

MMBT4401L, SMMBT4401L

Switching Transistor

NPN Silicon

Features

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

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	600	mAdc
Collector Current - Peak	I_{CM}	900	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (Note 1) @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	225 1.8	mW mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation Alumina Substrate (Note 2) @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300 2.4	mW 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_{stg}	-55 to +150	$^\circ\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

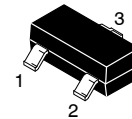
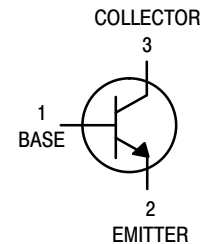
*Transient pulses must not cause the junction temperature to be exceeded.

1. FR-5 = $1.0 \times 0.75 \times 0.062$ in.
2. Alumina = $0.4 \times 0.3 \times 0.024$ in. 99.5% alumina.



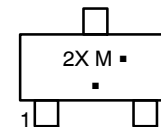
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SOT-23 (TO-236)
CASE 318
STYLE 6

MARKING DIAGRAM



2X = Specific Device Code
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

Device	Package	Shipping†
MMBT4401LT1G SMMBT4401LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
MMBT4401LT3G	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.

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ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector - Emitter Breakdown Voltage (Note 3) ($I_C = 1.0 \text{ mA dc}, I_B = 0$)	$V_{(BR)CEO}$	40	-	Vdc
Collector - Base Breakdown Voltage ($I_C = 0.1 \text{ mA dc}, I_E = 0$)	$V_{(BR)CBO}$	60	-	Vdc
Emitter - Base Breakdown Voltage ($I_E = 0.1 \text{ mA dc}, I_C = 0$)	$V_{(BR)EBO}$	6.0	-	Vdc
Base Cutoff Current ($V_{CE} = 35 \text{ Vdc}, V_{EB} = 0.4 \text{ Vdc}$)	I_{BEV}	-	0.1	$\mu\text{A dc}$
Collector Cutoff Current ($V_{CE} = 35 \text{ Vdc}, V_{EB} = 0.4 \text{ Vdc}$)	I_{CEX}	-	0.1	$\mu\text{A dc}$

ON CHARACTERISTICS (Note 3)

DC Current Gain ($I_C = 0.1 \text{ mA dc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 1.0 \text{ mA dc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mA dc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 150 \text{ mA dc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 500 \text{ mA dc}, V_{CE} = 2.0 \text{ Vdc}$)	h_{FE}	20 40 80 100 40	- - - 300 -	-
Collector - Emitter Saturation Voltage ($I_C = 150 \text{ mA dc}, I_B = 15 \text{ mA dc}$) ($I_C = 500 \text{ mA dc}, I_B = 50 \text{ mA dc}$)	$V_{CE(sat)}$	- -	0.4 0.75	Vdc
Base - Emitter Saturation Voltage ($I_C = 150 \text{ mA dc}, I_B = 15 \text{ mA dc}$) ($I_C = 500 \text{ mA dc}, I_B = 50 \text{ mA dc}$)	$V_{BE(sat)}$	0.75 -	0.95 1.2	Vdc

SMALL-SIGNAL CHARACTERISTICS

Current - Gain - Bandwidth Product ($I_C = 20 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}$)	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 ($I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{ie}	1.0	15	$k\Omega$
Voltage Feedback Ratio ($I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{re}	0.1	8.0	$\times 10^{-4}$
Small - Signal Current Gain ($I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{fe}	40	500	-
Output Admittance ($I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{oe}	1.0	30	μmhos

SWITCHING CHARACTERISTICS

Delay Time	($V_{CC} = 30 \text{ Vdc}, V_{EB} = 2.0 \text{ Vdc}, I_C = 150 \text{ mA dc}, I_{B1} = 15 \text{ mA dc}$)	t_d	-	15	ns
Rise Time		t_r	-	20	
Storage Time	($V_{CC} = 30 \text{ Vdc}, I_C = 150 \text{ mA dc}, I_{B1} = I_{B2} = 15 \text{ mA dc}$)	t_s	-	225	ns
Fall Time		t_f	-	30	

