



DATA SHEET

SEMICONDUCTOR

MMBT3904

General Purpose Transistor

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

ORDERING INFORMATION

Device	Package	Shipping
MMBT3904	SOT-23	3000/Tape & Reel

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	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board, (1) $T_A = 25^\circ\text{C}$	P_D	225	mW
Derate above 25°C		1.8	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation Alumina Substrate, (2) $T_A = 25^\circ\text{C}$	P_D	300	mW
Derate above 25°C		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$

DEVICE MARKING

MMBT3904 = 1AM

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(3) ($I_C = 1.0 \text{ mAdc}$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \mu\text{Adc}$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{Adc}$)	$V_{(BR)EBO}$	6.0	—	Vdc
Emitter cut-off current ($V_{CB}=60\text{V}, I_E=0$)	I_{CBO}	—	100	nA
Collector cut-off current ($V_{EB}=6\text{V}, I_C=0$)	I_{EBO}	—	100	nA
Base cut-off current ($V_{CE}=40\text{V}, I_B=0$)	I_{CEO}	—	5	μA

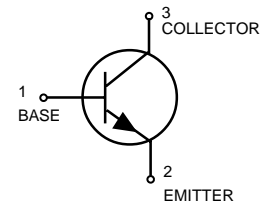
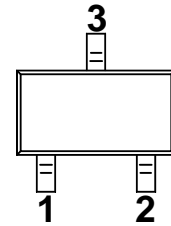
1. FR-5 = 1.0 x 0.75 x 0.062 in.

2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

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



SOT-23



DEVICE CHARACTERISTICS

MMBT3904

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS (3)				
DC Current Gain(1) ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)	h_{FE}	40	—	—
($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)		70	—	
($I_C = 10 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)		100	300	
($I_C = 50 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)		60	—	
($I_C = 100 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)		30	—	
Collector–Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$)(3)	$V_{CE(sat)}$	—	0.2	Vdc
($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)		—	0.3	
Base–Emitter Saturation Voltage(3) ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$)	$V_{BE(sat)}$	0.65	0.85	Vdc
($I_C = 50 \text{ mAdc}$, $I_B = 5.0 \text{ mAdc}$)		—	0.95	

SMALL–SIGNAL CHARACTERISTICS

Current–Gain — Bandwidth Product ($I_C = 10 \text{ mAdc}$, $V_{CE} = 20 \text{ Vdc}$, $f = 100 \text{ MHz}$)	f_T	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 ($V_{BE} = 0.5 \text{ Vdc}$, $I_C = 0$, $f = 1.0 \text{ MHz}$)	C_{ibo}	—	8.0	pF
Input Impedance ($V_{CE} = 10 \text{ Vdc}$, $I_C = 1.0 \text{ mAdc}$, $f = 1.0 \text{ kHz}$)	h_{ie}	1.0	10	pF
Voltage Feedback Ratio ($V_{CE} = 10 \text{ Vdc}$, $I_C = 1.0 \text{ mAdc}$, $f = 1.0 \text{ kHz}$)	h_{re}	0.5	8.0	$\times 10^{-4}$
Small–Signal Current Gain ($V_{CE} = 10 \text{ Vdc}$, $I_C = 1.0 \text{ mAdc}$, $f = 1.0 \text{ kHz}$)	h_{fe}	100	400	—
Output Admittance ($V_{CE} = 10 \text{ Vdc}$, $I_C = 1.0 \text{ mAdc}$, $f = 1.0 \text{ kHz}$)	h_{oe}	1.0	40	mhos
Noise Figure ($V_{CE} = 5.0 \text{ Vdc}$, $I_C = 100 \mu\text{Adc}$, $R_S = 1.0 \text{ k}\Omega$, $f = 1.0 \text{ kHz}$)	NF	—	5.0	dB

SWITCHING CHARACTERISTICS

Delay Time ($V_{CC} = 3.0 \text{ Vdc}$, $V_{BE} = -0.5 \text{ Vdc}$)	t_d	—	35	ns
Rise Time ($I_C = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$)	t_r	—	35	ns
Storage Time ($V_{CC} = 3.0 \text{ Vdc}$)	t_s	—	200	ns
Fall Time ($I_C = 10 \text{ mAdc}$, $I_{B1} = I_{B2} = 10 \text{ mAdc}$)	t_f	—	50	ns
Turn on Time ($V_{CC} = 3.0 \text{ Vdc}$, $V_{BE} = -0.5 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$)	$t_d + t_r$	—	70	ns
Turn off Time ($V_{CC} = 3.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $I_{B1} = I_{B2} = 10 \text{ mAdc}$)	$t_s + t_f$	—	250	ns

