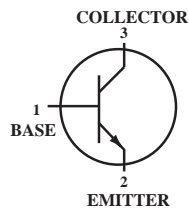


### Plastic-Encapsulate Transistors

### NPN Silicon

 Lead(Pb)-Free



**SC-89**  
**(SOT-523F)**

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CEO</sub>	40	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	75	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> T <sub>A</sub> =25°C	P <sub>D</sub>	150	mW
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	833	°C/W
Junction and Storage, Temperature	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C

### DEVICE MARKING

MMBT2222AT=1P

### ELECTRICAL CHARACTERISTICS

Characteristics	Symbol	Min	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I <sub>C</sub> = 10 mAdc, I <sub>B</sub> =0) <sup>(2)</sup>	V <sub>(BR)CEO</sub>	40	-	V
Collector-Base Breakdown Voltage (I <sub>C</sub> = 10 μAdc, I <sub>E</sub> =0)	V <sub>(BR)CBO</sub>	75	-	V
Emitter-Base Breakdown Voltage (I <sub>E</sub> = -10 μAdc, I <sub>C</sub> =0)	V <sub>(BR)EBO</sub>	6.0	-	V
Base Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB</sub> = 3.0 V)	I <sub>BL</sub>	-	20	nA
Collector Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB</sub> = 3.0 V)	I <sub>CEX</sub>	-	100	nA

## ON CHARACTERISTICS<sup>2</sup>

DC Current Gain ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )	$H_{FE}$	35 50 75 100 40	- - - - -	-
Collector-Emitter Saturation Voltage ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{CE(sat)}$	- -	0.3 1.0	V
Base-Emitter Saturation Voltage ( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ ) ( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )	$V_{BE(sat)}$	0.6 -	1.2 2.0	V

## SMALL-SIGNAL CHARACTERISTICS

Current-Gain - Bandwidth Product ( $I_C = 20 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )	$f_T$	250	-	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{obo}$	-	8.0	pF
Input Capacitance ( $V_{EB} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{ibo}$	-	30	pF
Input Impedance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 10 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{ie}$	0.25	1.25	k $\Omega$
Voltage Feedback Ratio ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 10 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{re}$	-	4.0	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 10 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{fe}$	75	375	-
Output Admittance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 10 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	25	200	$\mu\text{mhos}$
Noise Figure ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 100 \mu\text{Adc}$ , $R_S = 1.0 \text{ k ohms}$ , $f = 1.0 \text{ kHz}$ )	NF	-	4.0	dB

## SWITCHING CHARACTERISTICS

Delay Time	( $V_{CC} = 3.0 \text{ Vdc}$ , $V_{BE} = -0.5 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = 15 \text{ mAdc}$ )	$t_d$	-	10	ns
Rise Time		$t_r$	-	25	
Storage Time	( $V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mAdc}$ , $I_{B1} = I_{B2} = 15 \text{ mAdc}$ )	$t_s$	-	225	ns
Fall Time		$t_f$	-	60	