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

SWITCHING TIME EQUIVALENT TEST CIRCUITS

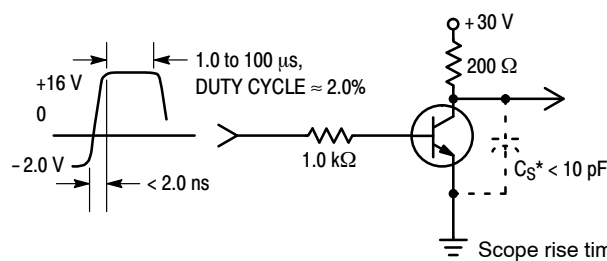


Figure 1. Turn-On Time

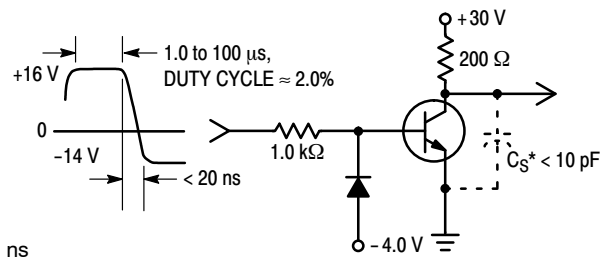


Figure 2. Turn-Off Time

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TRANSIENT CHARACTERISTICS

— 25°C - - - 100°C

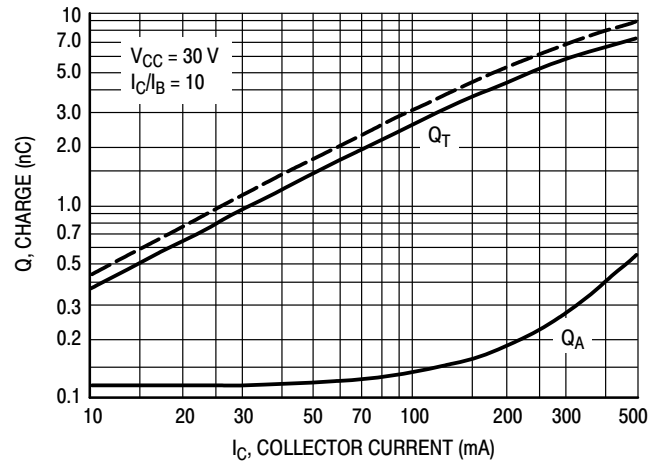


Figure 3. Charge Data

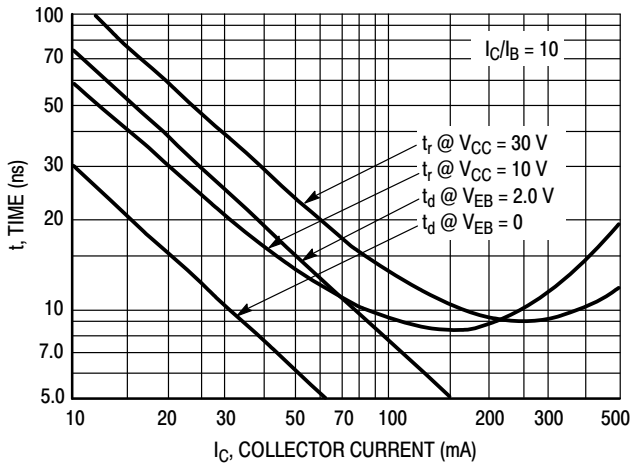


Figure 4. Turn-On Time

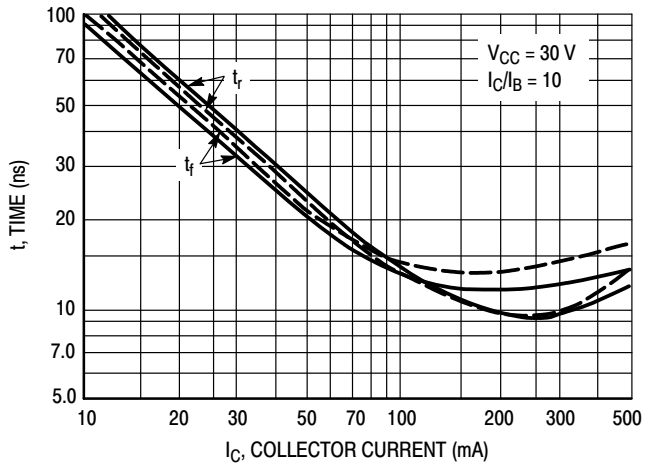


Figure 5. Rise and Fall Times

