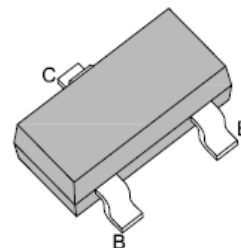


## SMD General Purpose Transistor (NPN)

### Features

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



SOT-23



### Mechanical Data

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

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

Symbol	Description	MMBT3904	Unit	Conditions
<b>V<sub>CEO</sub></b>	Collector-Emitter Voltage	40	V	
<b>V<sub>CB0</sub></b>	Collector-Base Voltage	60	V	
<b>V<sub>EB0</sub></b>	Emitter-Base Voltage	6.0	V	
<b>I<sub>C</sub></b>	Collector Current	200	mA	
<b>P<sub>D</sub></b>	Total Device Power Dissipation(Note 1)	225	mW	TA=25 °C
		1.8	mW/°C	Derate above 25 °C
<b>R<sub>θJA</sub></b>	Thermal Resistance, Junction to Ambient	556	°C /W	
<b>P<sub>D</sub></b>	Total Device Power Dissipation, Alumina Substrate (Note 2)	300	mW	TA=25 °C
		2.4	mW/°C	Derate above 25 °C
<b>R<sub>θJA</sub></b>	Thermal Resistance, Junction to Ambient	417	°C /W	
<b>T<sub>J</sub></b>	Junction Temperature	-55 to +150	°C	
<b>T<sub>STG</sub></b>	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.

# SMD General Purpose Transistor (NPN)

## MMBT3904

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

#### Off Characteristics

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

#### On Characteristics

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

#### Small-signal Characteristics

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

# SMD General Purpose Transistor (NPN)

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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

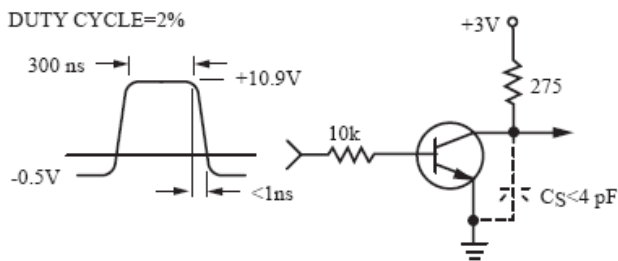
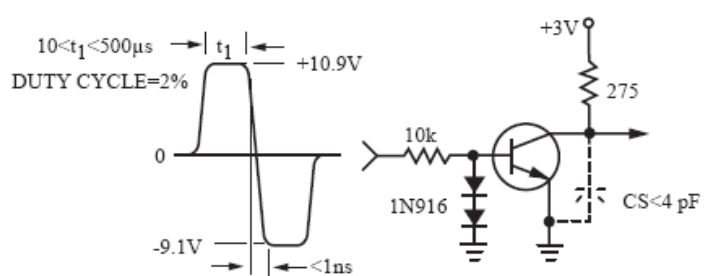


