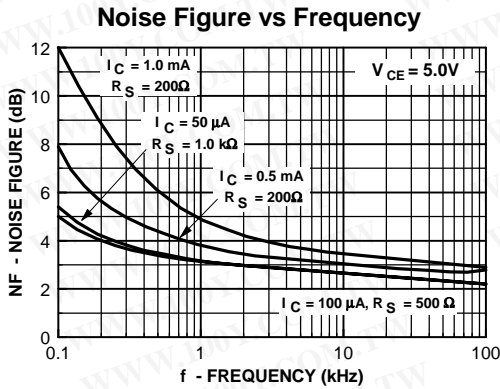


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NPN General Purpose Amplifier
 (continued)

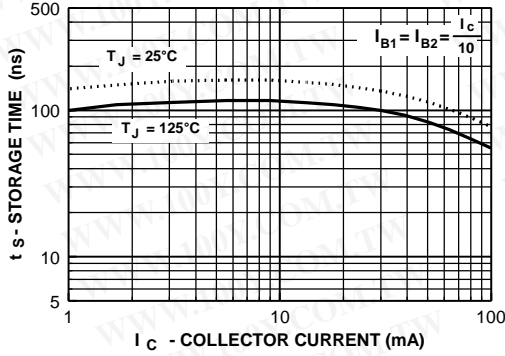
2N3904 / MMBT3904 / PZT3904

Typical Characteristics (continued)

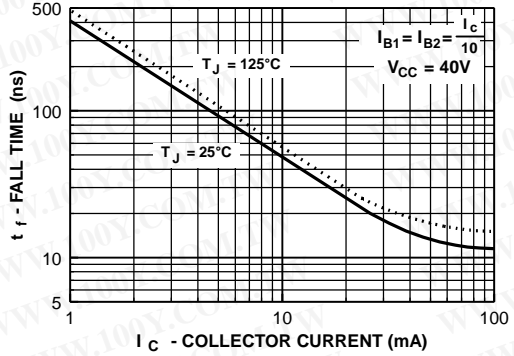


Typical Characteristics (continued)

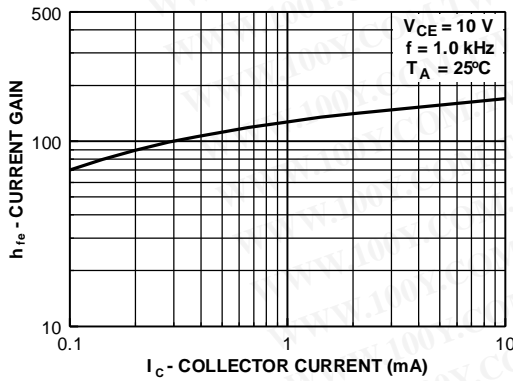
Storage Time vs Collector Current



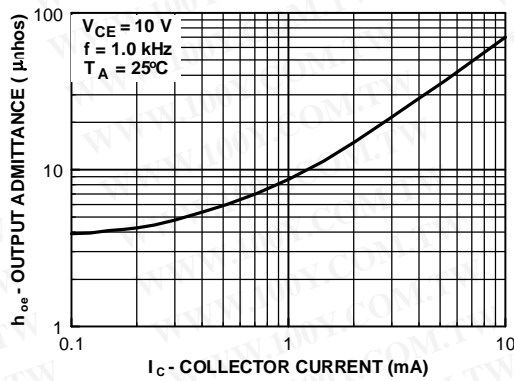
Fall Time vs Collector Current



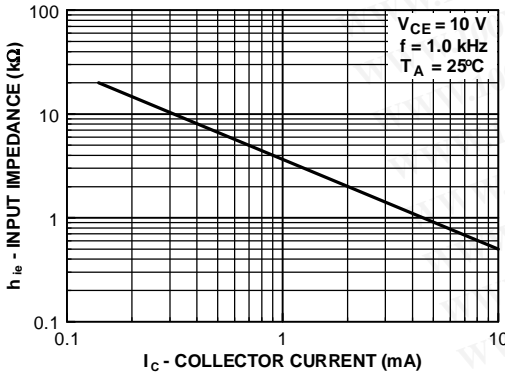
Current Gain



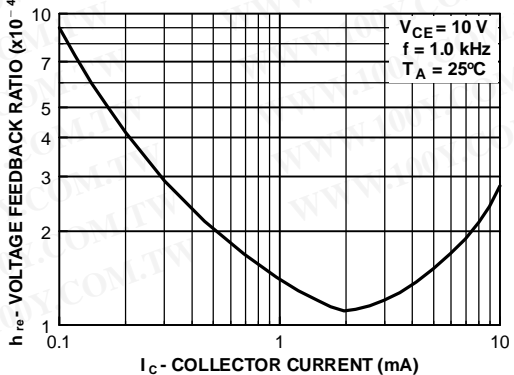
Output Admittance



Input Impedance



Voltage Feedback Ratio



Test Circuits

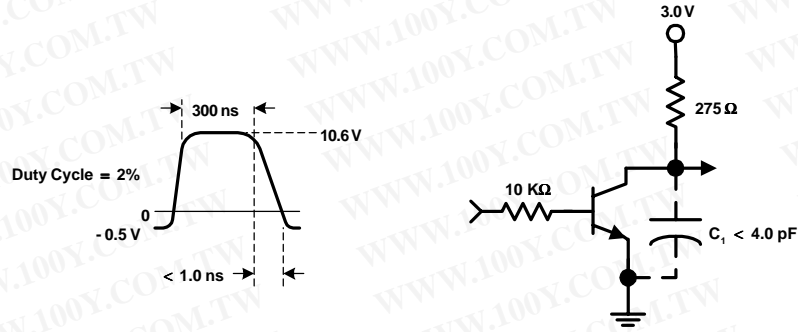


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

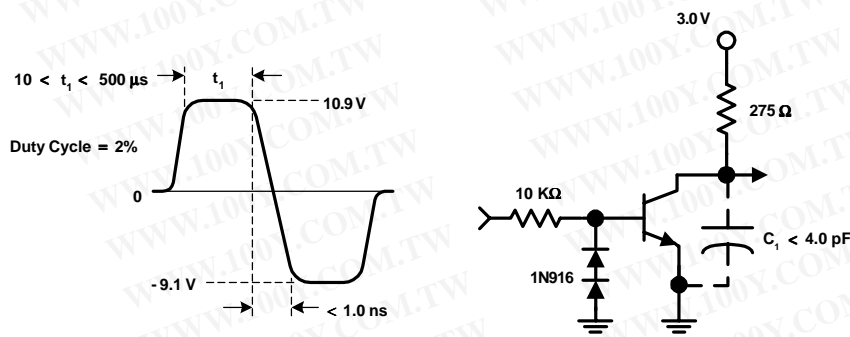


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

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