General Purpose Transistors

NPN Silicon

MMBT2222L, MMBT2222AL, SMMBT2222AL

COLLECTOR
3

1
BASE

2
EMITTER

Features

- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable

3

1

2

SOT−23
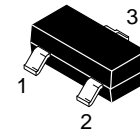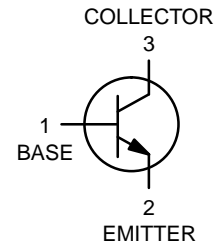**CASE 318**
STYLE 6

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector−Emitter Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{CEO}	30 40	Vdc
Collector−Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{CBO}	60 75	Vdc
Emitter−Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL	V_{EBO}	5.0 6.0	Vdc
Collector Current – Continuous	I_C	600	mAdc
Collector Current – Peak (Note 3)	I_{CM}	1100	mAdc

THERMAL CHARACTERISTICS

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

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
1. FR−5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Reference SOA curve.

MARKING DIAGRAM

xxx M ▪
▪
1
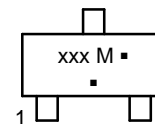
xxx = 1P or M1B
M = Date Code*
▪ = Pb−Free Package
(Note: Microdot may be in either location)
*Date Code orientation and/or overbar may vary depending upon manufacturing location.

ORDERING INFORMATION

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0) MMBT2222 MMBT2222A		$V_{(BR)CEO}$	30 40	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0) MMBT2222 MMBT2222A		$V_{(BR)CBO}$	60 75	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0) MMBT2222 MMBT2222A		$V_{(BR)EBO}$	5.0 6.0	– –	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A, SMMBT2222A	I_{CEX}	–	10	nAdc

Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)   MMBT2222
  (V_{CB} = 60 Vdc, I_E = 0)
  (V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)
  (V_{CB} = 60 Vdc, I_E = 0, T_A = 125°C)
	MMBT2222
	MMBT2222A, SMMBT2222A
	MMBT2222
	MMBT2222A, SMMBT2222A
		I_{CBO}	–
			–
			–
			–
				0.01
				0.01
				10
				10
					µAdc

Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	MMBT2222A, SMMBT2222A	I_{EBO}	–	100	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A, SMMBT2222A	I_{BL}	–	20	nAdc
ON CHARACTERISTICS					

DC Current Gain
  (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)
  (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)
  (I_C = 10 mAdc, V_{CE} = 10 Vdc)
  (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = –55°C)
  (I_C = 150 mAdc, V_{CE} = 10 Vdc) (Note 4)
  (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Note 4)
  (I_C = 500 mAdc, V_{CE} = 10 Vdc) (Note 4)
	
	MMBT2222A only
	
	MMBT2222
	MMBT2222A, SMMBT2222A
		h_{FE}	35
			50
			75
			35
			100
			50
			30
			40
				–
				–
				–
				–
				300
				–
				–
				–
					–

Collector–Emitter Saturation Voltage (Note 4)
  (I_C = 150 mAdc, I_B = 15 mAdc)
 	
  (I_C = 500 mAdc, I_B = 50 mAdc)
	
	MMBT2222
	MMBT2222A, SMMBT2222A
	MMBT2222
	MMBT2222A, SMMBT2222A
		$V_{CE(sat)}$	
			–
			–
			–
			–
				
				0.4
				0.3
				1.6
				1.0
					Vdc

Base–Emitter Saturation Voltage (Note 4) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	 MMBT2222 MMBT2222A, SMMBT2222A MMBT2222 MMBT2222A, SMMBT2222A	$V_{BE(sat)}$	 – 0.6 – –	 1.3 1.2 2.6 2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain–Bandwidth Product (Note 5) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	 MMBT2222 MMBT2222A, SMMBT2222A	f_T	250 300	– –	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	 MMBT2222 MMBT2222A, SMMBT2222A	C_{ibo}	– –	30 25	pF

Input Impedance
  (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
  (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
	
	MMBT2222A, SMMBT2222A
	MMBT2222A, SMMBT2222A
		h_{ie}	2.0
			0.25
				8.0
				1.25
					kΩ

Voltage Feedback Ratio
  (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
  (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
	
	MMBT2222A, SMMBT2222A
	MMBT2222A, SMMBT2222A
		h_{re}	–
			–
				8.0
				4.0
					X 10^{-4}

Small–Signal Current Gain
  (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
  (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)
	
