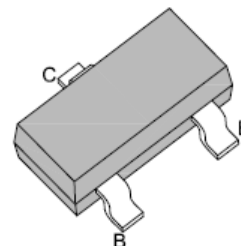


SMD General Purpose Transistor (NPN)

Features

- NPN Silicon Epitaxial Planar Transistor for Switching and Amplifier Applications
- RoHS compliance



SOT-23



Mechanical Data

Case:	SOT-23, Plastic Package
Terminals:	Solderable per MIL-STD-202G, Method 208
Weight:	0.008 gram

Maximum Ratings ($T_{Ambient}=25^{\circ}C$ unless noted otherwise)

Symbol	Description	MMBT3904	Unit	Conditions
V_{CEO}	Collector-Emitter Voltage	40	V	
V_{CB0}	Collector-Base Voltage	60	V	
V_{EB0}	Emitter-Base Voltage	6.0	V	
I_c	Collector Current	200	mA	
P_D	Total Device Power Dissipation(Note 1)	225	mW	TA=25 °C
		1.8	mW/°C	Derate above 25 °C
R_{θJA}	Thermal Resistance, Junction to Ambient	556	°C /W	
P_D	Total Device Power Dissipation, Alumina Substrate (Note 2)	300	mW	TA=25 °C
		2.4	mW/°C	Derate above 25 °C
R_{θJA}	Thermal Resistance, Junction to Ambient	417	°C /W	
T_J	Junction Temperature	-55 to +150	°C	
T_{STG}	Storage Temperature Range	-55 to +150	°C	

Note: 1. FR-5 Board=25.4 x 19.05 x 1.58 mm (1.0 x 0.75 x 0.062 inches.)

2. Alumina Substrate=10.16 x 7.62 x 0.61 mm (0.4 x 0.3 x 0.024 inches.) 99.5% alumina.

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Electrical Characteristics ($T_{Ambient}=25^{\circ}\text{C}$ unless noted otherwise)

Off Characteristics

Symbol	Description	Min.	Max.	Unit	Conditions
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage (Pulse width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2.0\%$)	40	-	V	$I_C=1\text{mA}$, $I_B=0$
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	60	-	V	$I_C=10\mu\text{A}$, $I_E=0$
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	6.0	-	V	$I_E=10\mu\text{A}$, $I_C=0$
I_{BL}	Base Cut-off Current	-	50	nA	$V_{EB}=3\text{V}$, $V_{CE}=30\text{V}$
I_{CEX}	Collector Cut-off Current	-	50	nA	$V_{EB}=3\text{V}$, $V_{CE}=30\text{V}$

On Characteristics

Symbol	Description	Min.	Max.	Unit	Conditions
h_{FE}	D.C. Current Gain	40	-		$V_{CE}=1\text{V}$, $I_C=0.1\text{mA}$
		70	-		$V_{CE}=1\text{V}$, $I_C=1\text{mA}$
		100	300		$V_{CE}=1\text{V}$, $I_C=10\text{mA}$
		60	-		$V_{CE}=1\text{V}$, $I_C=50\text{mA}$
		30	-		$V_{CE}=1\text{V}$, $I_C=100\text{mA}$
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	-	0.2	V	$I_C=10\text{mA}$, $I_B=1\text{mA}$
		-	0.3		$I_C=50\text{mA}$, $I_B=5\text{mA}$
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	0.65	0.85	V	$I_C=10\text{mA}$, $I_B=1\text{mA}$
		-	0.95		$I_C=50\text{mA}$, $I_B=5\text{mA}$

Small-signal Characteristics

Symbol	Description	Min.	Max.	Unit	Conditions
f_T	Current Gain-Bandwidth Product	300	-	MHz	$V_{CE}=20\text{V}$, $I_C=10\text{mA}$, $f=100\text{MHz}$
C_{OBO}	Output Capacitance	-	4.0	pF	$V_{CB}=5\text{V}$, $f=1.0\text{MHz}$, $I_E=0$
C_{IBO}	Input Capacitance	-	8.0	pF	$V_{EB}=0.5\text{V}$, $f=1.0\text{MHz}$, $I_C=0$
h_{ie}	Input Impedance	1.0	10	kohms	$V_{CE}=10\text{V}$, $I_C=1\text{mA}$, $f=1\text{kHz}$
h_{re}	Voltage Feedback Ratio	0.5	8.0	$\times 10^{-4}$	$V_{CE}=10\text{V}$, $I_C=1\text{mA}$, $f=1\text{kHz}$
h_{fe}	Small-Signal Current Gain	100	400	-	$V_{CE}=10\text{V}$, $I_C=1\text{mA}$, $f=1\text{kHz}$
h_{oe}	Output Admittance	1.0	40	UMHOS	$V_{CE}=10\text{V}$, $I_C=1\text{mA}$, $f=1\text{kHz}$
NF	Noise Figure	-	5.0	dB	$V_{CE}=5\text{V}$, $I_C=100\mu\text{A}$, $R_s=1.0\text{kohms}$, $f=1\text{kHz}$

