

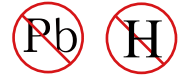


# DATA SHEET

SEMICONDUCTOR

## MMBT2222-A & MMBT2222A-A

### General Purpose Transistors

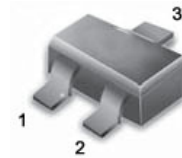


#### NPN Silicon

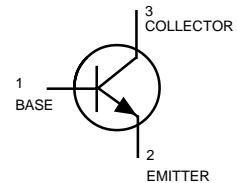
- We declare that the material of product compliance with RoHS requirements.
- AEC-Q101 qualified
  - Base P/N - RoHS compliant, commercial grade
  - Base P/N-A - RoHS compliant, AEC-Q101 qualified

#### MAXIMUM RATINGS

Rating	Symbol	2222	2222A	Unit
Collector-Emitter Voltage	$V_{CEO}$	30	40	Vdc
Collector-Base Voltage	$V_{CBO}$	60	75	Vdc
Emitter-Base Voltage	$V_{EBO}$	5.0	6.0	Vdc
Collector Current — Continuous	$I_C$	600	600	mAdc



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#### 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 $25^\circ\text{C}$		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 $25^\circ\text{C}$		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature	$T_J, T_{sig}$	-55 to +150	$^\circ\text{C}$

#### ORDERING INFORMATION

Device	Marking	Shipping
MMBT2222	M1B	3000/Tape & Reel
MMBT2222A	1P	3000/Tape & Reel

#### DEVICE MARKING

MMBT2222 = M1B ; MMBT2222A = 1P

#### 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 ( $I_C = 10\text{ mAdc}, I_E = 0$ )	MMBT2222 MMBT2222A	$V_{(BR)CEO}$	30 40	—	Vdc
Collector-Base Breakdown Voltage ( $I_C = 10\text{ }\mu\text{Adc}, I_E = 0$ )	MMBT2222 MMBT2222A	$V_{(BR)CBO}$	60 75	—	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 10\text{ }\mu\text{Adc}, I_C = 0$ )	MMBT2222 MMBT2222A	$V_{(BR)EBO}$	5.0 6.0	—	Vdc
Collector Cutoff Current ( $V_{CE} = 60\text{ Vdc}, I_{EB(off)} = 3.0\text{Vdc}$ )	MMBT2222A	$I_{CEX}$	—	10	nAdc
Collector Cutoff Current ( $V_{CB} = 50\text{ Vdc}, I_E = 0$ )	MMBT2222	$I_{CBO}$	—	0.01	$\mu\text{Adc}$
( $V_{CB} = 60\text{ Vdc}, I_E = 0$ )	MMBT2222A		—	0.01	
( $V_{CB} = 50\text{ Vdc}, I_E = 0, T_A = 125^\circ\text{C}$ )	MMBT2222		—	10	
( $V_{CB} = 60\text{ Vdc}, I_E = 0, T_A = 125^\circ\text{C}$ )	MMBT2222A		—	10	
Emitter Cutoff Current ( $V_{EB} = 3.0\text{ Vdc}, I_C = 0$ )	MMBT2222A	$I_{EBO}$	—	100	nAdc
Base Cutoff Current ( $V_{CE} = 60\text{ Vdc}, V_{EB(off)} = 3.0\text{ Vdc}$ )	MMBT2222A	$I_{BL}$	—	20	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.

# MMBT2222-A & MMBT2222A-A

## ELECTRICAL CHARACTERISTICS (T A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS</b>				
DC Current Gain (I <sub>C</sub> = 0.1 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , T <sub>A</sub> = -55°C) (I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (3) (I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (3) (I <sub>C</sub> = 500 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )(3)	h <sub>FE</sub>	35 50 75 35 100 50 30 40	— — — — 300 — — —	—
				MMBT2222A only
				MMBT2222
				MMBT2222A
Collector–Emitter Saturation Voltage(3) (I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )  (I <sub>C</sub> = 500mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )	V <sub>CE(sat)</sub>	— — —	0.4 0.3 1.6 1.0	V <sub>dc</sub>
				MMBT2222
				MMBT2222A
				MMBT2222
				MMBT2222A
Base–Emitter Saturation Voltage (I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )  (I <sub>C</sub> = 500 mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )	V <sub>BE(sat)</sub>	— 0.6 — —	1.3 1.2 2.6 2.0	V <sub>dc</sub>
				MMBT2222
				MMBT2222A
				MMBT2222
				MMBT2222A