DEVICE CHARACTERISTICS

MMBT3904

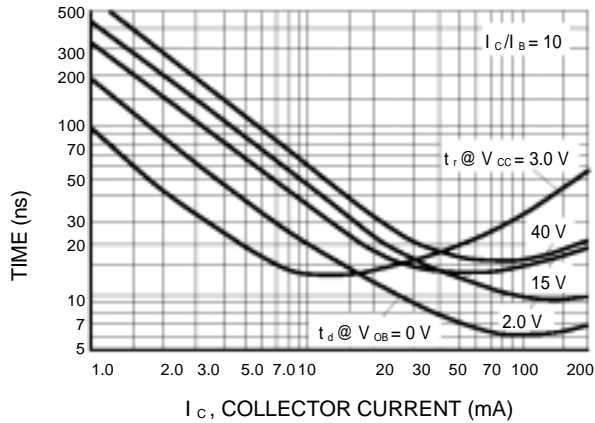


Figure 5. Turn-On Time

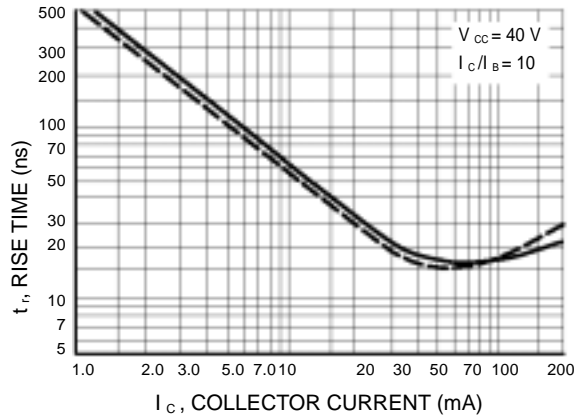


Figure 6. Rise Time

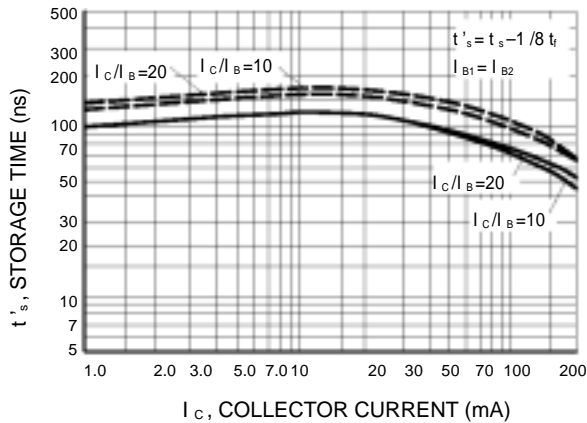


Figure 7. Storage Time

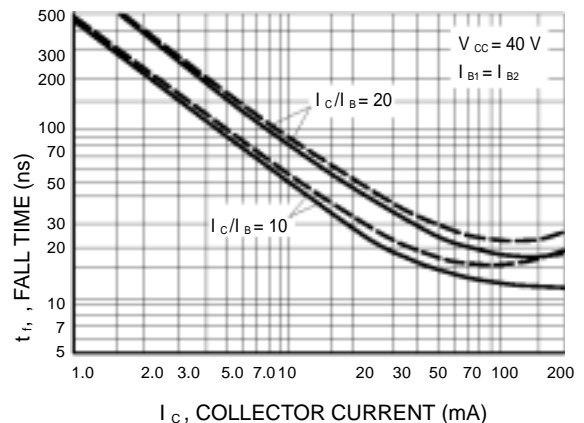


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

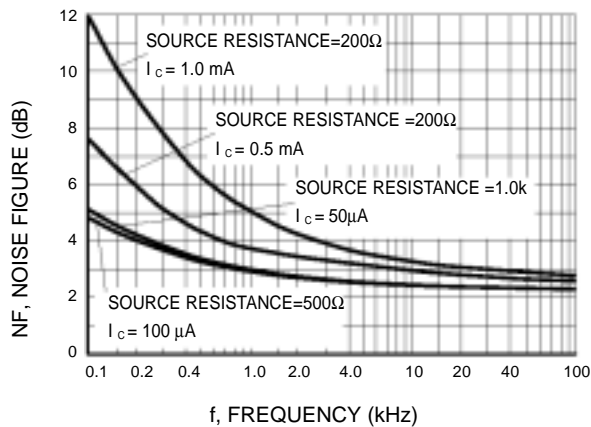


Figure 9.