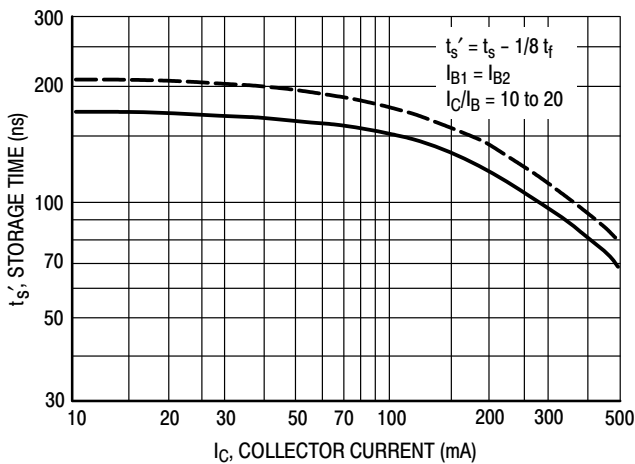


Figure 6. Storage Time

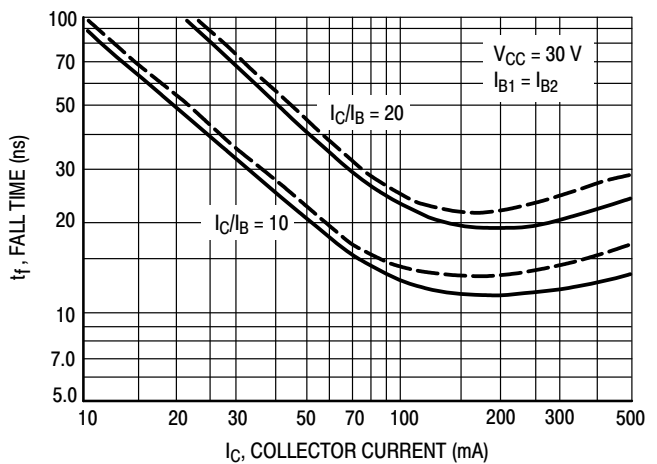


Figure 7. Fall Time

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SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

$V_{CE} = 10 \text{ Vdc}$, $T_A = 25^\circ\text{C}$; Bandwidth = 1.0 Hz

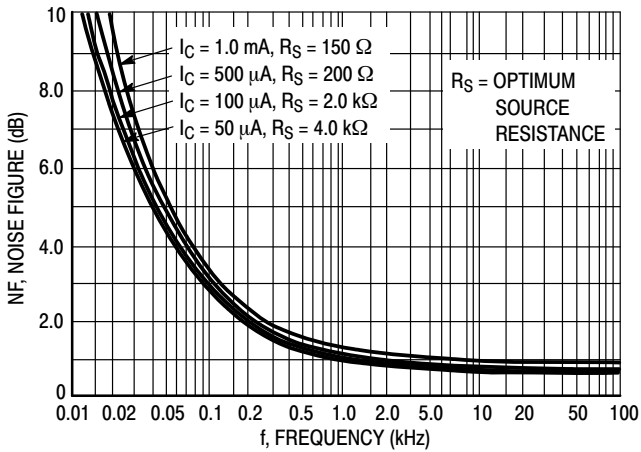


Figure 8. Frequency Effects

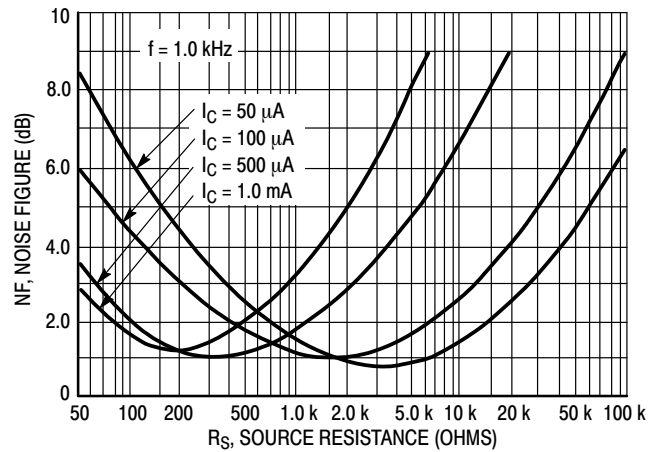


Figure 9. Source Resistance Effects

h PARAMETERS

$V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$, $T_A = 25^\circ\text{C}$