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Switching Characteristics

Symbol	Description	Min.	Max.	Unit	Conditions
t_d	Delay Time	-	35	ns	$V_{CC}=3V, V_{BE}=-0.5V$ $I_C=10mA, I_{B1}=1mA$
t_r	Rise Time	-	35		
t_s	Storage Time	-	200		$V_{CC}=3V, I_C=10mA,$ $I_{B1}= I_{B2}=1mA$
t_f	Fall Time	-	50		

Equivalent Test Circuit

Fig.1- Delay and Rise Time

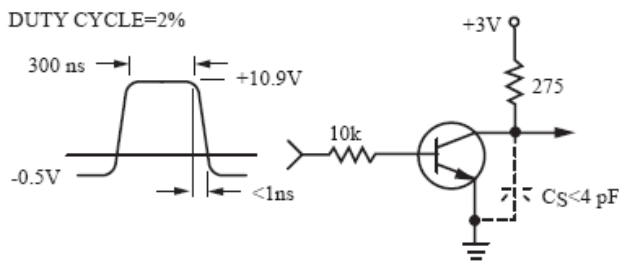
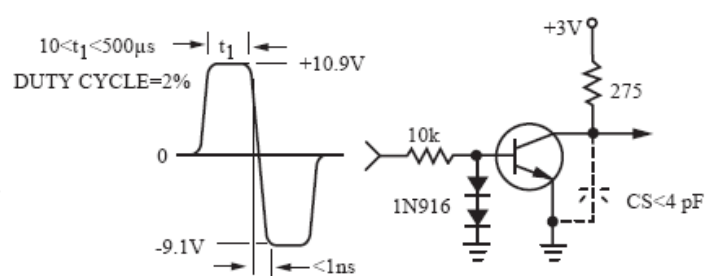


Fig.2- Storage and Fall Time



Total Shunt Capacitance of test jig and connectors

SMD General Purpose Transistor (NPN)

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Typical Characteristics Curves (— $T_J = 25^\circ\text{C}$ --- $T_J = 125^\circ\text{C}$)

