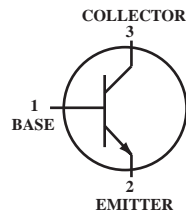


General Purpose Transistor
NPN Silicon
 **Lead(Pb)-Free**

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

Characteristics	Symbol	Max	Unit
Total Device Dissipation FR-5 Board ⁽¹⁾ T _A =25 °C	P _D	225	mW
Derate above 25 °C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	R _{θJA}	556	°C/W
Total Device Dissipation Alumina Substrate, ⁽²⁾ T _A =25 °C	P _D	300	mW
Derate above 25 °C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	R _{θJA}	417	°C/W
Junction and Storage, Temperature	T _J , T _{stg}	-55 to +150	°C

Device Marking

MMBT3904=1AM

Electrical Characteristics (T_A=25 °C Unless Otherwise noted)

Characteristics	Symbol	Min	Max	Unit
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Off Characteristics

Collector-Emitter Breakdown Voltage ⁽³⁾ (I _C =1.0mAdc, I _B =0)	V _{(BR)CEO}	40	-	Vdc
Collector-Base Breakdown Voltage (I _C =10 μAdc, I _E =0)	V _{(BR)CBO}	60	-	Vdc
Emitter-Base Breakdown Voltage (I _E =10 μAdc, I _C =0)	V _{(BR)EBO}	6.0	-	Vdc
Base Cutoff Current (V _{CE} =30 Vdc, V _{EB} =3.0 Vdc)	I _{BL}	-	50	nAdc
Collector Cutoff Current (V _{CE} =30Vdc, V _{EB} =3.0Vdc)	I _{CEX}	-	50	nAdc

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 ≤ 300 μs, Duty Cycle ≤ 2.0%.

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

Characteristics	Symbol	Min	Max	Unit
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On Characteristics ⁽³⁾

DC Current Gain ($I_C=0.1\text{ mA}$, $V_{CE}=1.0\text{ Vdc}$) ($I_C=1.0\text{ mA}$, $V_{CE}=1.0\text{ Vdc}$) ($I_C=10\text{ mA}$, $V_{CE}=1.0\text{ Vdc}$) ($I_C=50\text{ mA}$, $V_{CE}=1.0\text{ Vdc}$) ($I_C=100\text{ mA}$, $V_{CE}=1.0\text{ Vdc}$)	H_{FE}	40 70 100 60 30	- - 300 - -	-
Collector-Emitter Saturation Voltage ⁽³⁾ ($I_C=10\text{ mA}$, $I_B=1.0\text{ mA}$) ($I_C=50\text{ mA}$, $I_B=5.0\text{ mA}$)	$V_{CE(sat)}$	- -	0.2 0.3	Vdc
Base-Emitter Saturation Voltage ⁽³⁾ ($I_C=10\text{ mA}$, $I_B=1.0\text{ mA}$) ($I_C=50\text{ mA}$, $I_B=5.0\text{ mA}$)	$V_{BE(sat)}$	0.65 -	0.85 0.95	Vdc