This group of graphs illustrates the relationship between h_{fe} and other “h” parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from the MMBT4401LT1 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

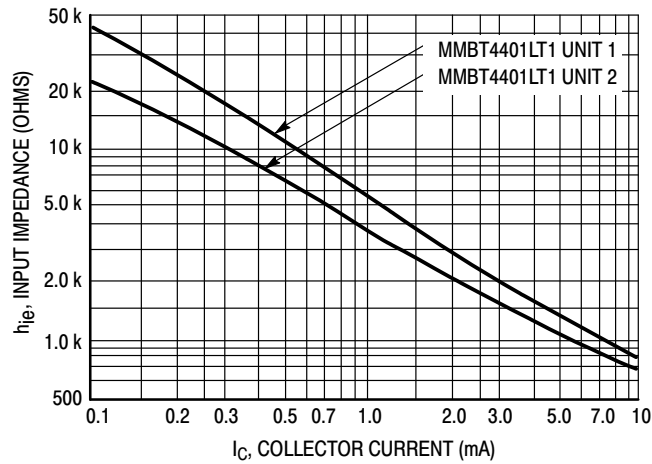


Figure 10. Input Impedance

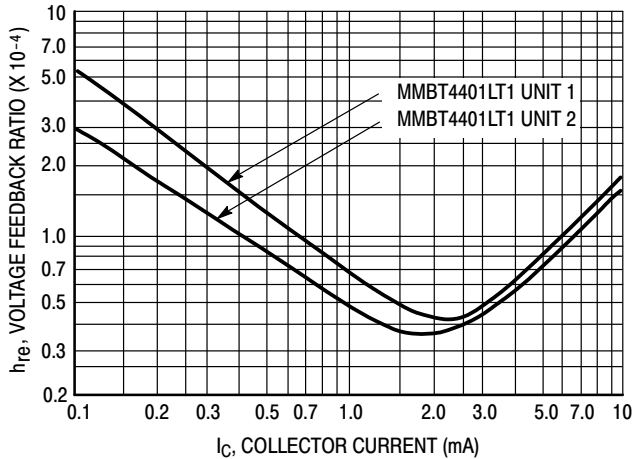


Figure 11. Voltage Feedback Ratio

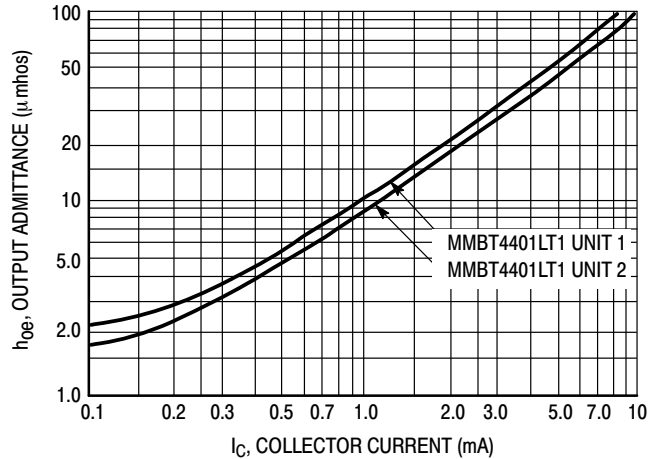