	MMBT2222A, SMMBT2222A
	MMBT2222A, SMMBT2222A
		h_{fe}	50
			75
				300
				375
					–

MMBT2222L, MMBT2222AL, SMMBT2222AL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
SMALL−SIGNAL CHARACTERISTICS					
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) MMBT2222A, SMMBT2222A (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) MMBT2222A, SMMBT2222A		h_{oe}	5.0 25	35 200	µmhos
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz) MMBT2222A, SMMBT2222A		rb, C_c	–	150	ps
Noise Figure (I_C = 100 µAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz) MMBT2222A, SMMBT2222A		NF	–	4.0	dB
SWITCHING CHARACTERISTICS (MMBT2222A only)					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = −0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	–	10	ns
Rise Time		t_r	–	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	–	225	ns
Fall Time		t_f	–	60	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.
4. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
5. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS
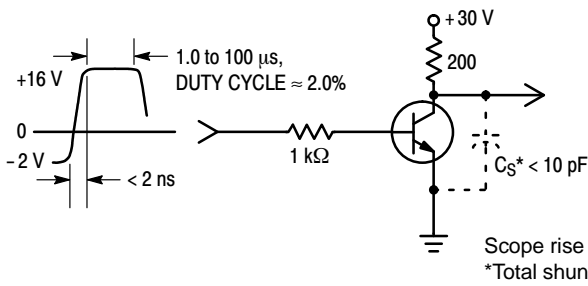
Figure 1. Turn−On Time
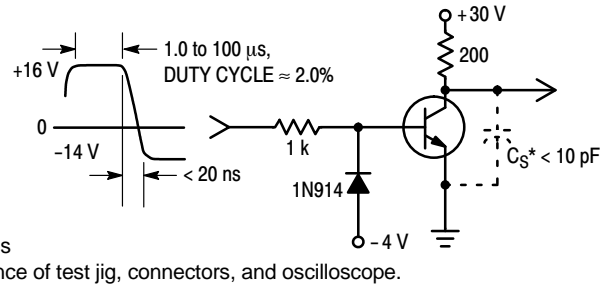
Figure 2. Turn−Off Time
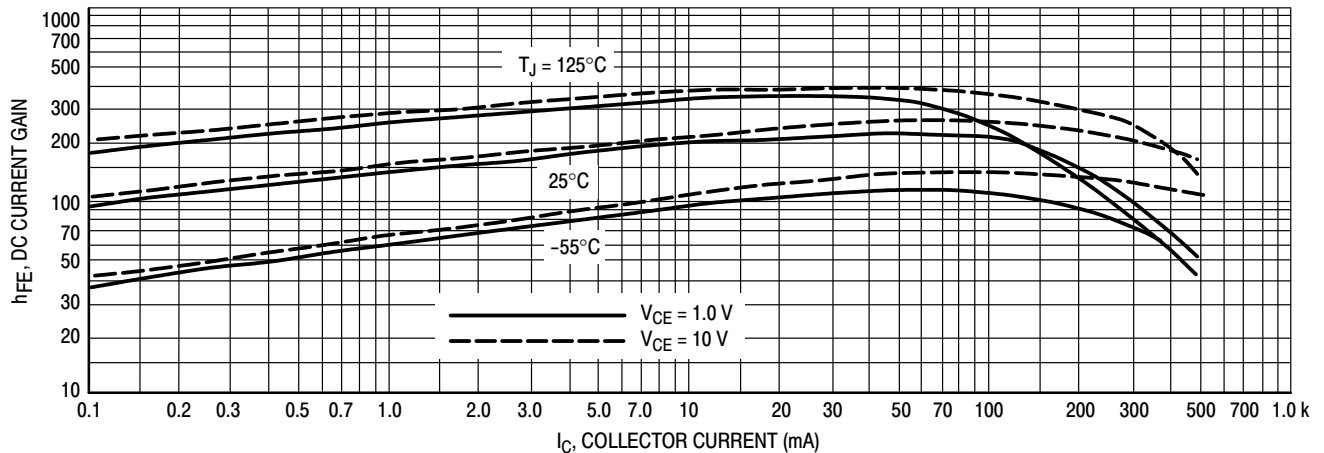
Figure 3. DC Current Gain