Fig.2- Storage and Fall Time



Total Shunt Capacitance of test jig and connectors

# SMD General Purpose Transistor (NPN)

## MMBT3904

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

Fig.3- Capacitance

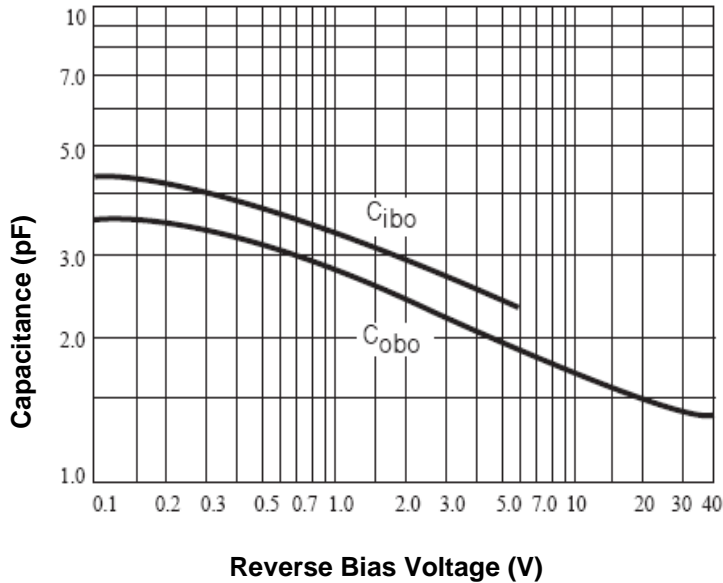


Fig.4- Charge Data

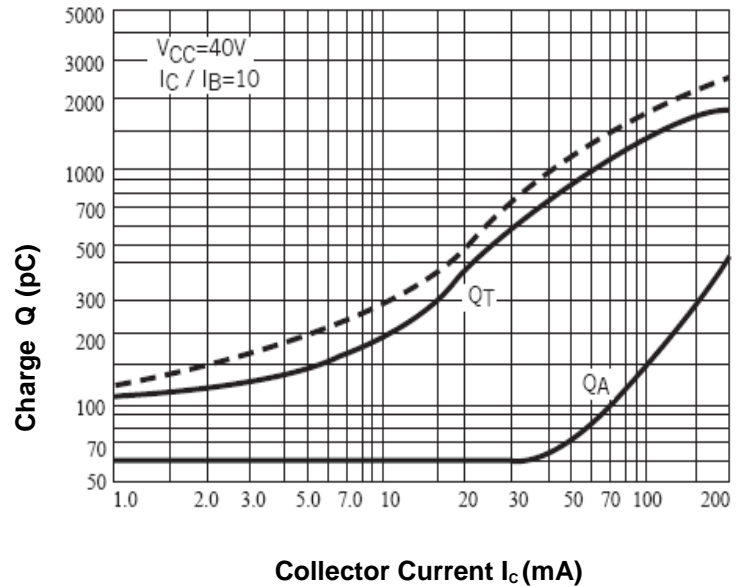


Fig.5- Turn-On Time

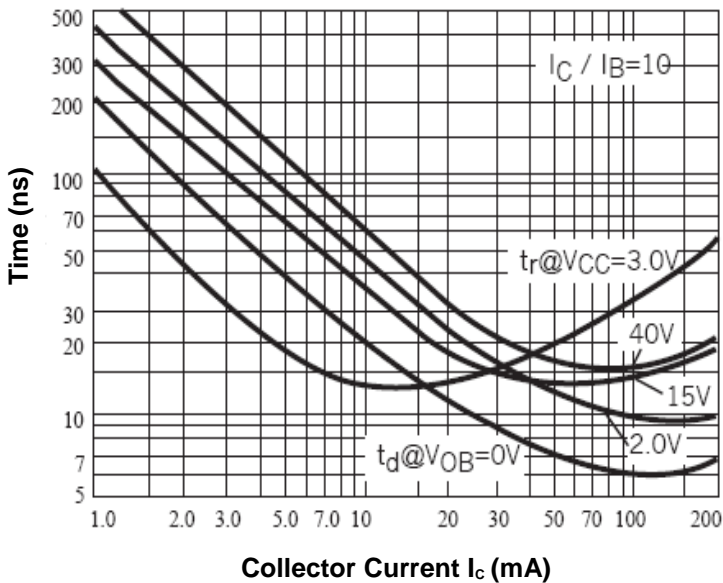
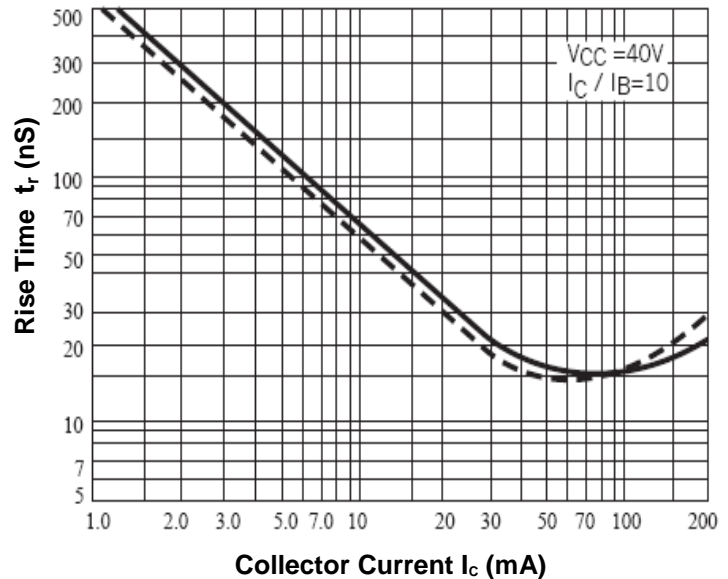