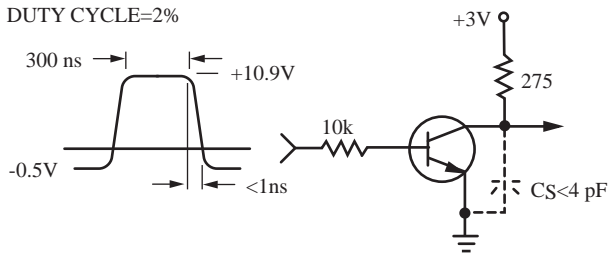
Small-signal Characteristics

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

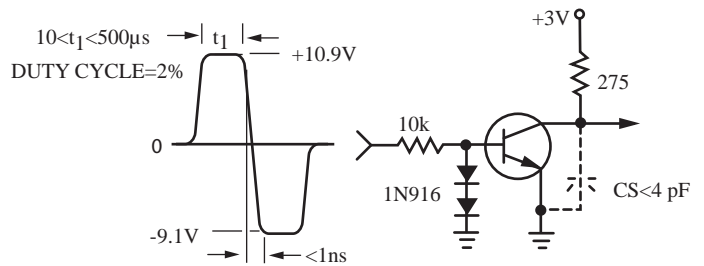
Switching Characteristics

Delay Time	(Vcc= 3.0 Vdc, VBE= -0.5 Vdc Ic= 10 mA, IB1= 1.0 mA)	t_d	-	35	ns
Rise Time		t_r	-	35	
Storage Time	(Vcc= 3.0 Vdc, Ic= 10 mA, IB1=IB2= 1.0 mA)	t_s	-	200	ns
Fall Time		t_f	-	50	