MMBT2222L, MMBT2222AL, SMMBT2222AL
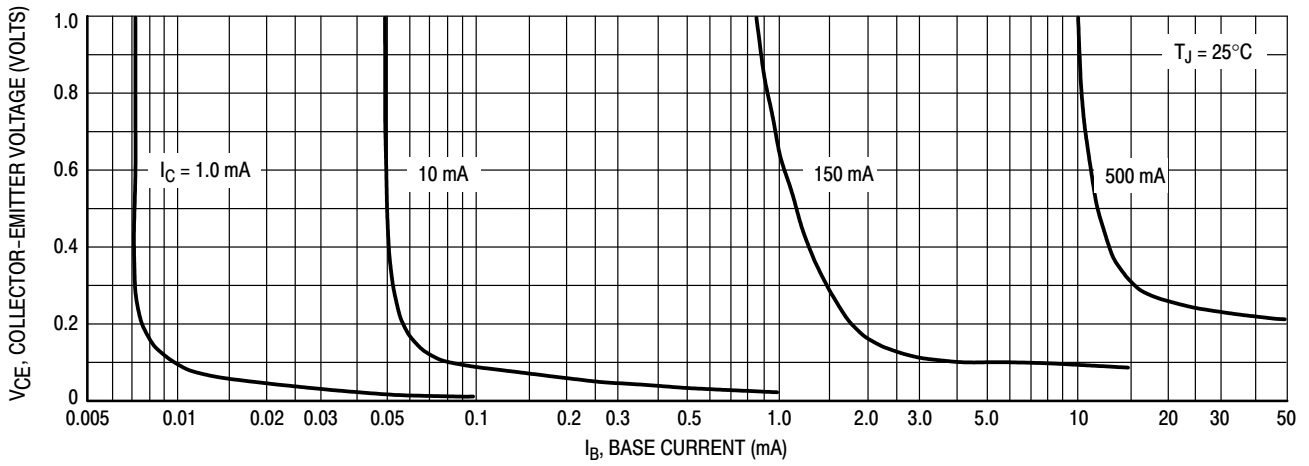
Figure 4. Collector Saturation Region
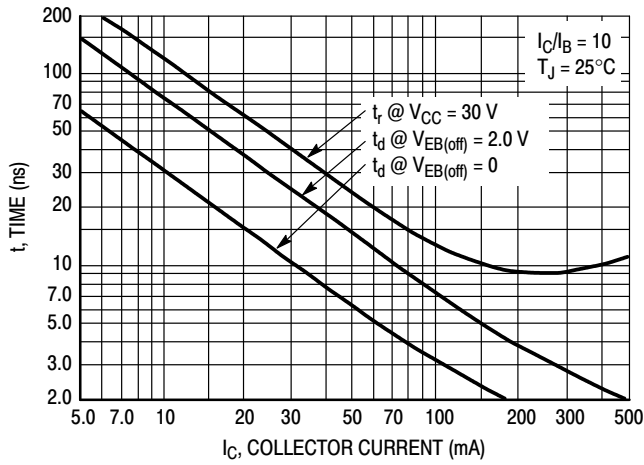
Figure 5. Turn-On Time
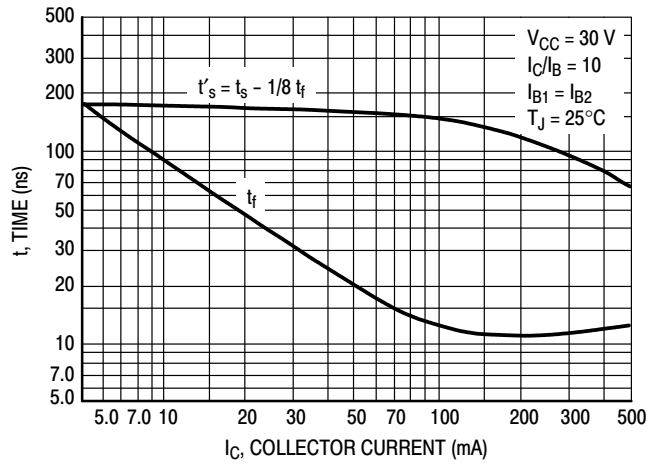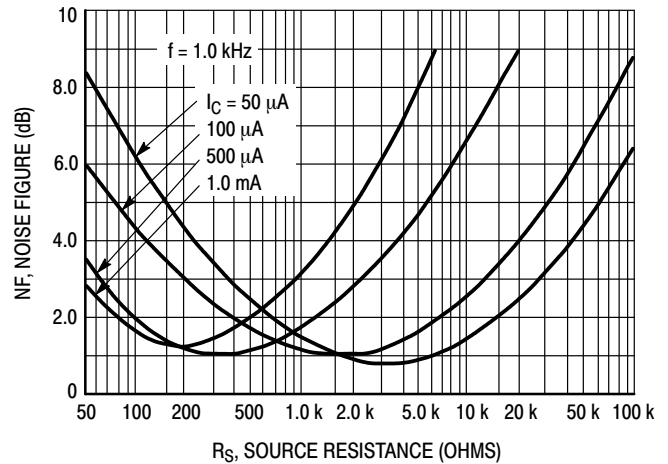

