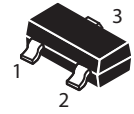
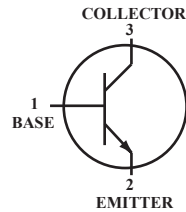


### Switching Transistor NPN Silicon

 Lead(Pb)-Free



SOT-23

### Maximum Ratings

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CEO</sub>	40	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	60	Vdc
Emitter-Base Voltage	V <sub>EBO</sub>	6.0	Vdc
Collector Current-Continuous	I <sub>C</sub>	600	mAdc

### Thermal Characteristics

Characteristics	Symbol	Max	Unit
Total Device Dissipation FR-5 Board <sup>(1)</sup> TA=25 °C	P <sub>D</sub>	225	mW
Derate above 25 °C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	556	°C/W
Total Device Dissipation Alumina Substrate, <sup>(2)</sup> TA=25 °C	P <sub>D</sub>	300	mW
Derate above 25 °C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	417	°C/W
Junction and Storage, Temperature	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C

### Device Marking

MMBT4401=2X

### Electrical Characteristics (TA=25 °C Unless Otherwise noted)

Characteristics	Symbol	Min	Max	Unit
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### Off Characteristics

Collector-Emitter Breakdown Voltage <sup>(3)</sup> (I <sub>C</sub> =1.0mAdc, I <sub>B</sub> =0)	V(BR)CEO	40	-	Vdc
Collector-Base Breakdown Voltage (I <sub>C</sub> =0.1mAdc, I <sub>E</sub> =0)	V(BR)CBO	60	-	Vdc
Emitter-Base Breakdown Voltage (I <sub>E</sub> =0.1mAdc, I <sub>C</sub> =0)	V(BR)EBO	6.0	-	Vdc
Base Cutoff Current (V <sub>CE</sub> =35 Vdc, V <sub>EB</sub> =0.4 Vdc)	I <sub>BEV</sub>	-	0.1	uAdc
Collector Cutoff Current (V <sub>CE</sub> =35Vdc, V <sub>EB</sub> =0.4Vdc)	I <sub>CEX</sub>	-	0.1	uAdc

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** <sup>(3)</sup>

DC Current Gain ( $I_C=0.1\text{ mAdc}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=1.0\text{ mAdc}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=10\text{ mAdc}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=150\text{ mAdc}$ , $V_{CE}=1.0\text{Vdc}$ ) ( $I_C=500\text{ mAdc}$ , $V_{CE}=2.0\text{Vdc}$ )	$H_{FE}$	20 40 80 100 40	. . 300 . .	-
Collector-Emitter Saturation Voltage <sup>(3)</sup> ( $I_C=150\text{ mAdc}$ , $I_B=15\text{mAdc}$ ) ( $I_C=500\text{ mAdc}$ , $I_B=50\text{mAdc}$ )	$V_{CE(sat)}$	. .	0.4 0.75	Vdc
Base-Emitter Saturation Voltage <sup>(3)</sup> ( $I_C=150\text{ mAdc}$ , $I_B=15\text{ mAdc}$ ) ( $I_C=500\text{ mAdc}$ , $I_B=50\text{ mAdc}$ )	$V_{BE(sat)}$	0.75 .	0.95 1.2	Vdc

**Small-signal Characteristics**

Current-Gain-Bandwidth Product ( $I_C=20\text{ mAdc}$ , $V_{CE}=10\text{Vdc}$ , $f=100\text{MHz}$ )	$f_T$	250	-	MHz
Collector-Base Capacitance ( $V_{CB}=5.0\text{Vdc}$ , $I_E=0$ , $f=1.0\text{MHz}$ )	$C_{cb}$	-	6.5	pF
Emitter-Base Capacitance ( $V_{EB}=0.5\text{Vdc}$ , $I_C=0$ , $f=1.0\text{MHz}$ )	$C_{eb}$	-	30	pF
Input Impedance ( $V_{CE}=10\text{Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ )	$h_{ie}$	1.0	15	k ohms
Voltage Feedback Ratio ( $V_{CE}=10\text{Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ )	$h_{re}$	0.1	8.0	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE}=10\text{Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{ kHz}$ )	$h_{fe}$	40	500	.
Output Admittance ( $V_{CE}=10\text{Vdc}$ , $I_C=1.0\text{ mAdc}$ , $f=1.0\text{kHz}$ )	$h_{oe}$	1.0	30	$\mu\text{mhos}$