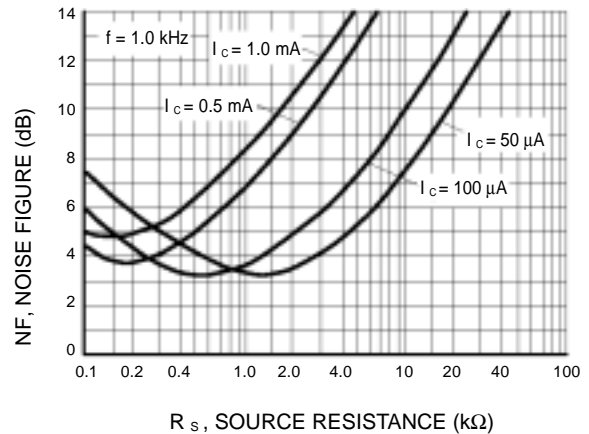


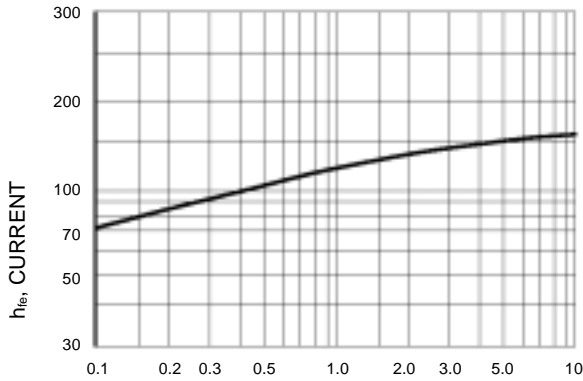
Figure 10.

DEVICE CHARACTERISTICS

MMBT3904

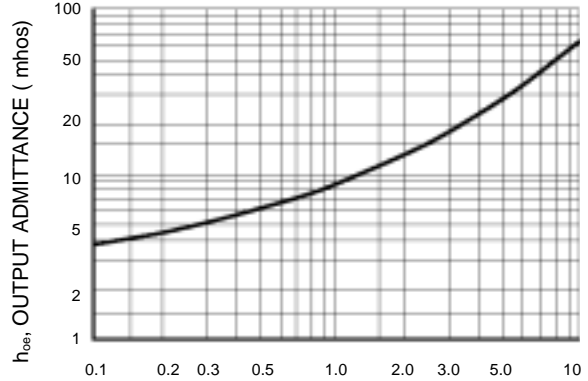
h PARAMETERS

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



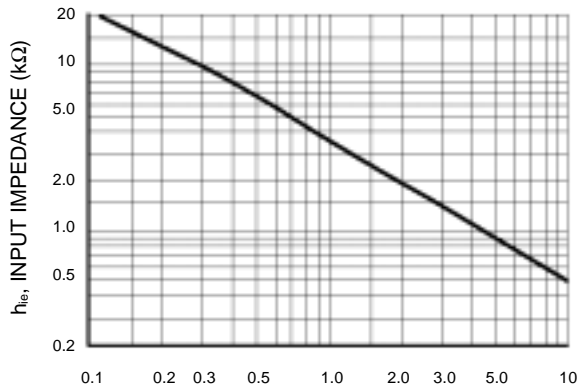
I_C, COLLECTOR CURRENT (mA)

Figure 11. Current Gain



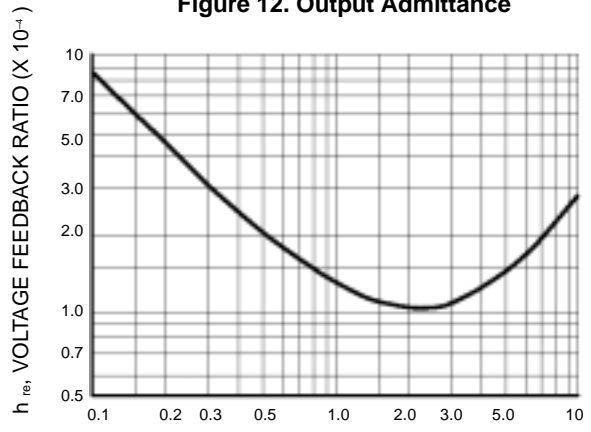
I_C, COLLECTOR CURRENT (mA)

Figure 12. Output Admittance



I_C, COLLECTOR CURRENT (mA)