Figure 6. Turn-Off Time
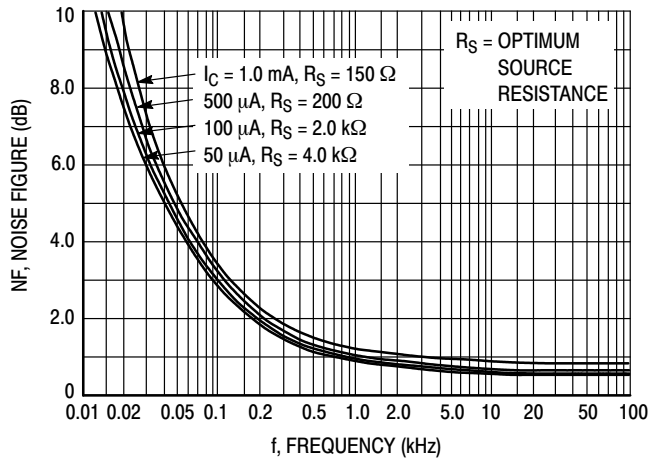
Figure 7. Frequency Effects

Figure 8. Source Resistance Effects

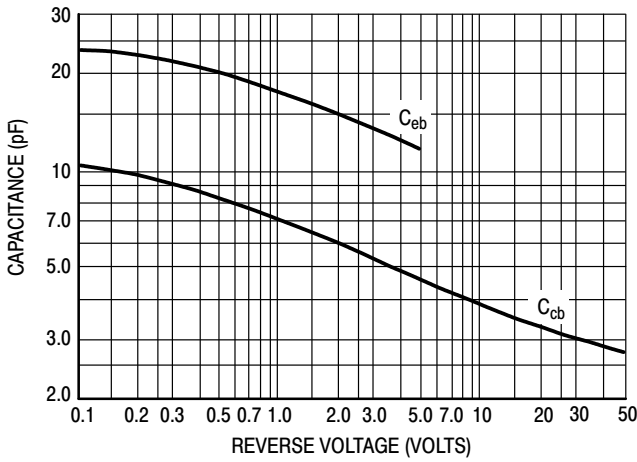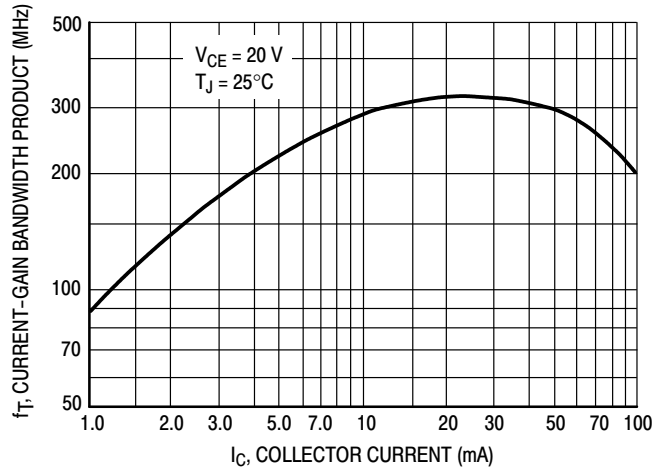**MMBT2222L, MMBT2222AL, SMMBT2222AL**