**Switching Characteristics**

Delay Time	(Vcc= 30 Vdc, VBE= 2.0 Vdc $I_C=150\text{ mAdc}$ , $I_{B1}=15\text{ mAdc}$ )	$t_d$	-	15	ns
Rise Time		$t_r$	-	20	
Storage Time	(Vcc= 30Vdc, $I_C=150\text{ mAdc}$ , $I_{B1}=I_{B2}=15\text{ mAdc}$ )	$t_s$	-	225	ns
Fall Time		$t_f$	-	30	

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

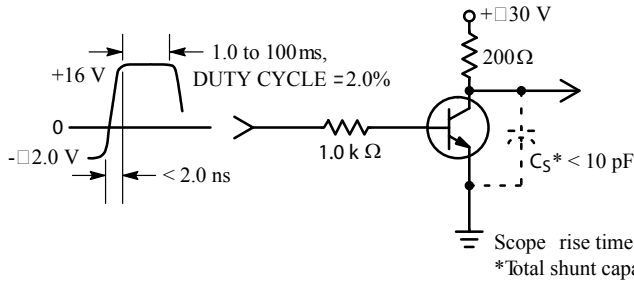


Figure 1. Turn-On Time

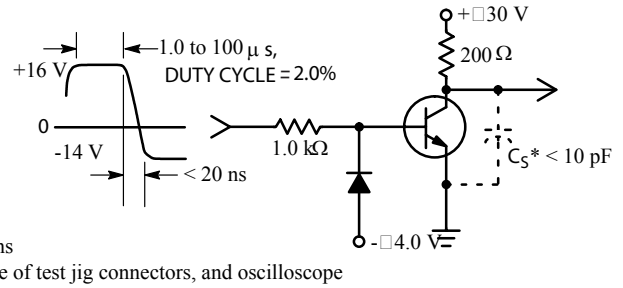


Figure 2. Turn-Off Time

## TRANSIENT CHARACTERISTICS

— 25°C    - - - 105°C

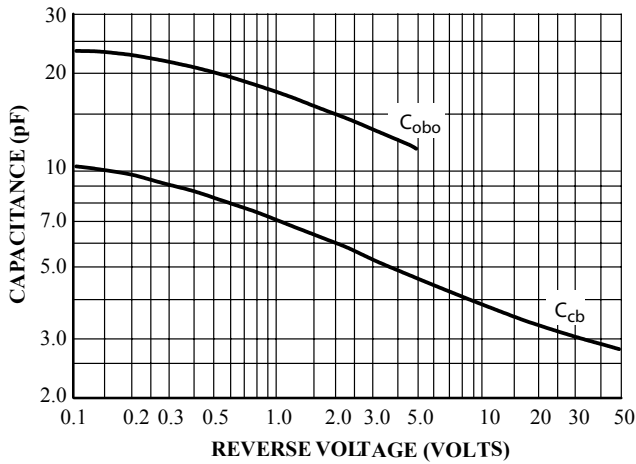


Figure 3. Capacitances

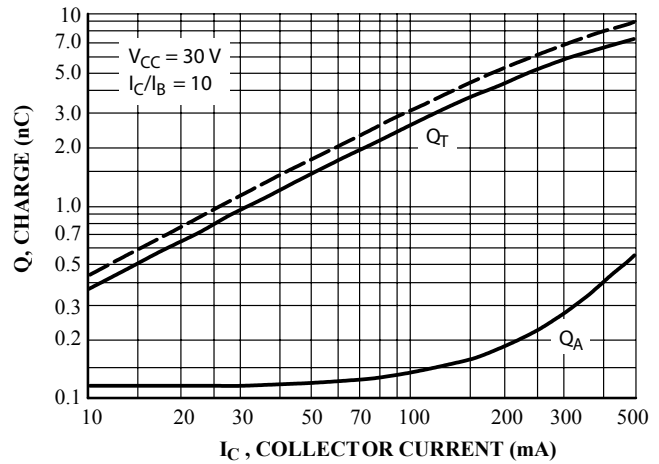


Figure 4. Charge Data