## SMALL-SIGNAL CHARACTERISTICS

Current–Gain — Bandwidth Product(4) (I <sub>C</sub> = 20mA <sub>dc</sub> , V <sub>CE</sub> = 20V <sub>dc</sub> , f = 100MHz)	MMBT2222 MMBT2222A	f <sub>T</sub>	250 300	— —	MHz
Output Capacitance(V <sub>CB</sub> = 10 V <sub>dc</sub> , I <sub>E</sub> = 0, f = 1.0 MHz)		C <sub>obo</sub>	—	8.0	pF
Input Capacitance (V <sub>EB</sub> = 0.5 V <sub>dc</sub> , I <sub>C</sub> = 0, f = 1.0 MHz)	MMBT2222 MMBT2222A	C <sub>ibo</sub>	— —	30 25	pF
Input Impedance(V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz) (V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 10 mA <sub>dc</sub> , f = 1.0 kHz)	MMBT2222A MMBT2222A	h <sub>ie</sub>	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio(V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz) (V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 10 mA <sub>dc</sub> , f = 1.0 kHz)	MMBT2222A MMBT2222A	h <sub>re</sub>	— —	8.0 4.0	X 10 <sup>-4</sup>
Small–Signal Current Gain(V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz) (V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 10 mA <sub>dc</sub> , f = 1.0 kHz)	MMBT2222A MMBT2222A	h <sub>fe</sub>	50 75	300 375	—
Output Admittance(V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 1.0 mA <sub>dc</sub> , f = 1.0 kHz) (V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 10 mA <sub>dc</sub> , f = 1.0 kHz)	MMBT2222A MMBT2222A	h <sub>oe</sub>	5.0 25	35 200	μmhos
Current Base Time Constant (V <sub>CB</sub> = 20 V <sub>dc</sub> , I <sub>E</sub> = 20 mA <sub>dc</sub> , f = 31.8 MHz)	MMBT2222A	r <sub>b</sub> , C <sub>C</sub>	—	150	ps
Noise Figure(V <sub>CE</sub> = 10 V <sub>dc</sub> , I <sub>C</sub> = 100 μA <sub>dc</sub> , R <sub>S</sub> = 1.0 kΩ, f = 1.0 kHz)	MMBT2222A	NF	—	4.0	dB

## SWITCHING CHARACTERISTICS

Delay Time	(V <sub>CC</sub> = 30 V <sub>dc</sub> , V <sub>EB(off)</sub> = -0.5 V <sub>dc</sub> )	t <sub>d</sub>	—	10	ns
Rise Time	I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B1</sub> = 15 mA <sub>dc</sub> )	t <sub>r</sub>	—	25	
Storage Time	(V <sub>CC</sub> = 30 V <sub>dc</sub> , I <sub>C</sub> = 150 mA <sub>dc</sub> )	t <sub>s</sub>	—	225	ns
Fall Time	I <sub>B1</sub> = I <sub>B2</sub> = 15 mA <sub>dc</sub> )	t <sub>f</sub>	—	60	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

4. f<sub>T</sub> is defined as the frequency at which |h<sub>ie</sub>| extrapolates to unity.