Figure 9. Capacitances
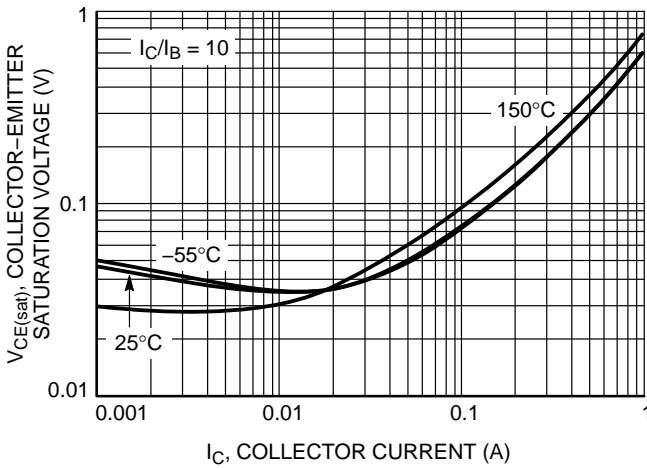

Figure 10. Current−Gain Bandwidth Product

Figure 11. Collector Emitter Saturation Voltage
vs. Collector Current

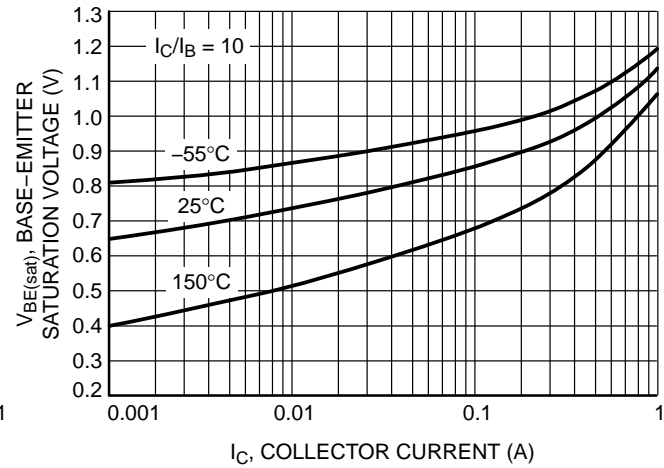

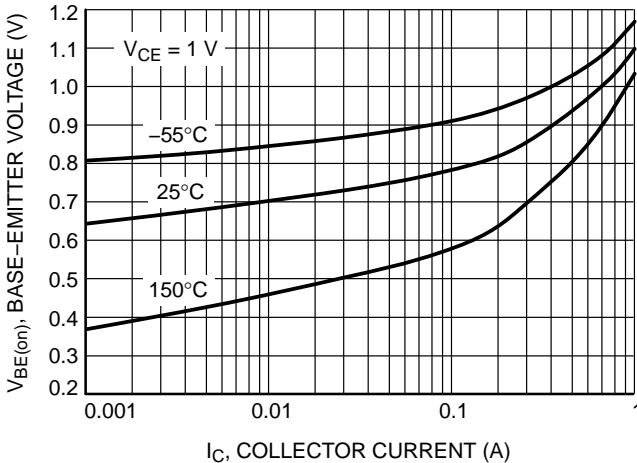Figure 12. Base Emitter Saturation Voltage vs.
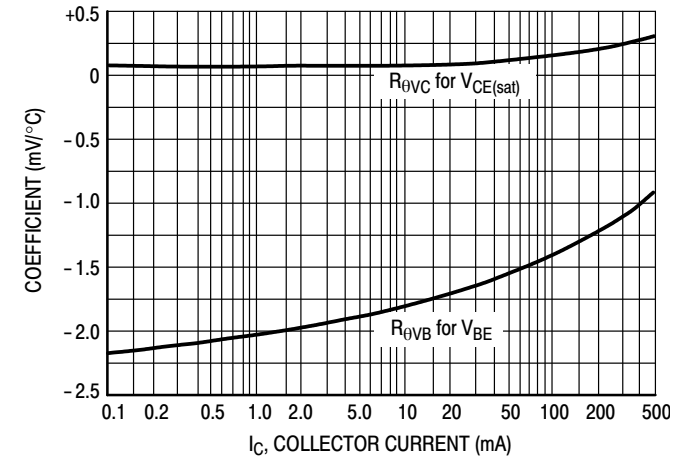Collector Current