Figure 12. Output Admittance

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STATIC CHARACTERISTICS

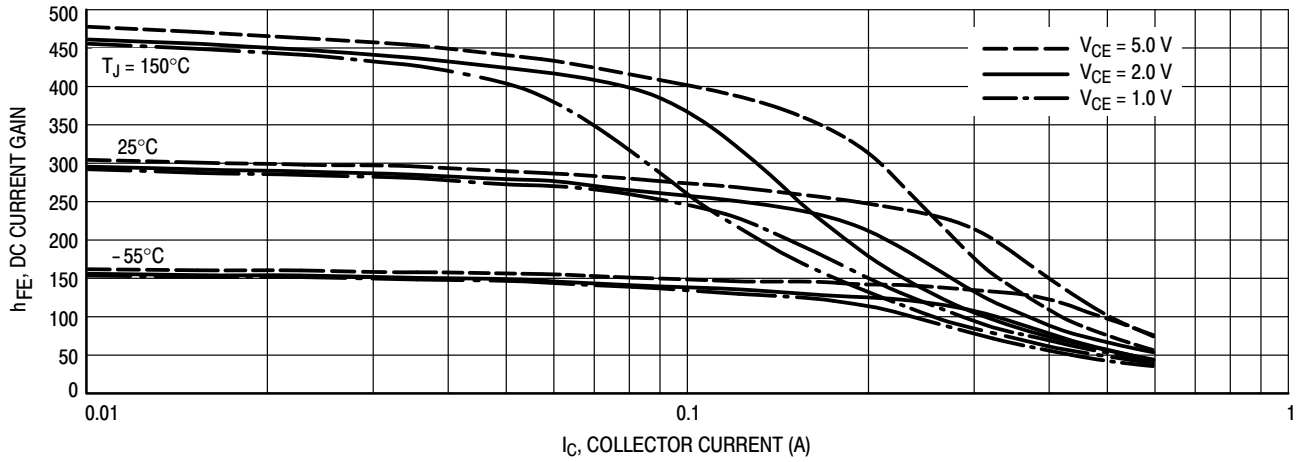


Figure 13. DC Current Gain

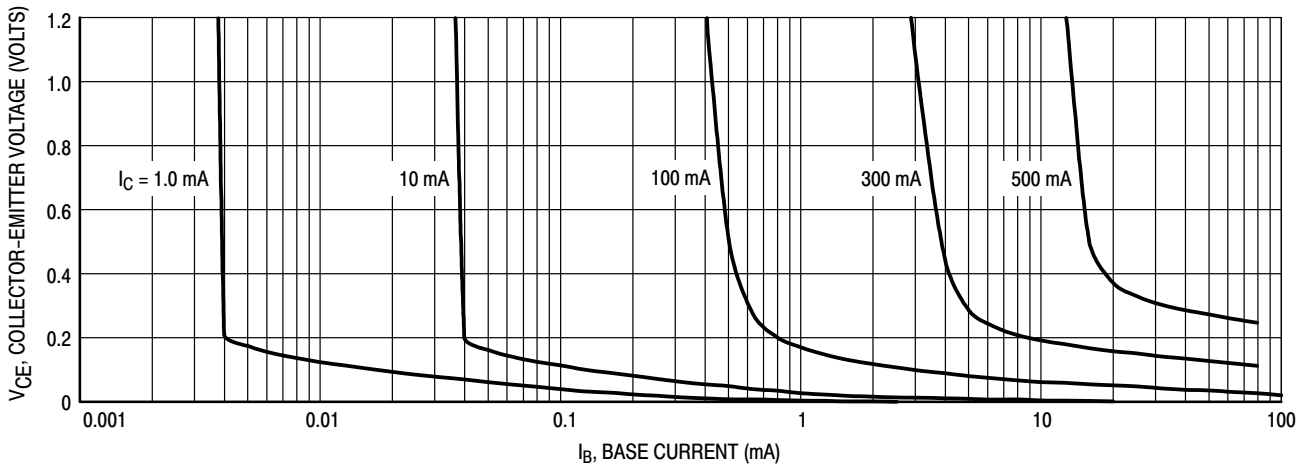


Figure 14. Collector Saturation Region

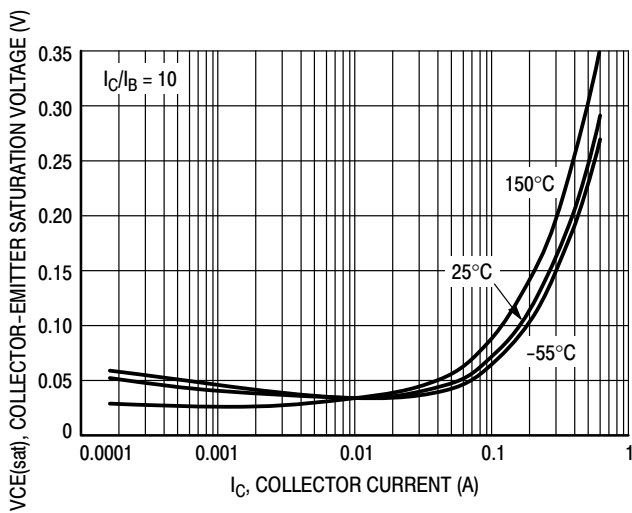


Figure 15. Collector-Emitter Saturation Voltage vs. Collector Current