# DEVICE CHARACTERISTICS

## MMBT2222-A & MMBT2222A-A

### SWITCHING TIME EQUIVALENT TEST CIRCUITS

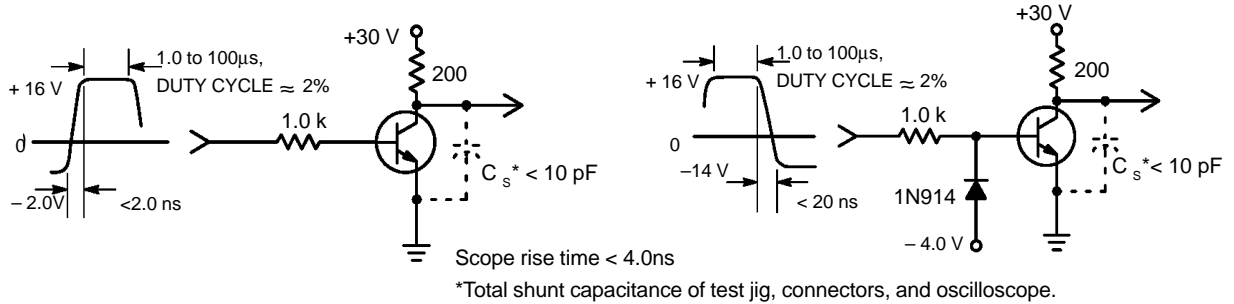


Figure 1. Turn-On Time

Figure 2. Turn-Off Time

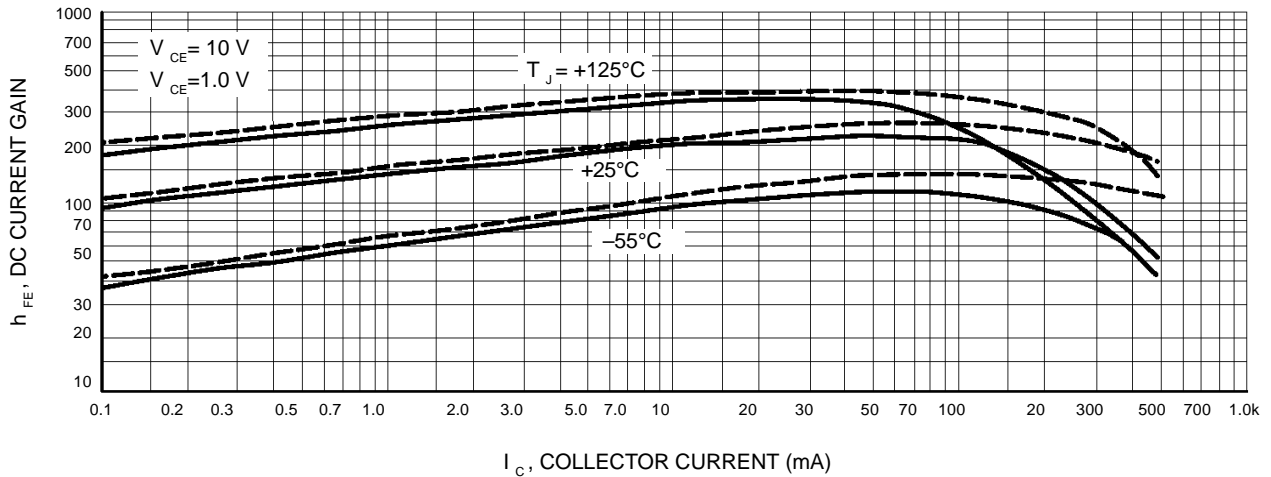


Figure 3. DC Current Gain

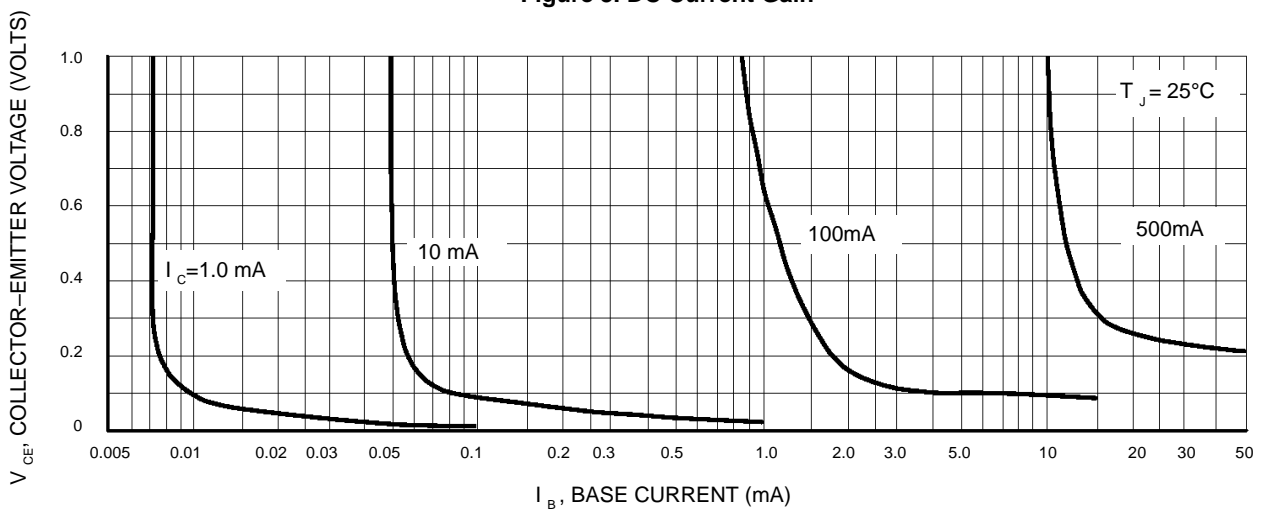


Figure 4. Collector Saturation Region

# DEVICE CHARACTERISTICS

## MMBT2222-A & MMBT2222A-A

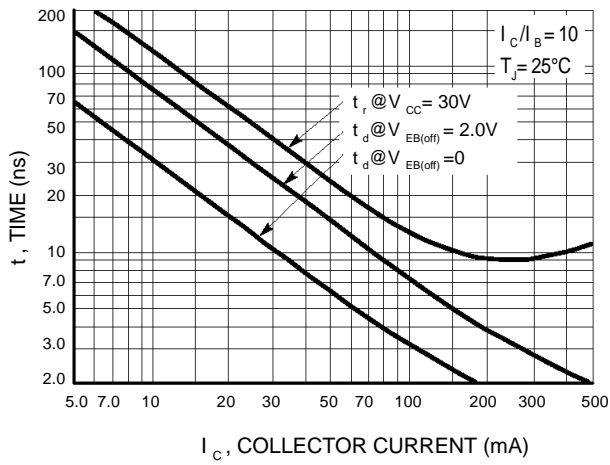