Figure 13. Base Emitter Voltage vs. Collector
Current

Figure 14. Temperature Coefficients

MMBT2222L, MMBT2222AL, SMMBT2222AL
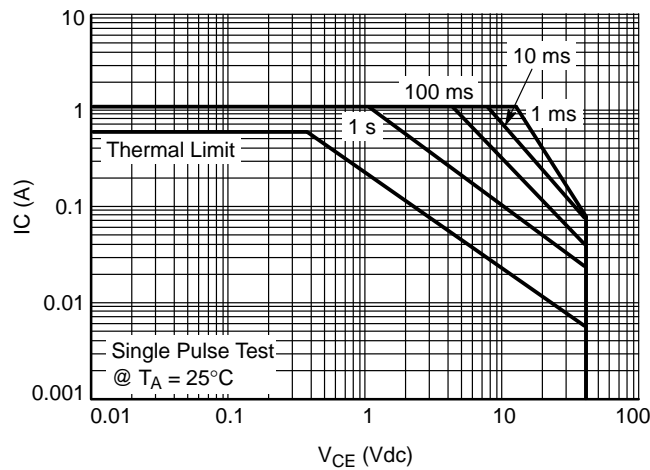
Figure 15. Safe Operating Area

ORDERING INFORMATION

Device	Specific Marking Code	Package	Shipping†
MMBT2222LT1G	M1B	SOT−23 (Pb−Free)	3000 / Tape & Reel
MMBT2222ALT1G, SMMBT2222ALT1G	1P	SOT−23 (Pb−Free)	3000 / Tape & Reel
MMBT2222LT3G	M1B	SOT−23 (Pb−Free)	10,000 / Tape & Reel
MMBT2222ALT3G, SMMBT2222ALT3G	1P	SOT−23 (Pb−Free)	10,000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable.

SOT−23 (TO−236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

SCALE 4:1

TOP VIEW

DETAIL A

SIDE VIEW

DETAIL A

END VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M,1994.

2. CONTROLLING DIMENSION: MILLIMETERS

3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.

4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080
L	0.30	0.43	0.55	0.012	0.017	0.022
L1	0.35	0.54	0.69	0.014	0.021	0.027
H_E	2.10	2.40	2.64	0.083	0.094	0.104
T	0°	---	10°	0°	---	10°

GENERIC MARKING DIAGRAM*

XXXM▪
▪
1

XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

2.90

3X 0.95

3X 0.56

0.95

PITCH

RECOMMENDED MOUNTING FOOTPRINT

✱ For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

STYLES ON PAGE 2

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DESCRIPTION:	SOT−23 (TO−236)	PAGE 1 OF 2

SOT−23 (TO−236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

STYLE 1 THRU 5:
CANCELLED

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 7:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 8:
PIN 1. ANODE
2. NO CONNECTION
3. CATHODE

STYLE 9:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 10:
PIN 1. DRAIN
2. SOURCE
3. GATE

STYLE 11:
PIN 1. ANODE
2. CATHODE
3. CATHODE−ANODE

STYLE 12:
PIN 1. CATHODE
2. CATHODE
3. ANODE

STYLE 13:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 14:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 15:
PIN 1. GATE
2. CATHODE
3. ANODE

STYLE 16:
PIN 1. ANODE
2. CATHODE
3. CATHODE

STYLE 17:
PIN 1. NO CONNECTION
2. ANODE
3. CATHODE

STYLE 18:
PIN 1. NO CONNECTION
2. CATHODE
3. ANODE

STYLE 19:
PIN 1. CATHODE
2. ANODE
3. CATHODE−ANODE

STYLE 20:
PIN 1. CATHODE
2. ANODE
3. GATE

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

STYLE 22:
PIN 1. RETURN
2. OUTPUT
3. INPUT

STYLE 23:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 24:
PIN 1. GATE
2. DRAIN
3. SOURCE

STYLE 25:
PIN 1. ANODE
2. CATHODE
3. GATE

STYLE 26:
PIN 1. CATHODE
2. ANODE
3. NO CONNECTION

STYLE 27:
PIN 1. CATHODE
2. CATHODE
3. CATHODE

STYLE 28:
PIN 1. ANODE
2. ANODE
3. ANODE

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