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



**FIG.1 Delay and Rise Time
Equivalent Test Circuit**



**FIG.2 Storage and Fall Time
Equivalent Test Circuit**

*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

— $T_J=25^\circ\text{C}$ - - - $T_J=125^\circ\text{C}$

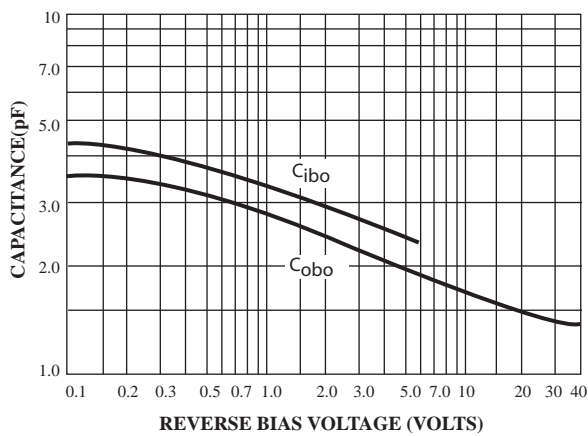


FIG.3 Capacitance

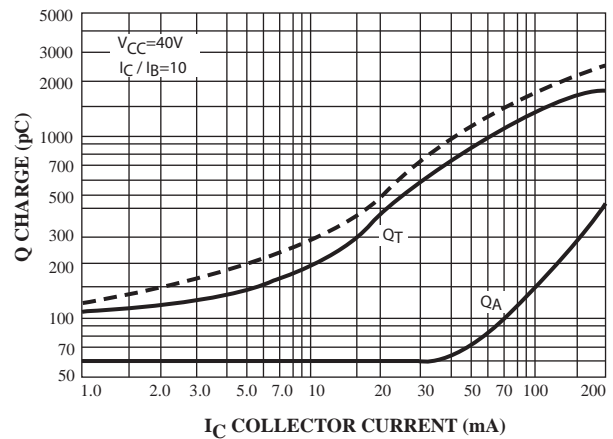


FIG.4 Charge Data

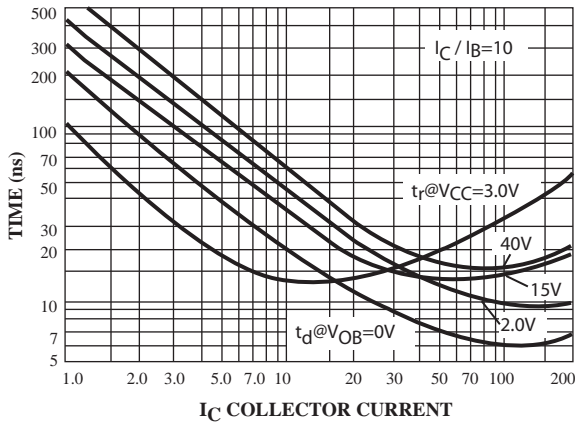


FIG.5 Turn-On Time

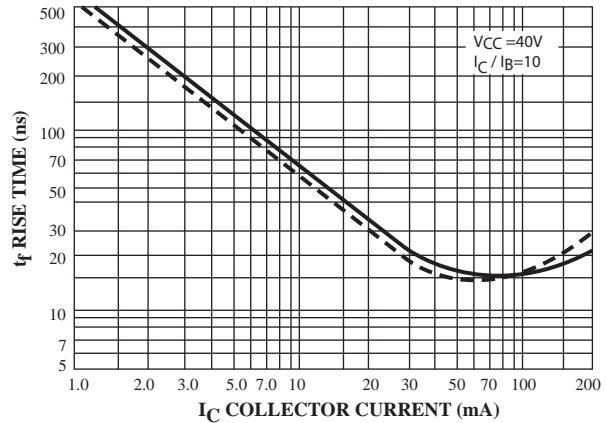


FIG.6 Rise Time

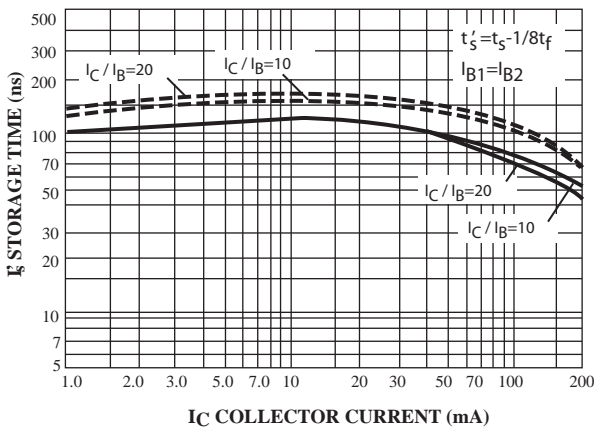


FIG.7 Storage Time

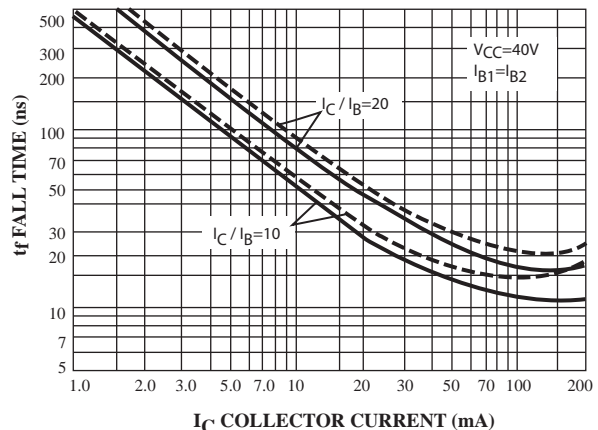


FIG.8 Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

(V_{CE}=5.0 Vdc, T_A=25°C, Bandwidth=1.0Hz)