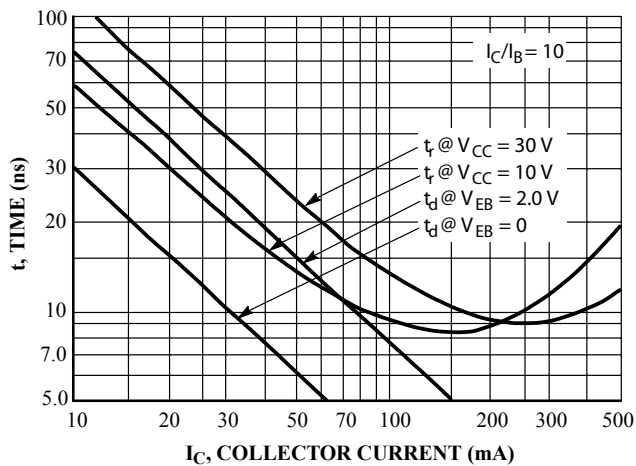


Figure 5. Turn-On Time

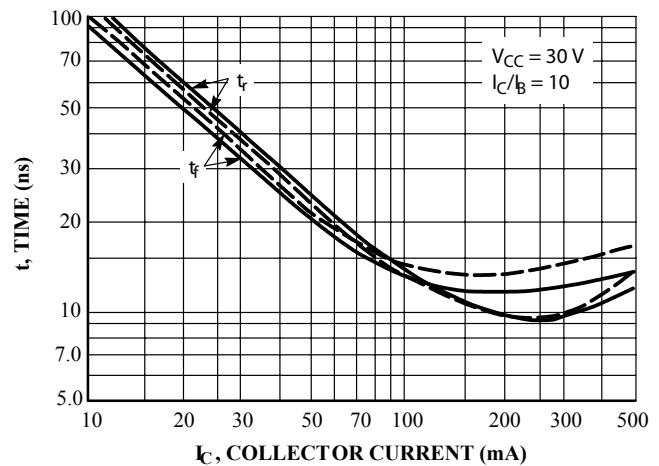


Figure 6. Rise and Fall Times

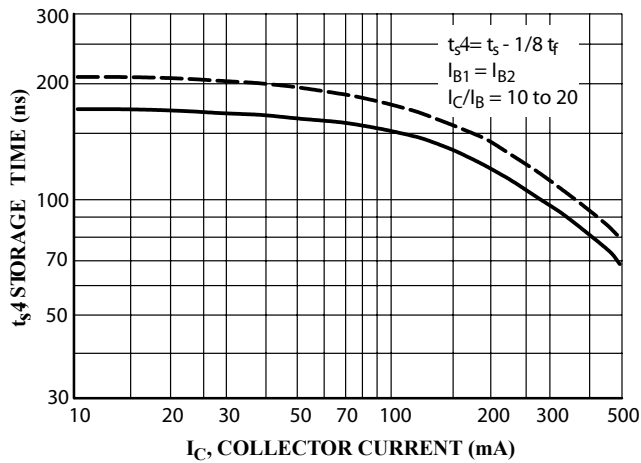


Figure 7. Storage Time

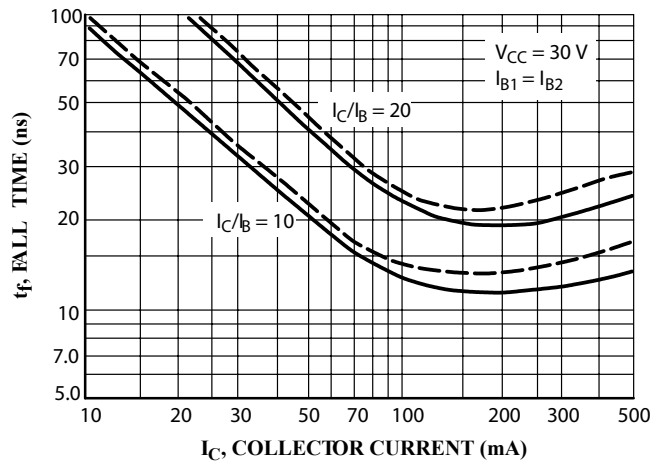


Figure 8. Fall Time

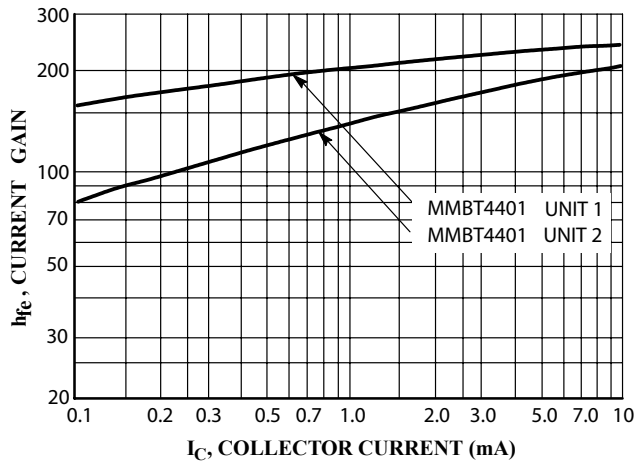


Figure 11. Current Gain