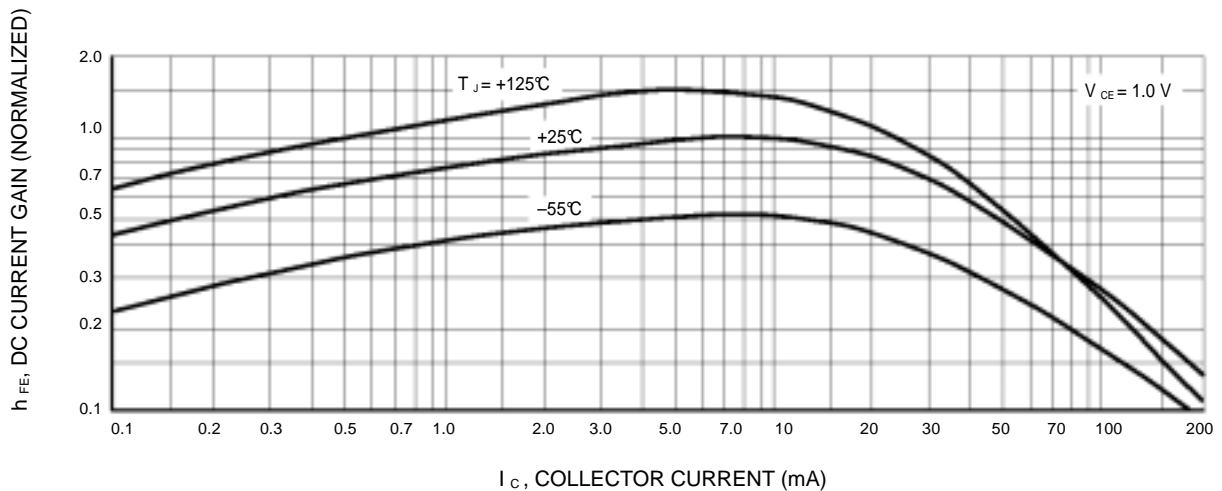
Figure 13. Input Impedance



I_C, COLLECTOR CURRENT (mA)

Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS



I_C, COLLECTOR CURRENT (mA)