Fig.6- Rise Time



# SMD General Purpose Transistor (NPN)

## MMBT3904

Fig.7- Storage Time

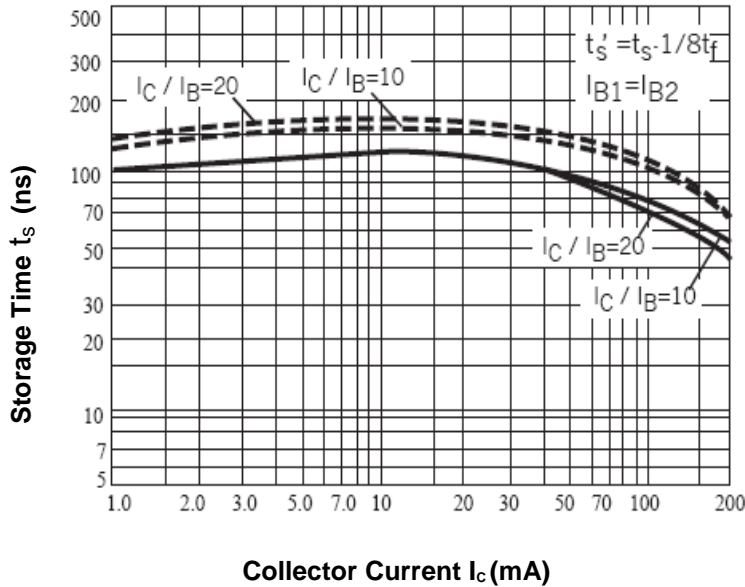
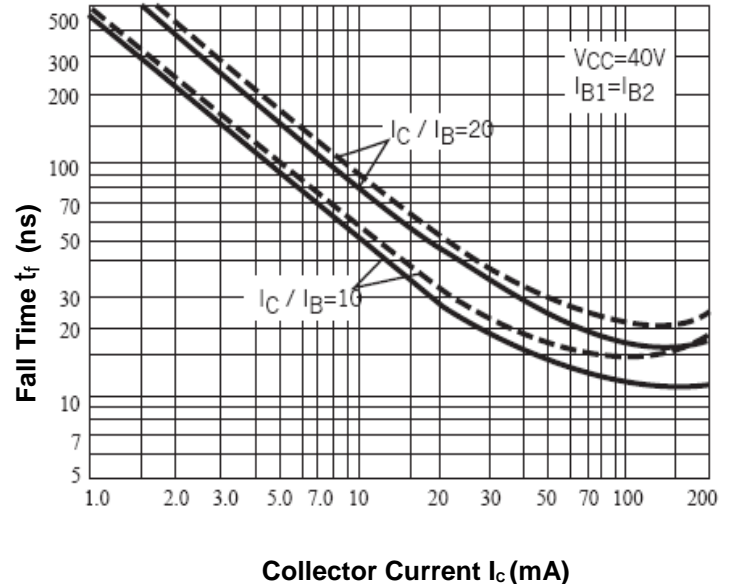