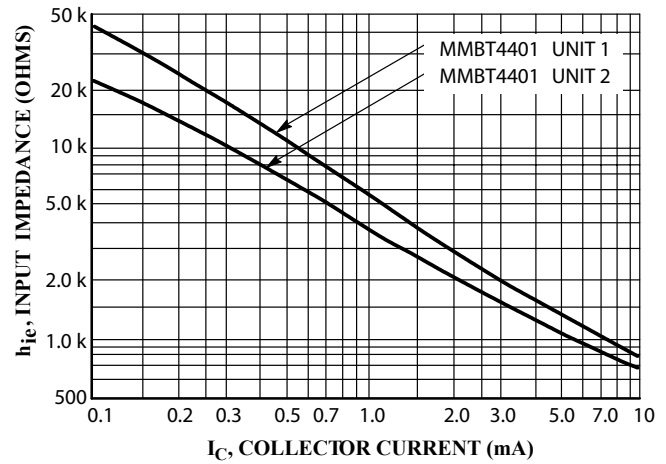


Figure 12. Input Impedance

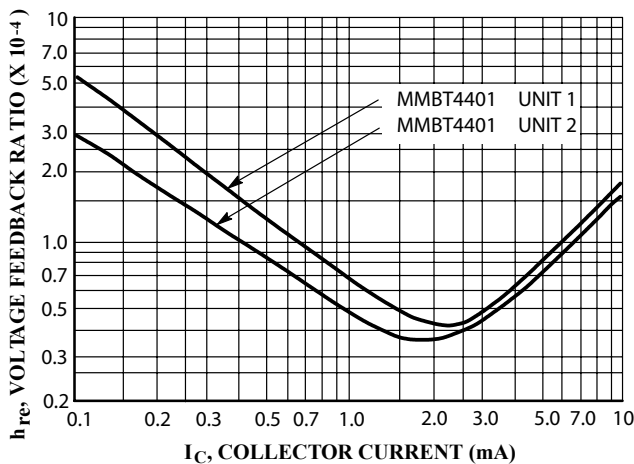


Figure 13. Voltage Feedback Ratio

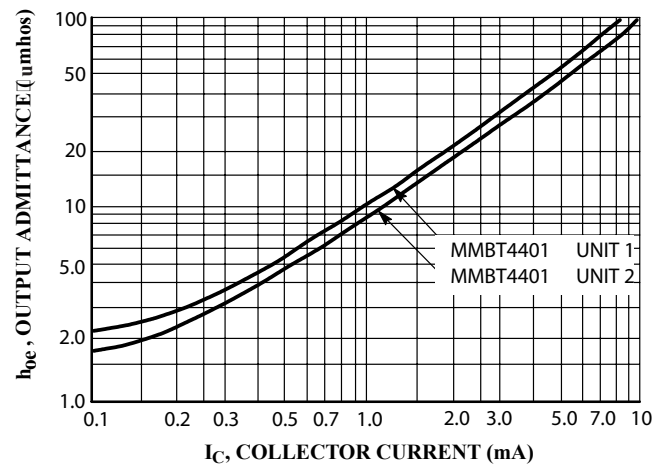


Figure 14. Output Admittance

## STATIC CHARACTERISTICS

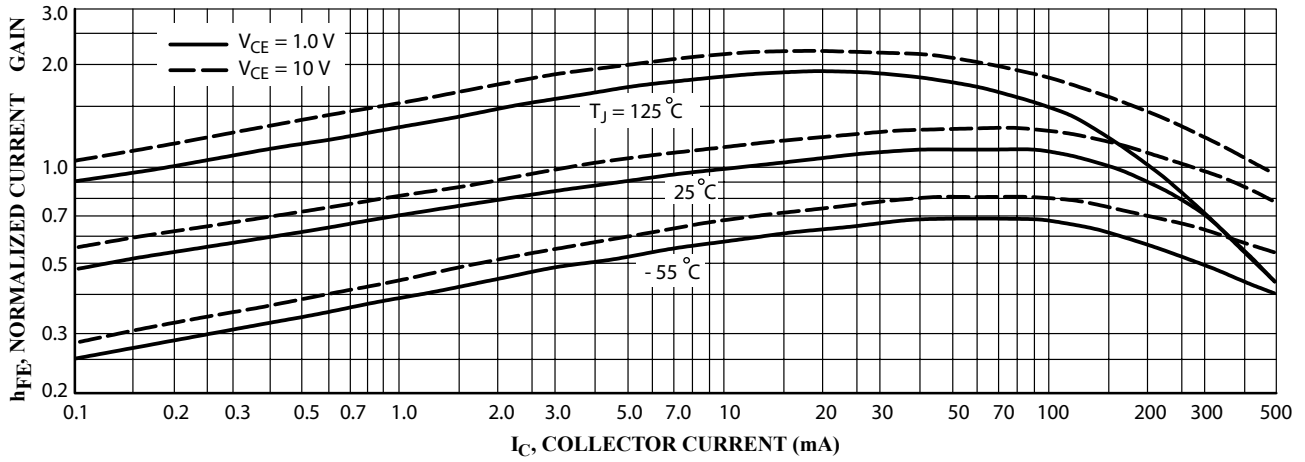


Figure 15. DC Current Gain