Fig.3- Capacitance

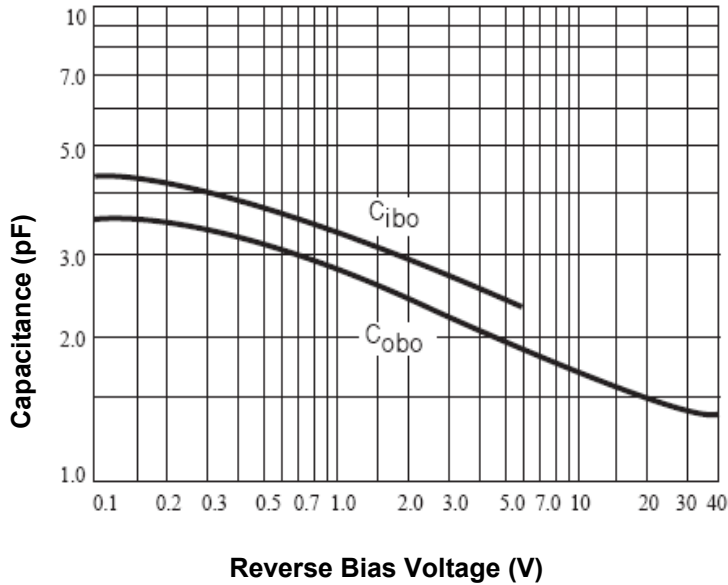


Fig.4- Charge Data

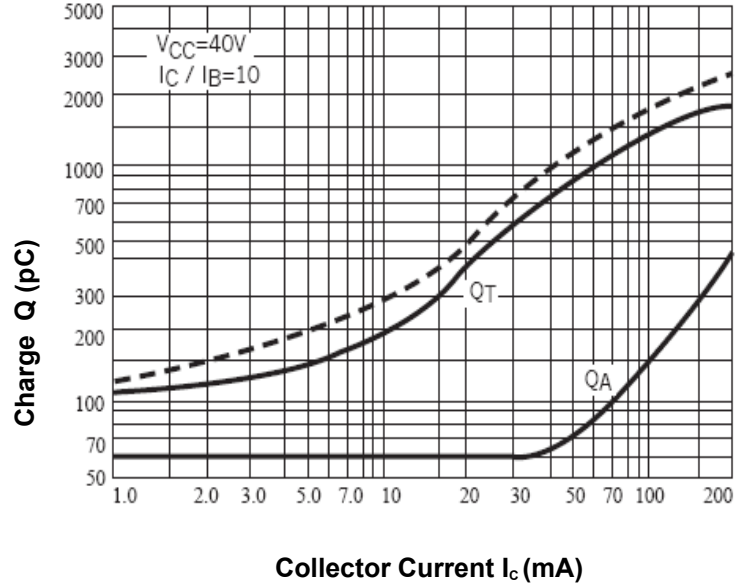


Fig.5- Turn-On Time

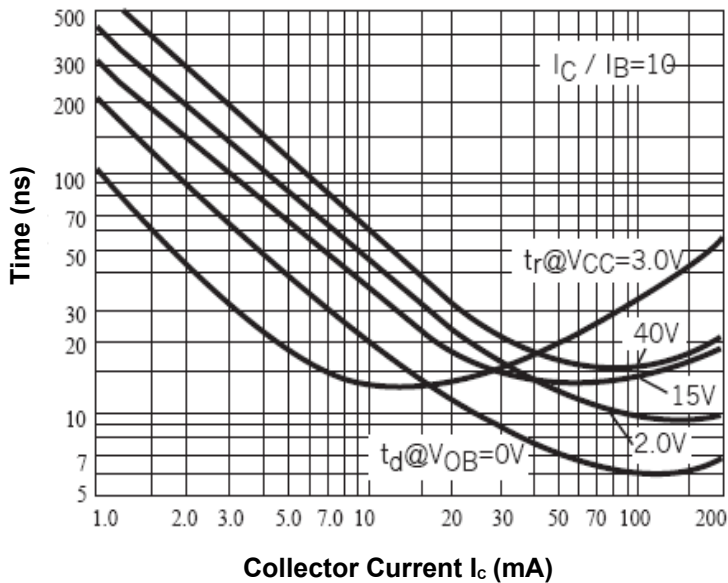
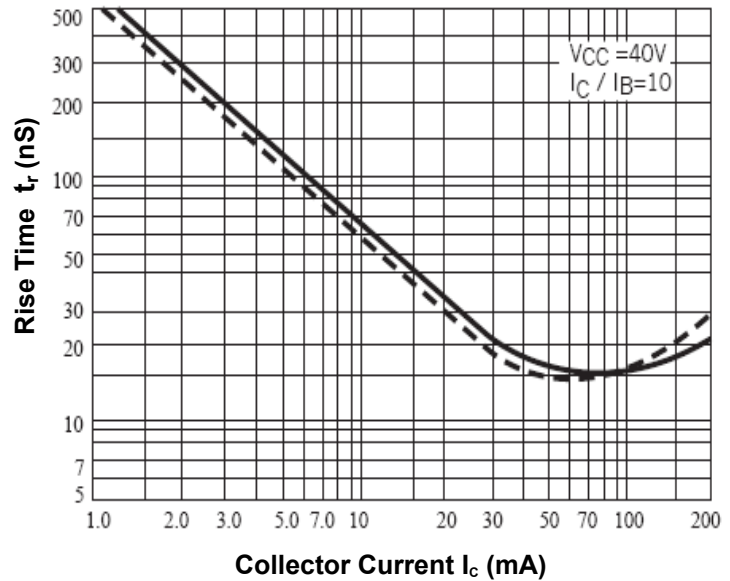