Fig.8- Fall Time



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

Fig.9- Noise Figure

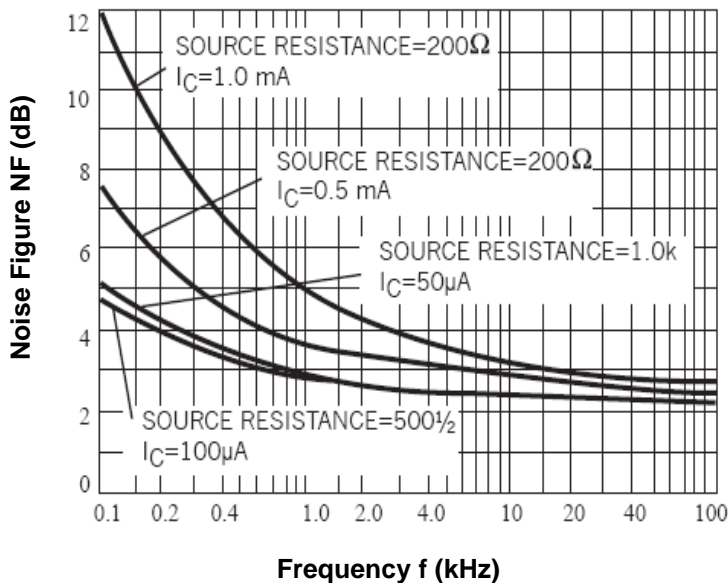
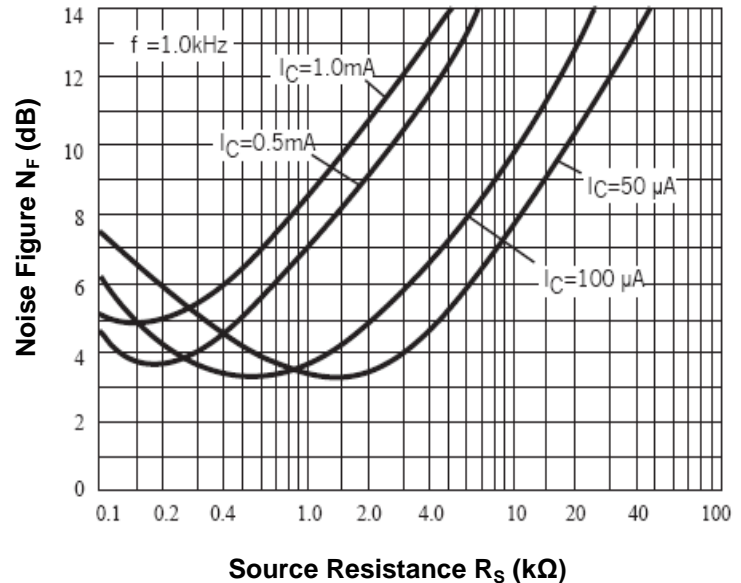