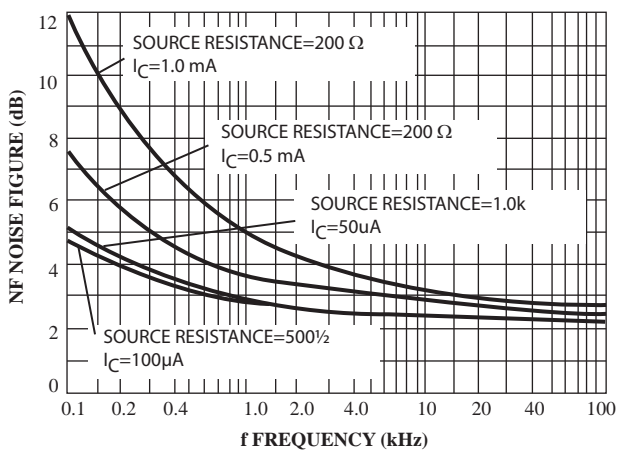


FIG.9

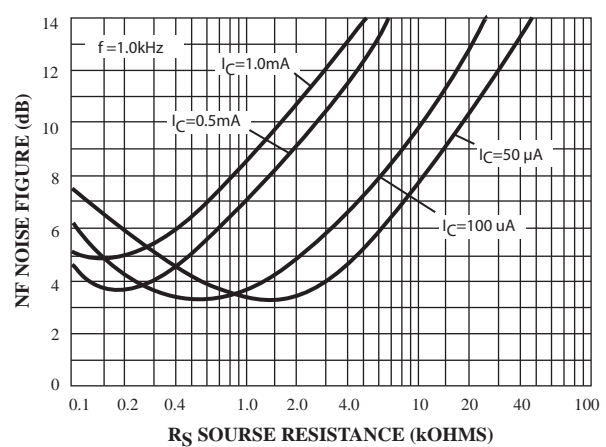


FIG.10

(NPN)