Fig.6- Rise Time



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Fig.7- Storage Time

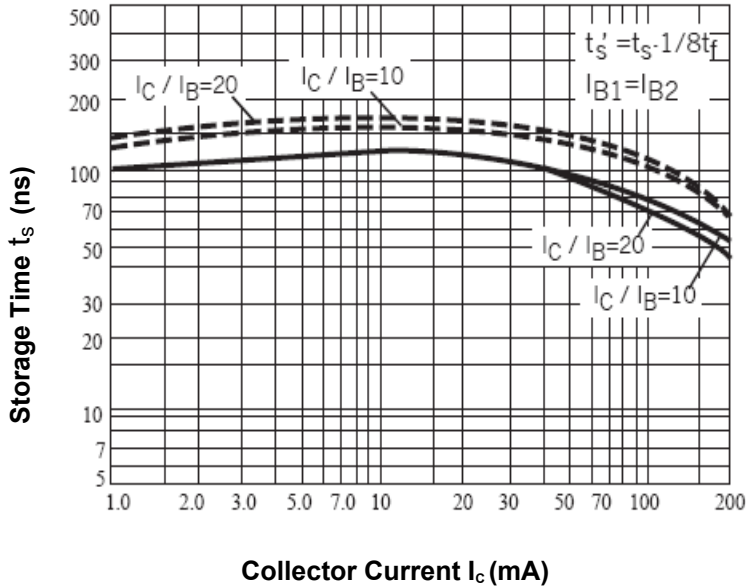
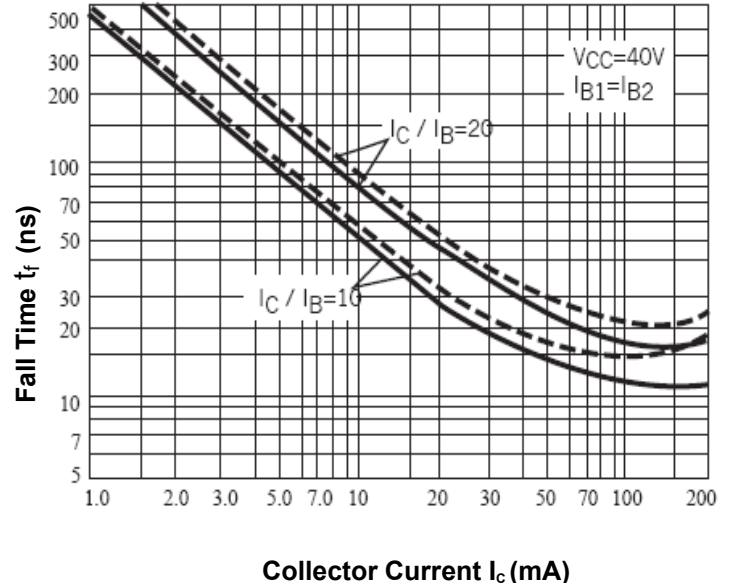


Fig.8- Fall Time



Typical Audio Small-Signal Characteristics Noise Figure Variations ($V_{CE} = 5.0V$, $T_A = 25^\circ C$, Bandwidth = 1.0Hz)