Figure 15. DC Current Gain

DEVICE CHARACTERISTICS

MMBT3904

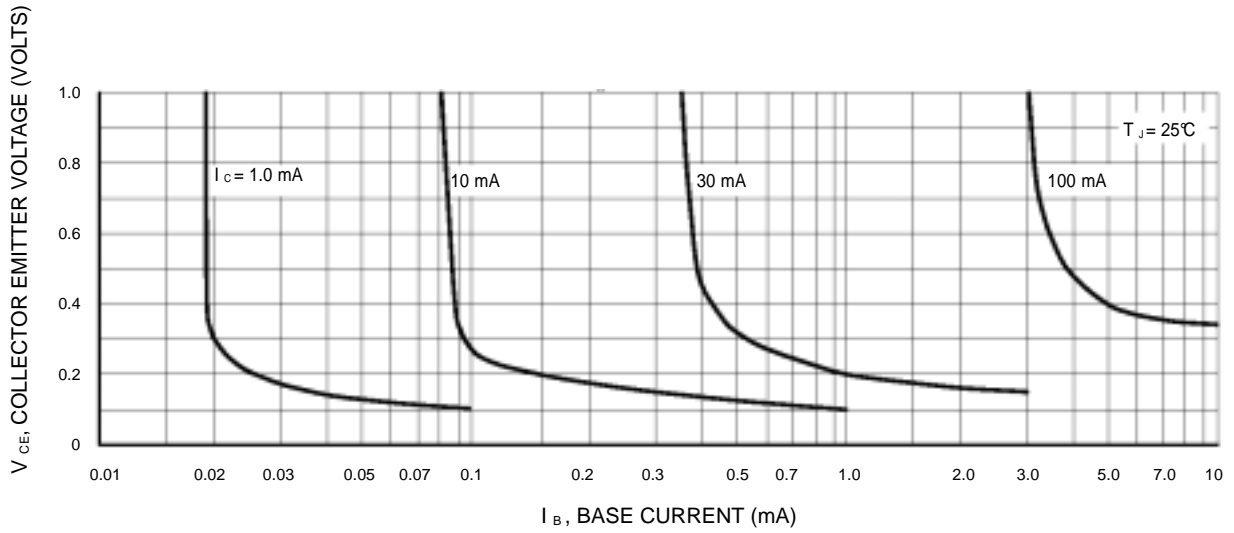


Figure 16. Collector Saturation Region

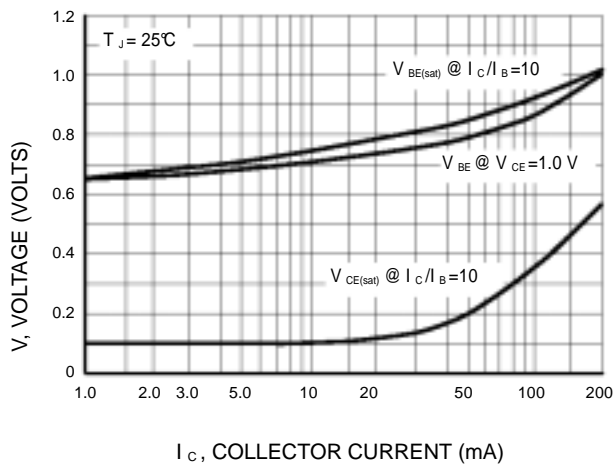


Figure 17. "ON" Voltages

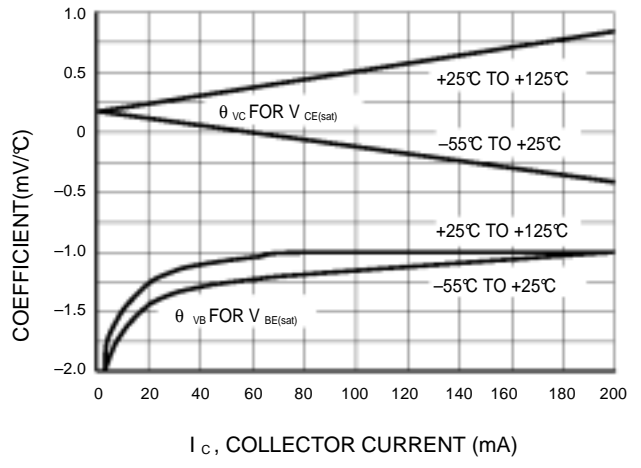
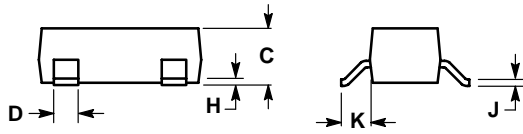
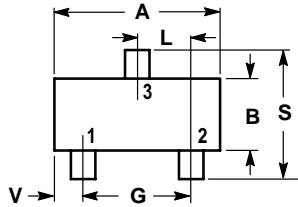


Figure 18. Temperature Coefficients

PACKAGE OUTLINE & DIMENSIONS

MMBT3904

SOT-23

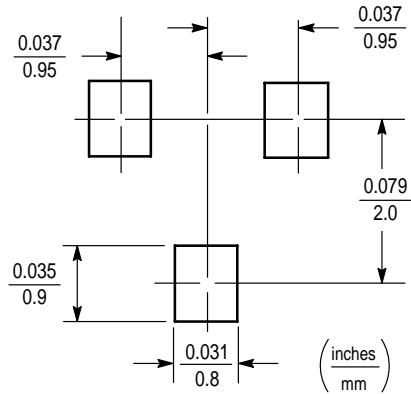


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0140	0.0285	0.35	0.69
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.1039	2.10	2.64
V	0.0177	0.0236	0.45	0.60

- PIN 1. BASE
 2. EMITTER
 3. COLLECTOR



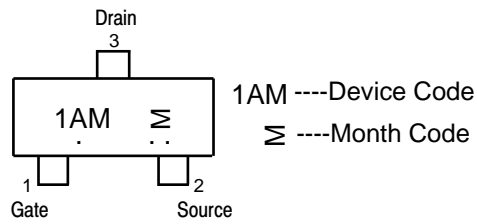


SEMICONDUCTOR

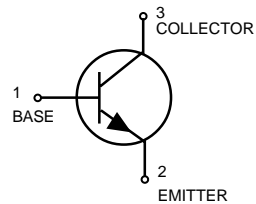
Approve Sheet: Part Number: MMBT3904

MARKING

SOT-23



CIRCUIT FIGURE



MARKING DIAGRAM & PIN ASSIGNMENT

ORDERING INFORMATION

Device	Marking	Minimum Q'ty
MMBT3904	1AM	3000/TR



SEMICONDUCTOR

Approve Sheet: Part Number: SOD/SOT

MARKING

MONTH CODE

ODD YEARS (2001/1/3)

Jan	1
Feb	2
Mar	3
Apr	4
May	5
Jun	6
Jul	7
Aug	8
Sep	9
Oct	T
Nov	V
Dec	C

MONTH CODE

EVEN YEARS (2002/1/3)

Jan	E
Feb	F
Mar	H
Apr	J
May	K
Jun	L
Jul	N
Aug	P
Sep	U
Oct	X
Nov	Y
Dec	Z

Location coding features

(DEV=Device code, M=Date code)



DEV----Device Code

M----Month Code



Pb Free

Wafer Source Code