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

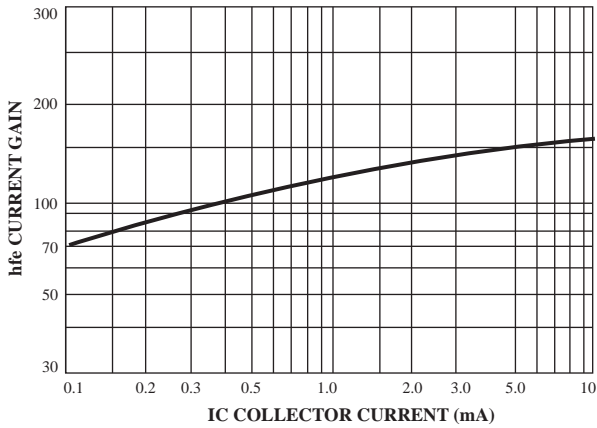


FIG.11 Current Gain

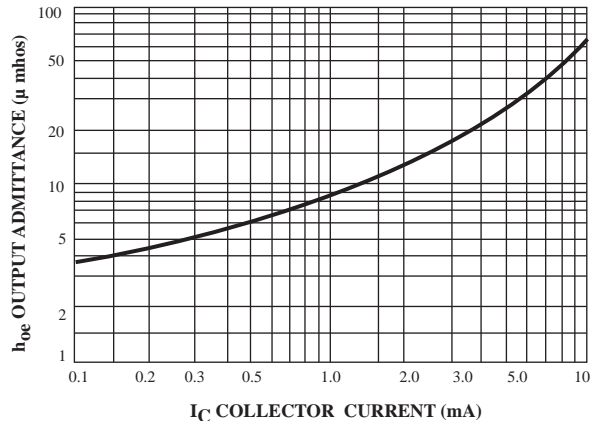


FIG.12 Output Admittance

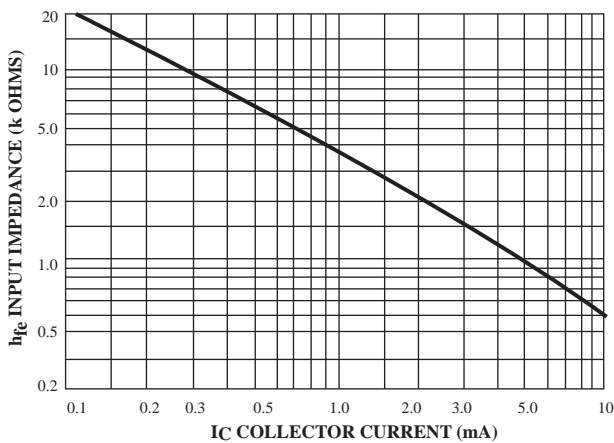


FIG.13 Input Impedance

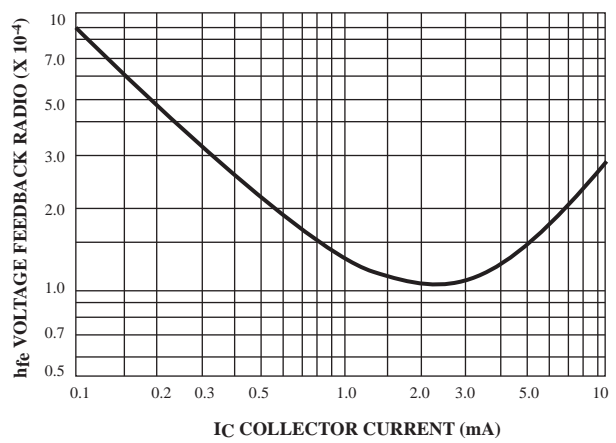


FIG.14 Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

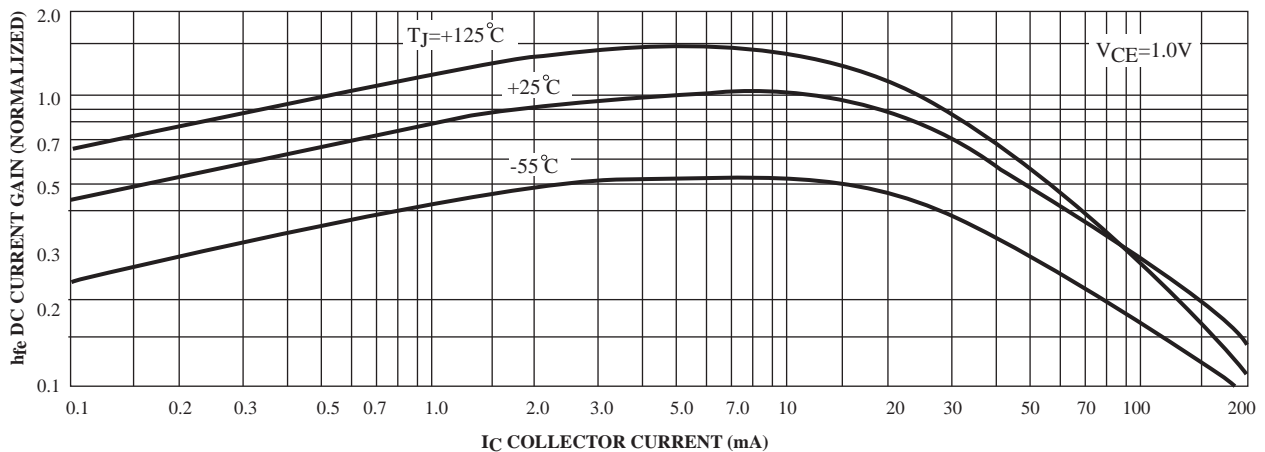


FIG.15 DC Current Gain