Fig.9- Noise Figure

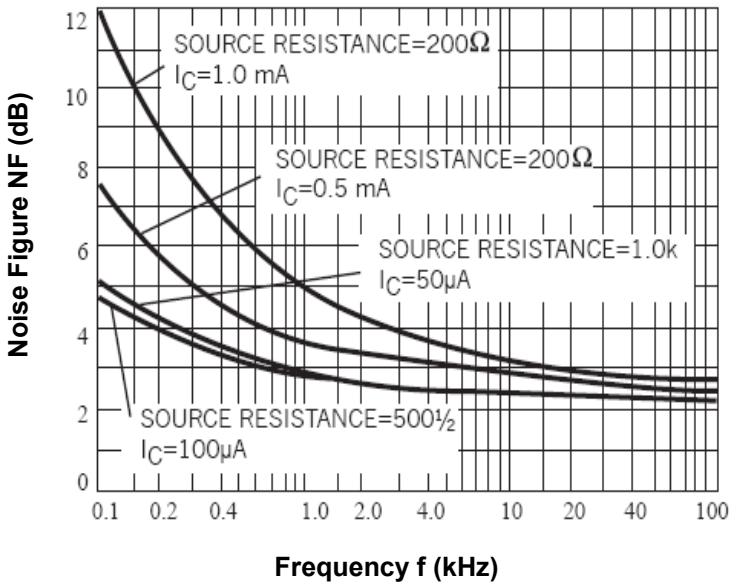
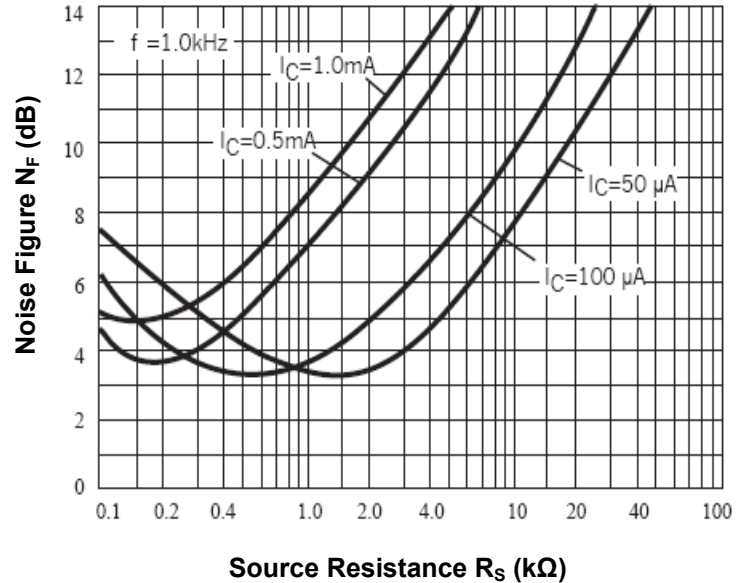


Fig.10- Noise Figure



SMD General Purpose Transistor (NPN)

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h Parameters ($V_{CE}=10V$, $f=1.0kHz$, $T_A=25^\circ C$)