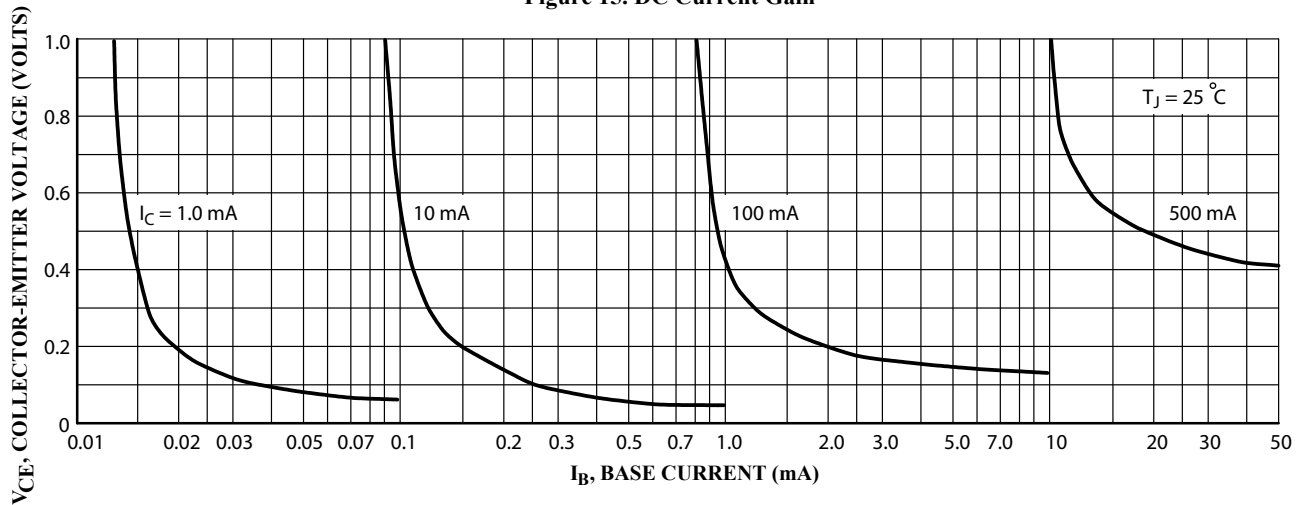


Figure 16. Collector Saturation Region

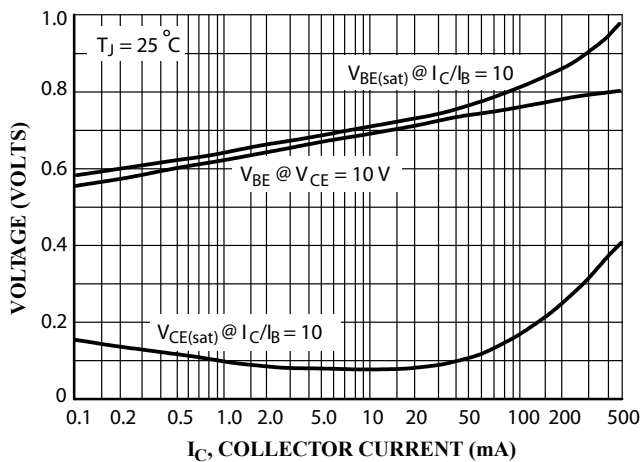


Figure 17. "On" Voltages

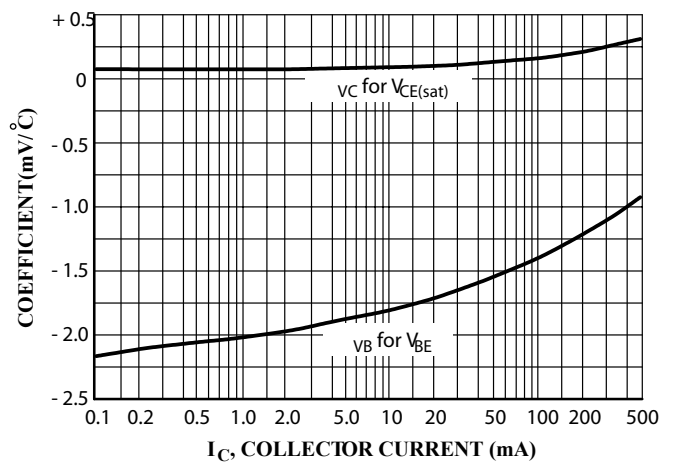
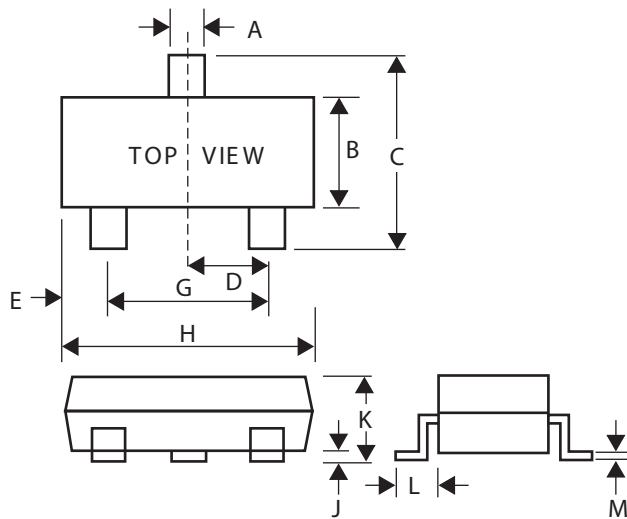


Figure 18. Temperature Coefficients

## 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