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

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

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

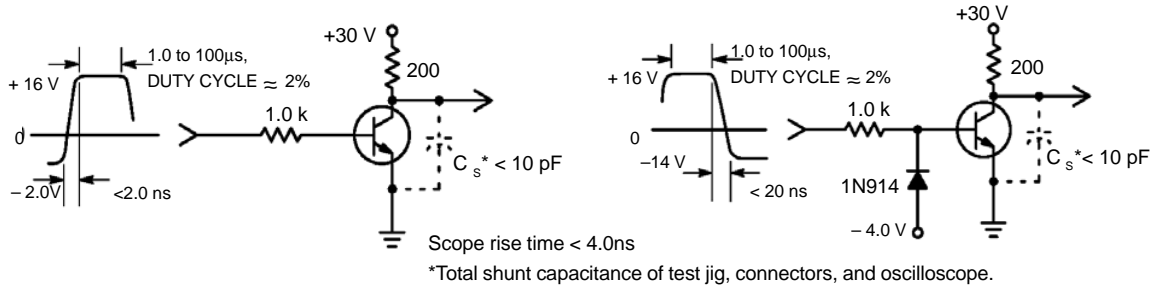


Figure 1. Turn-On Time

Figure 2. Turn-Off Time

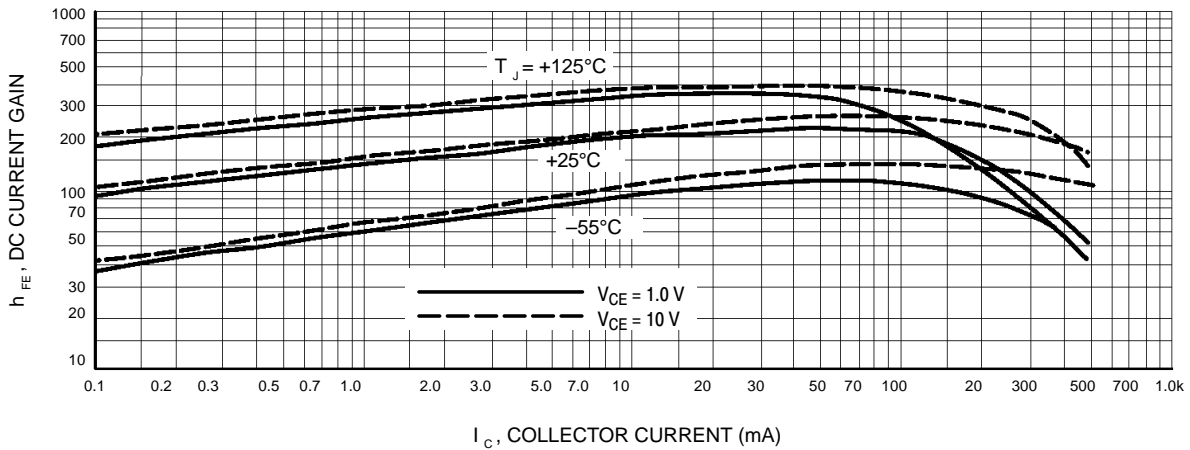


Figure 3. DC Current Gain

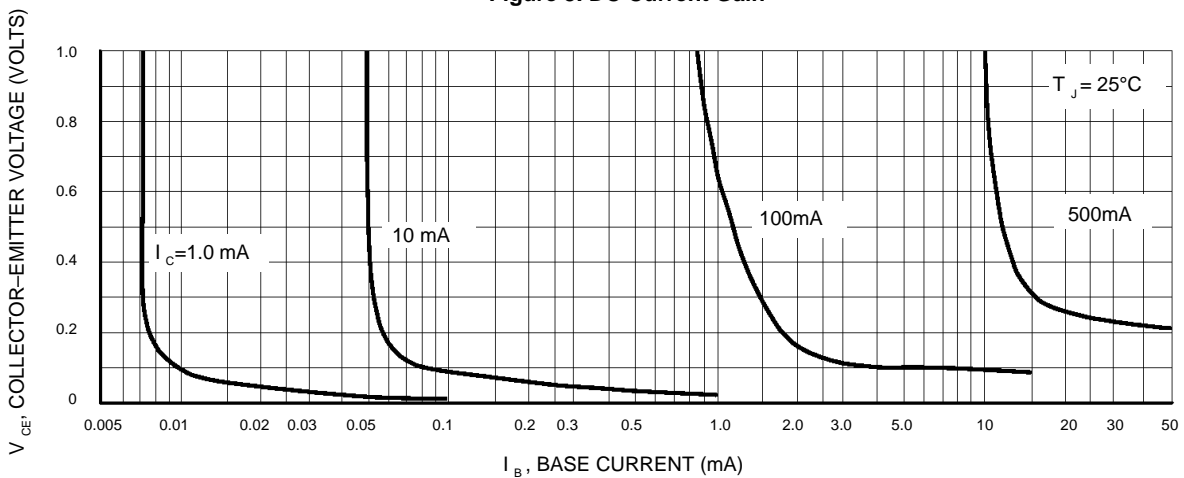


Figure 4. Collector Saturation Region

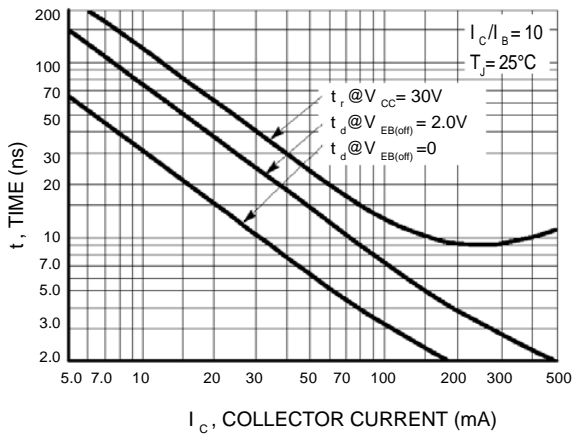


Figure 5. Turn-On Time