Fig.11- Current Gain

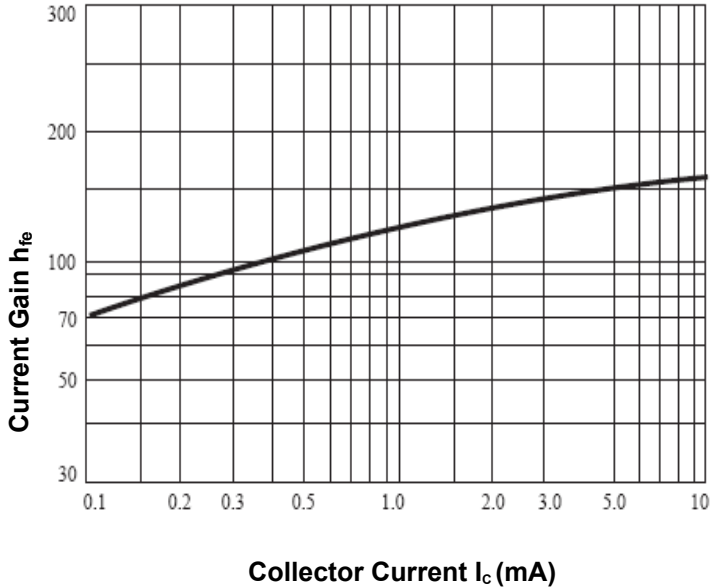


Fig.12- Output Admittance

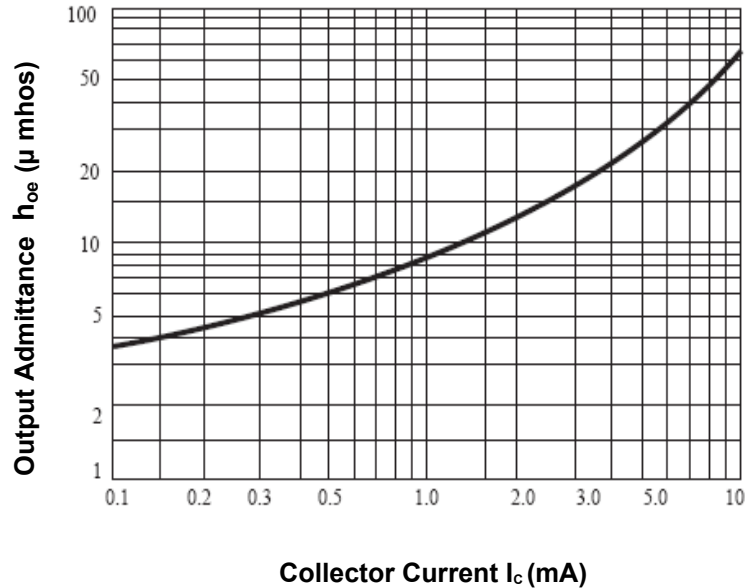


Fig.13- Input Impedance

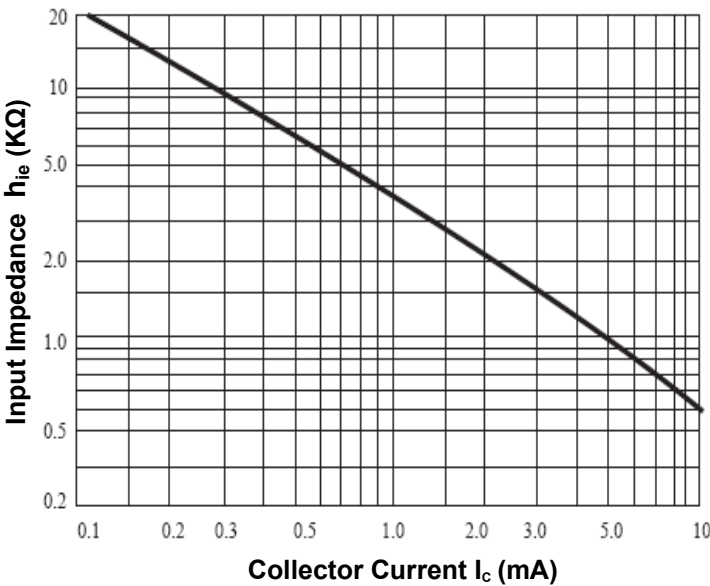
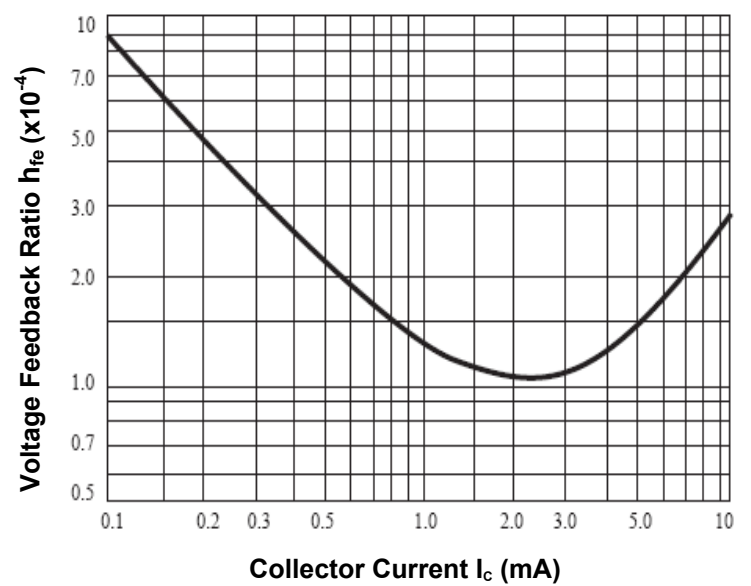


Fig.14- Voltage Feedback Ratio



SMD General Purpose Transistor (NPN)

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Typical Static Characteristics