Figure 5. Turn-On Time

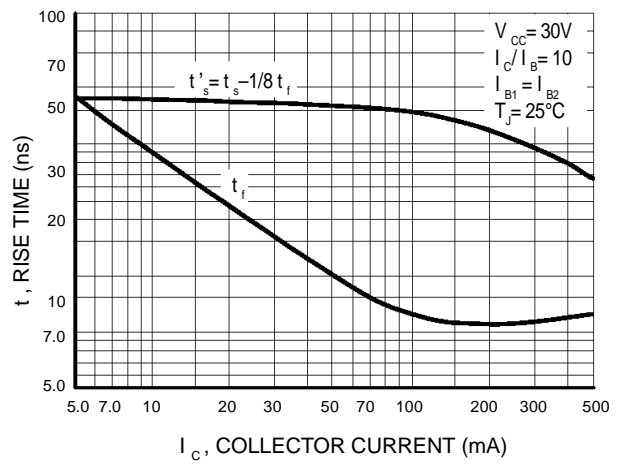


Figure 6. Turn - Off Time

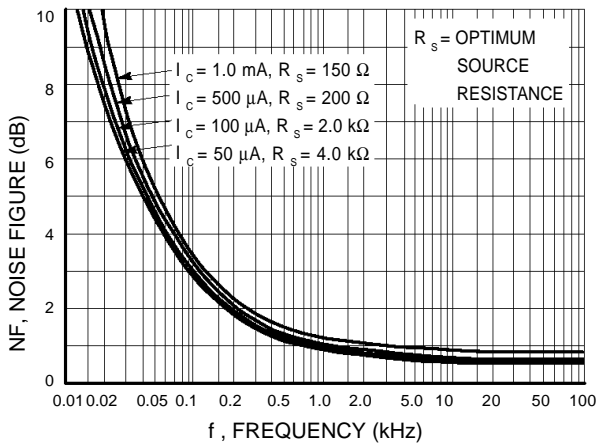


Figure 7. Frequency Effects

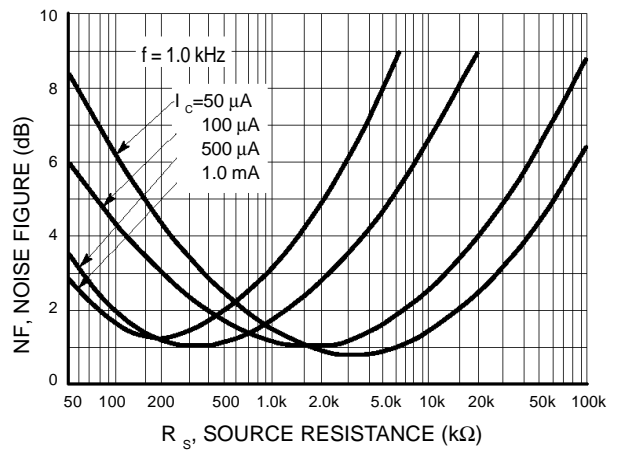


Figure 8. Source Resistance Effects

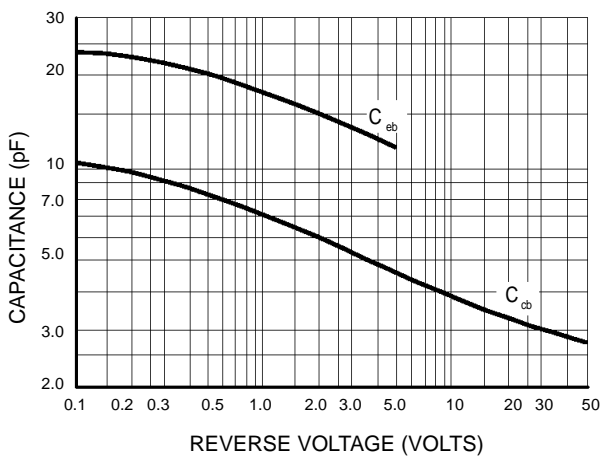


Figure 9. Capacitance

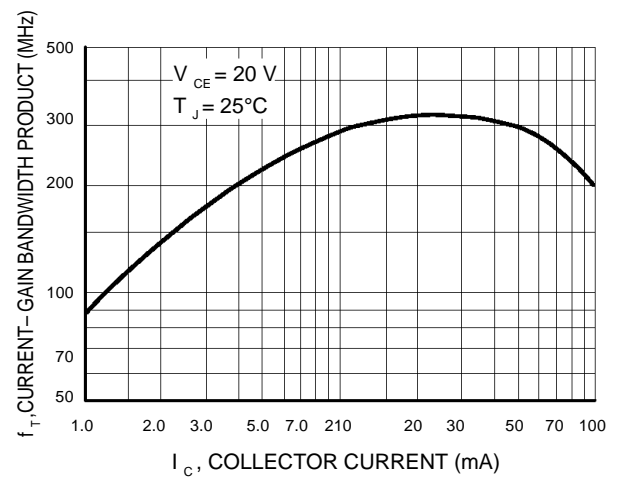
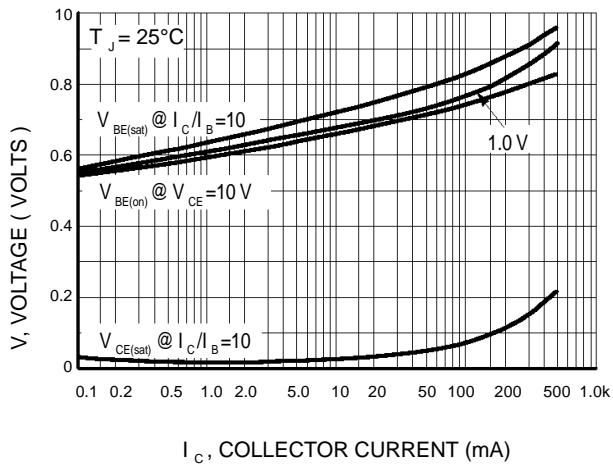


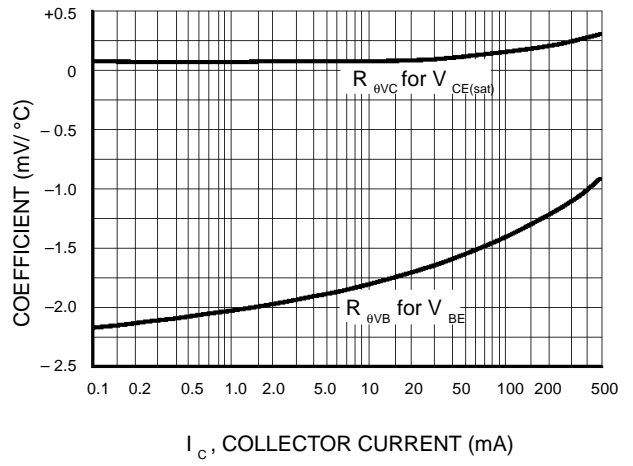