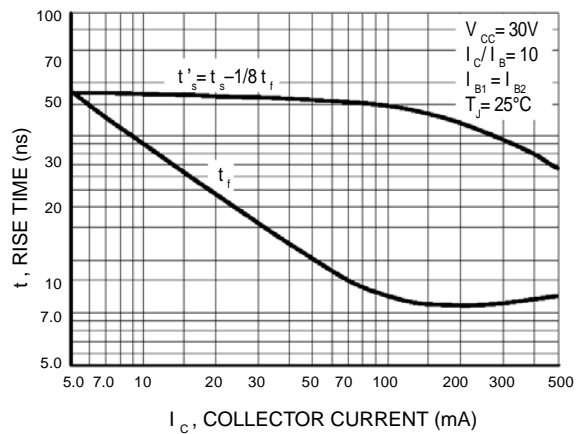


Figure 6. Turn - Off Time

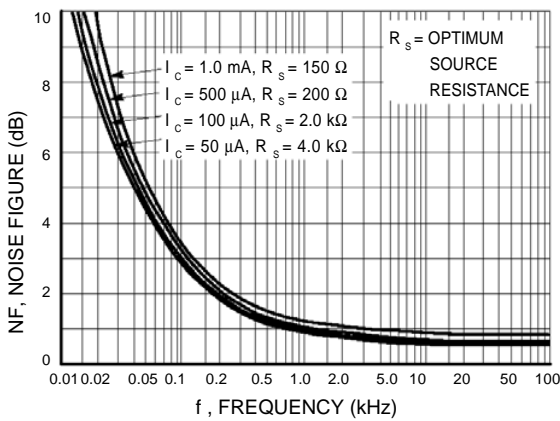


Figure 7. Frequency Effects

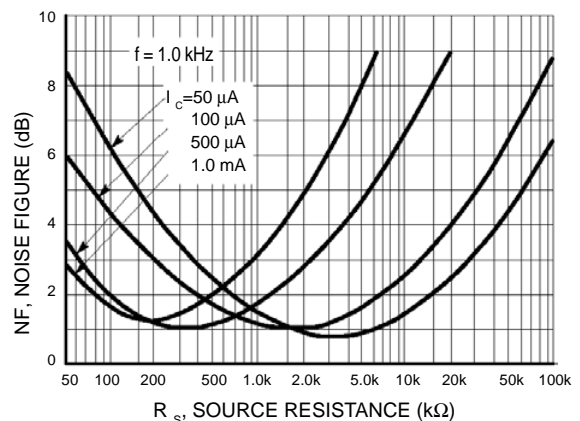


Figure 8. Source Resistance Effects

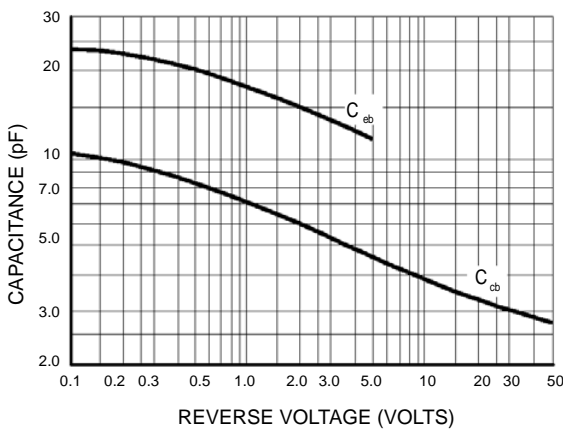


Figure 9. Capacitance

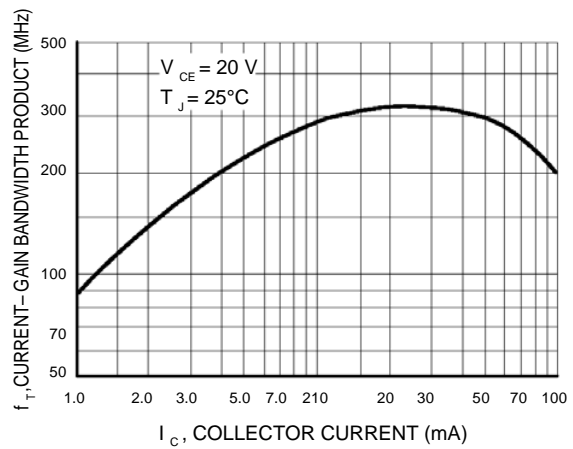
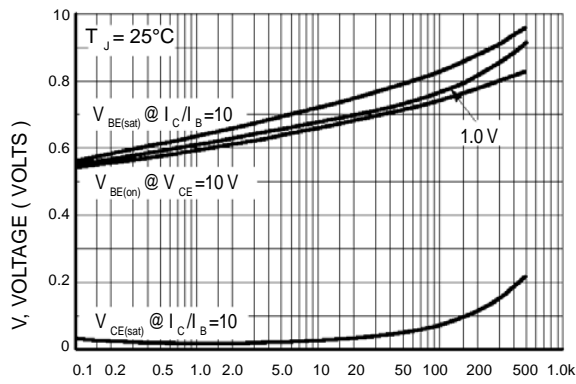
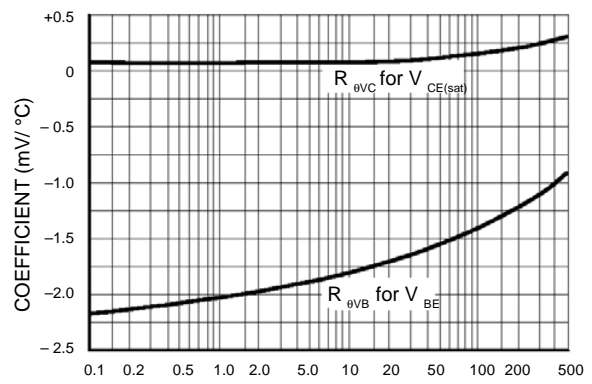


Figure 10. Current-Gain Bandwidth Product