Fig.15- DC Current Gain

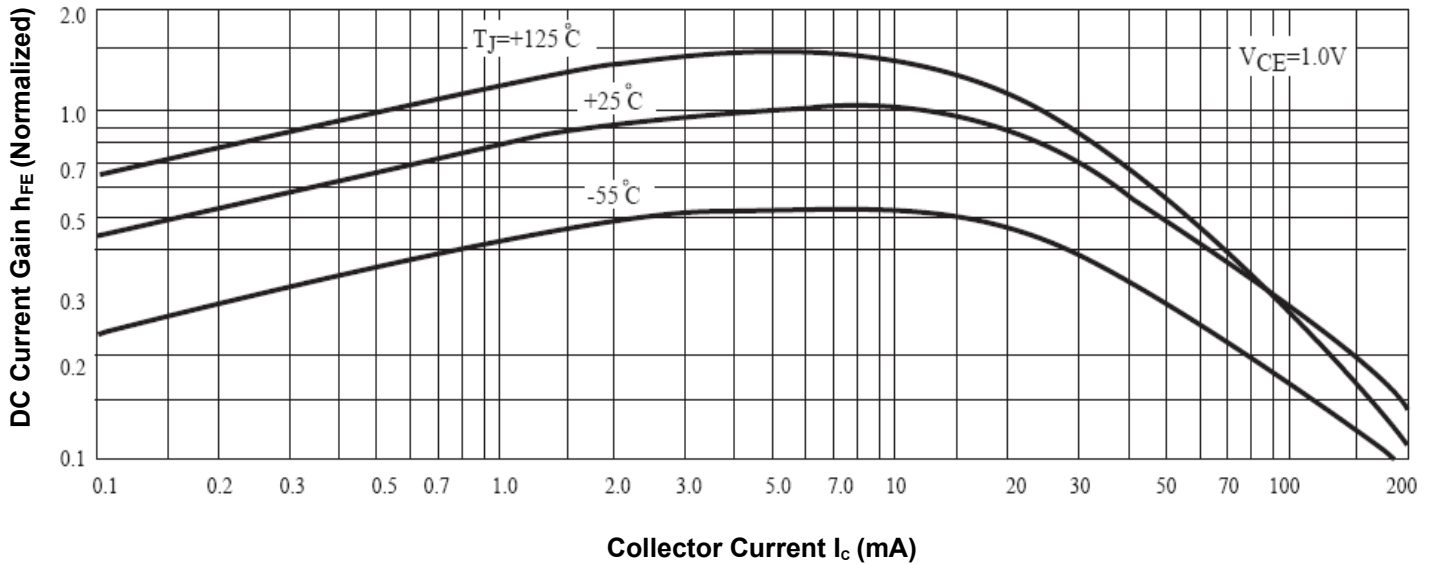
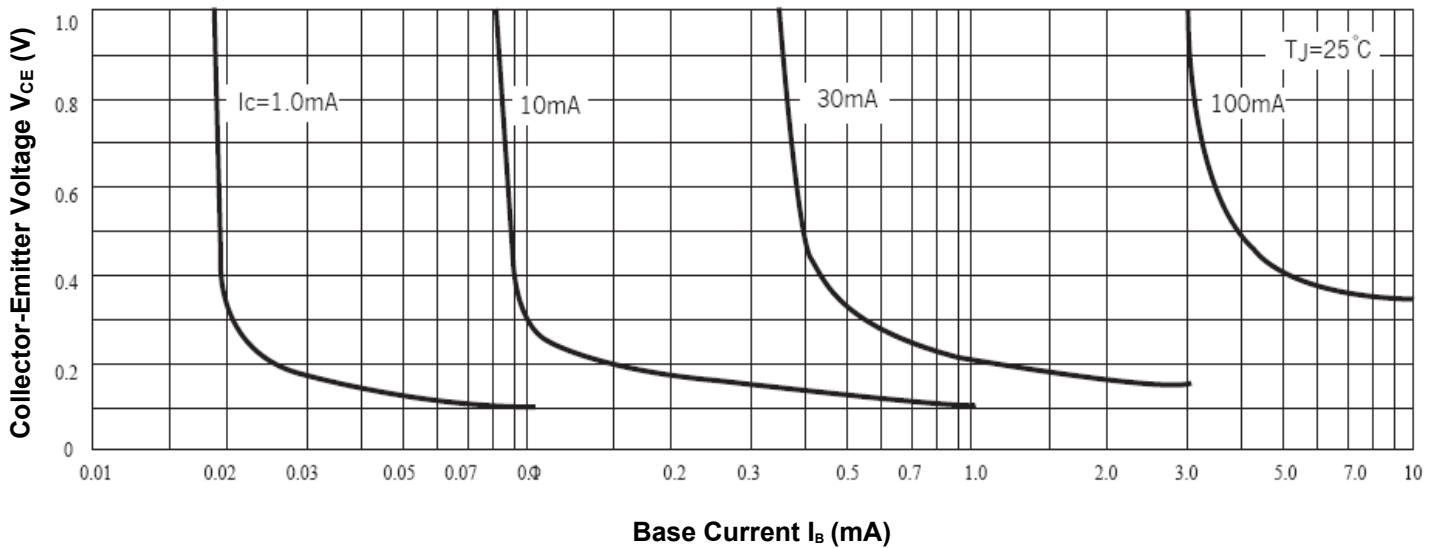


Fig.16- Collector Saturation Region



SMD General Purpose Transistor (NPN)