Fig.10- Noise Figure

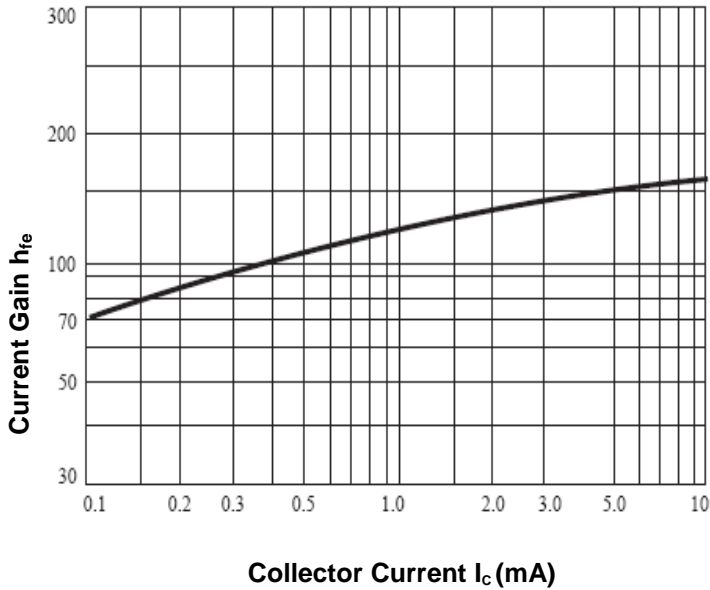


# SMD General Purpose Transistor (NPN)

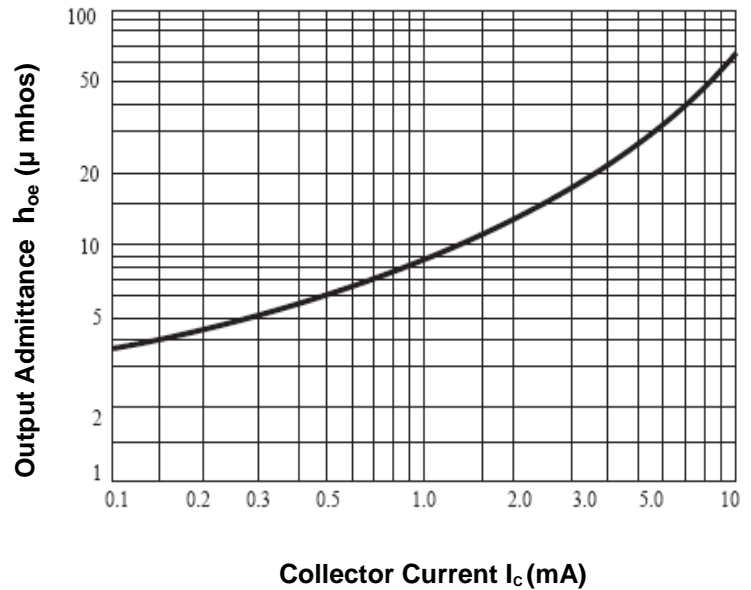
## MMBT3904

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

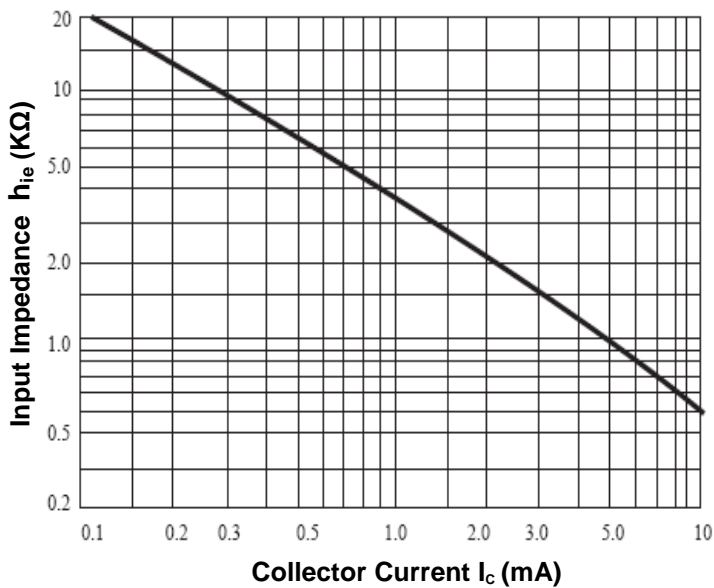
**Fig.11- Current Gain**



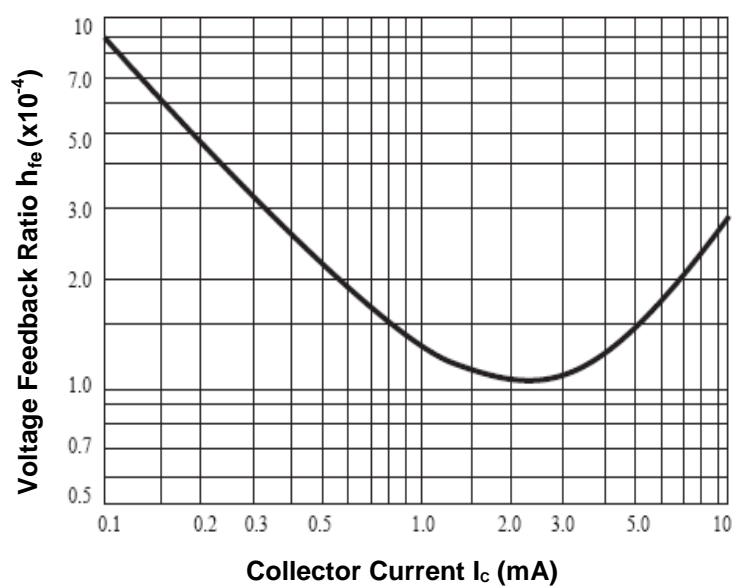