Figure 10. Current-Gain Bandwidth Product

# DEVICE CHARACTERISTICS

## MMBT2222-A & MMBT2222A-A



$I_C$ , COLLECTOR CURRENT (mA)  
**Figure 11. "On" Voltages**

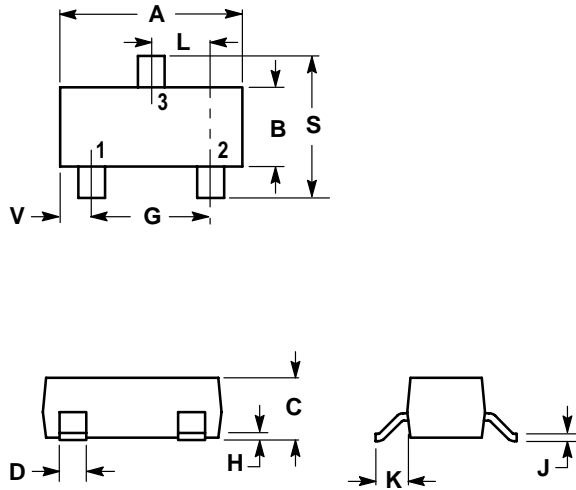


$I_C$ , COLLECTOR CURRENT (mA)  
**Figure 12. Temperature Coefficients**

# PACKAGE OUTLINE & DIMENSIONS

## MMBT2222-A & MMBT2222A-A

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#### 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