$I_C$ , COLLECTOR CURRENT (mA)

Figure 11. "On" Voltages

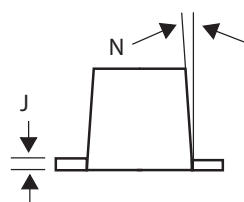
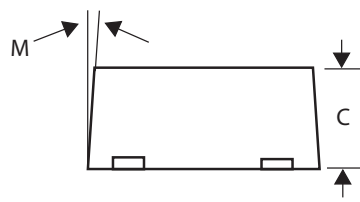
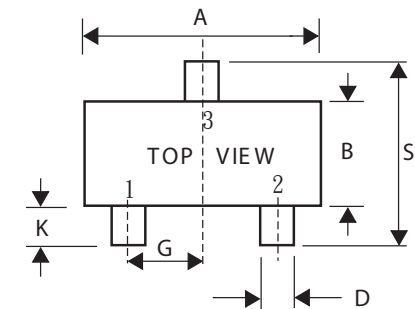


$I_C$ , COLLECTOR CURRENT (mA)

Figure 12. Temperature Coefficients

## SC-89 Package Outline Dimensions

Unit:mm



SC-89			
Dim	Min	Nom	Max
A	1.50	1.60	1.70
B	0.75	0.85	0.95
C	0.60	0.70	0.80
D	0.23	0.28	0.33
G	0.50BSC		
J	0.10	0.15	0.20
K	0.30	0.40	0.50
M	---	---	10°
N	---	---	10°
S	1.50	1.60	1.70