**Fig.12- Output Admittance**



**Fig.13- Input Impedance**



**Fig.14- Voltage Feedback Ratio**



# SMD General Purpose Transistor (NPN)

MMBT3904

## Typical Static Characteristics

Fig.15- DC Current Gain

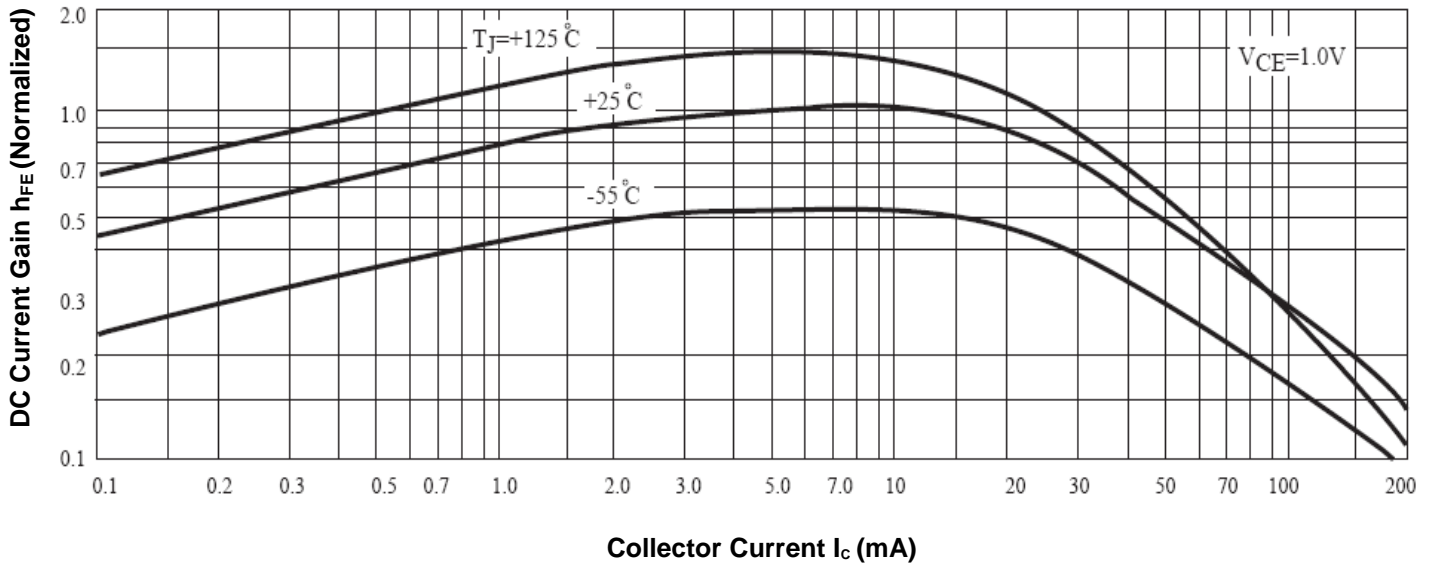
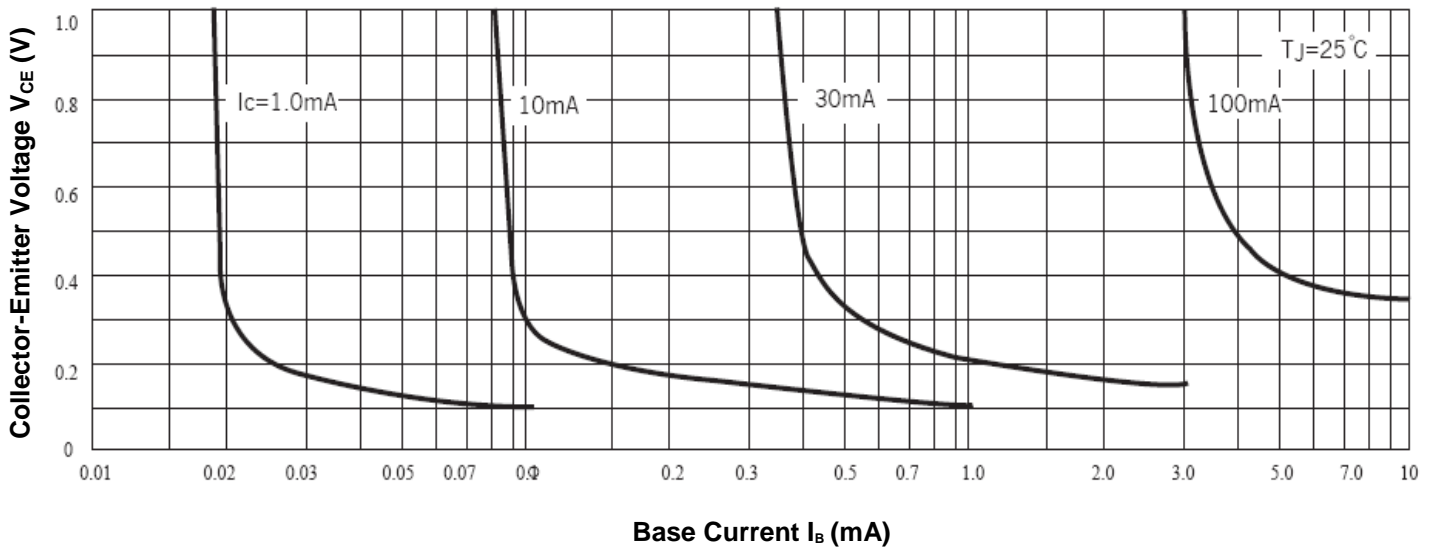