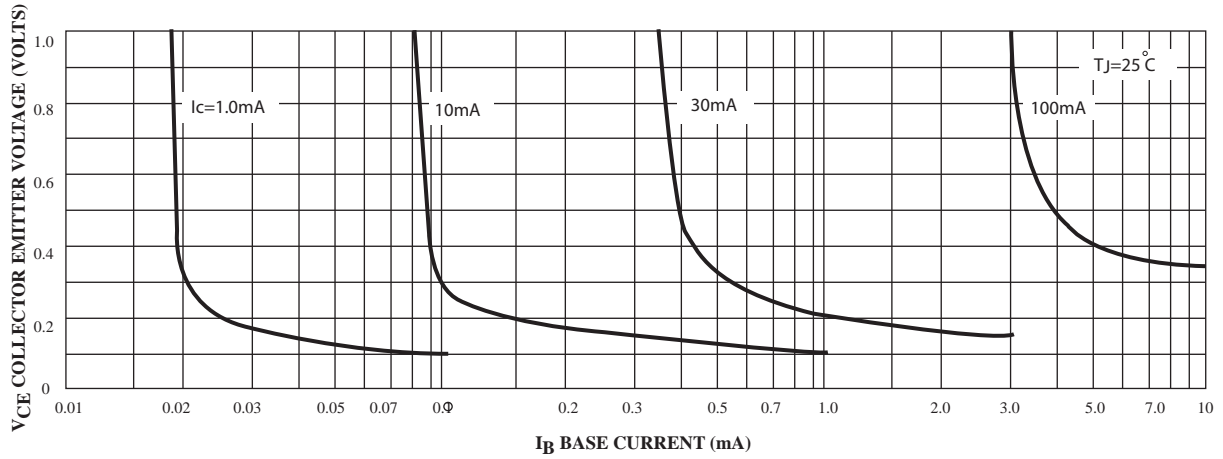


FIG.16 Collector Saturation Region

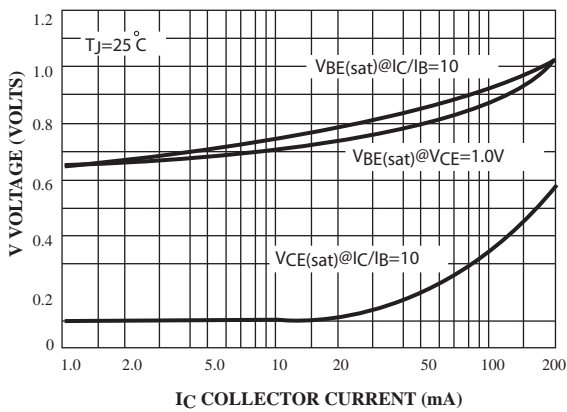


FIG.17 "ON" Voltage

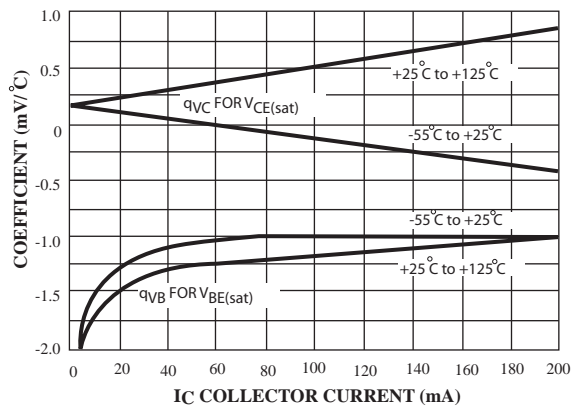
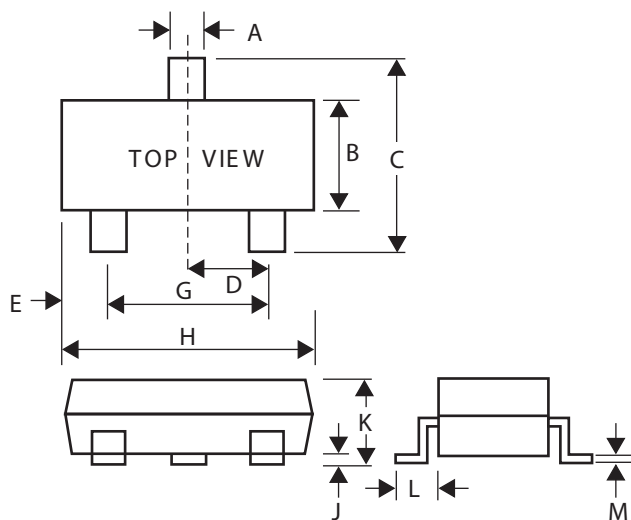


FIG.18 Temperature Coefficients

SOT-23 Package Outline Dimensions

Unit:mm



Dim	Min	Max
A	0.35	0.51
B	1.19	1.40
C	2.10	3.00
D	0.85	1.05
E	0.46	1.00
G	1.70	2.10
H	2.70	3.10
J	0.01	0.13
K	0.89	1.10
L	0.30	0.61
M	0.076	0.25