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Fig.17- "On" Voltage

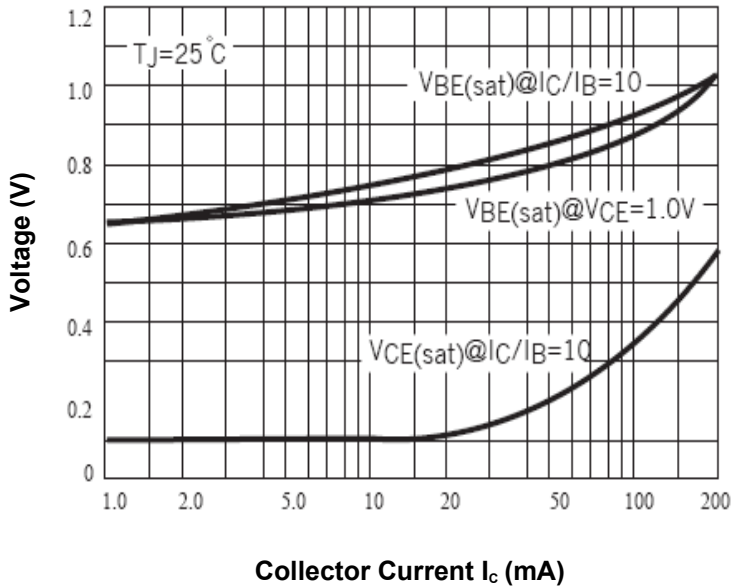
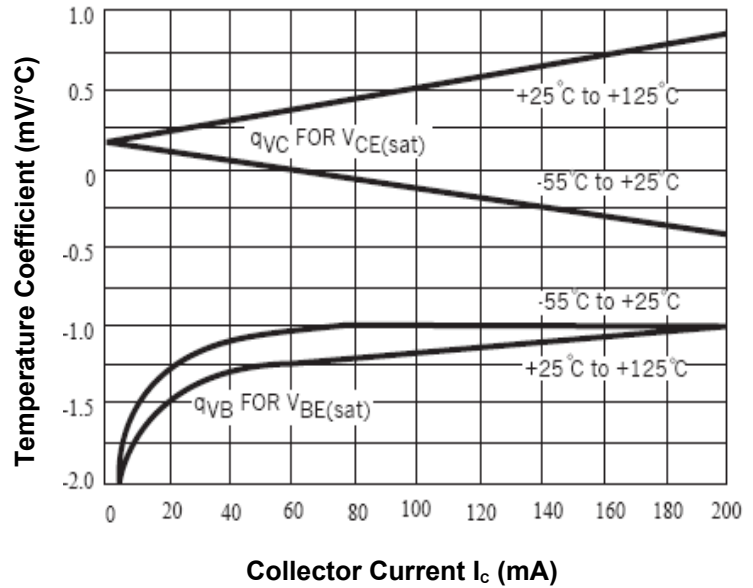


Fig.18- Temperature Coefficients



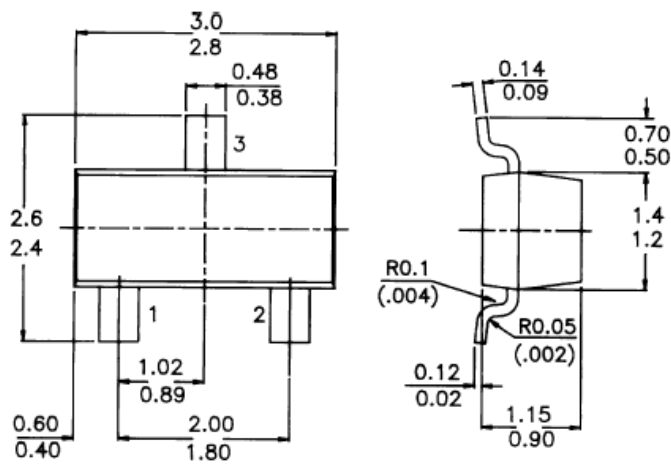
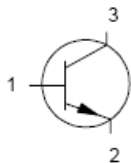
Device Marking: MMBT3904=1AM

Dimensions in mm

SOT-23

Pin configuration

- 1 = BASE
- 2 = EMITTER
- 3 = COLLECTOR



SMD General Purpose Transistor (NPN)

MMBT3904

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