Fig.16- Collector Saturation Region



# SMD General Purpose Transistor (NPN)

## MMBT3904

Fig.17- "On" Voltage

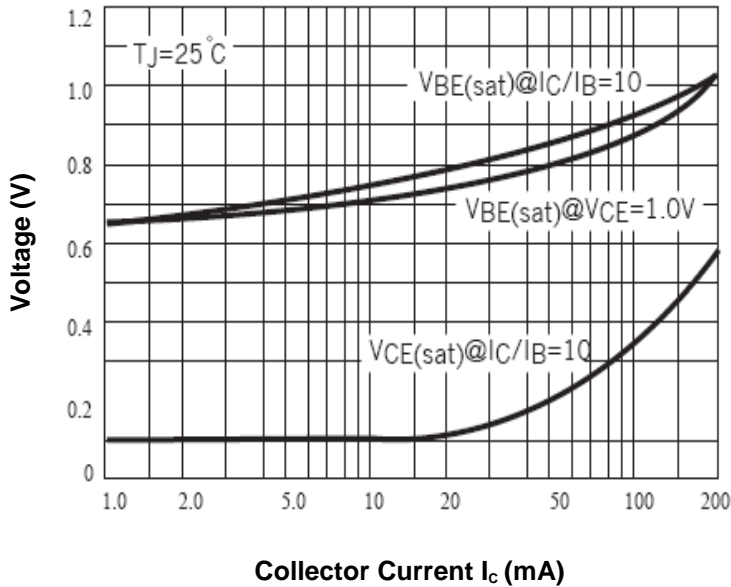
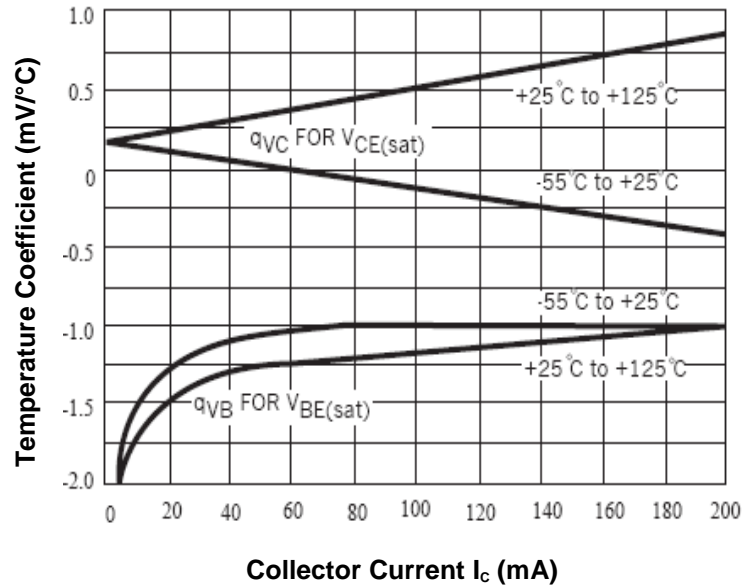


Fig.18- Temperature Coefficients



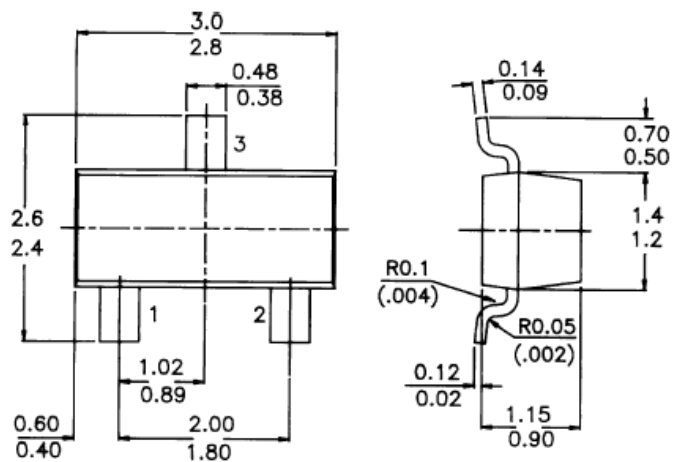
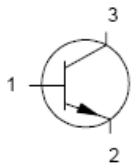
Device Marking: MMBT3904=1A/1AM/ZC

Dimensions in mm

SOT-23

Pin configuration

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





# SMD General Purpose Transistor (NPN)

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MMBT3904

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