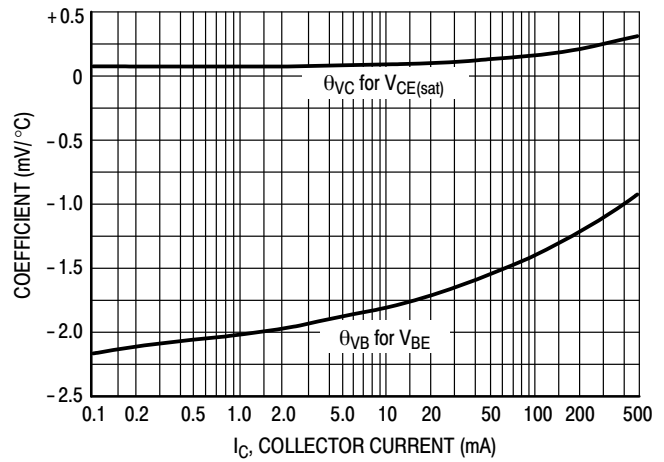


Figure 16. Temperature Coefficients

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STATIC CHARACTERISTICS

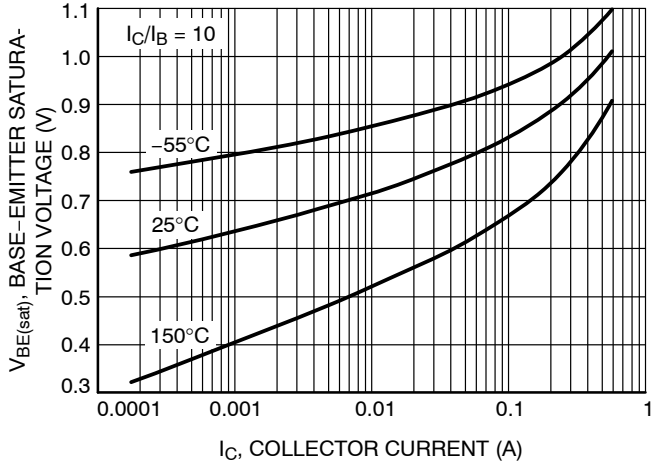


Figure 17. Base-Emitter Saturation Voltage vs. Collector Current

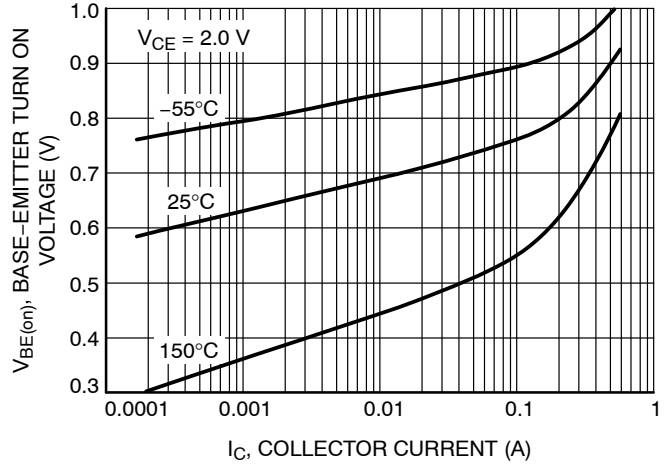


Figure 18. Base-Emitter Turn On Voltage vs. Collector Current

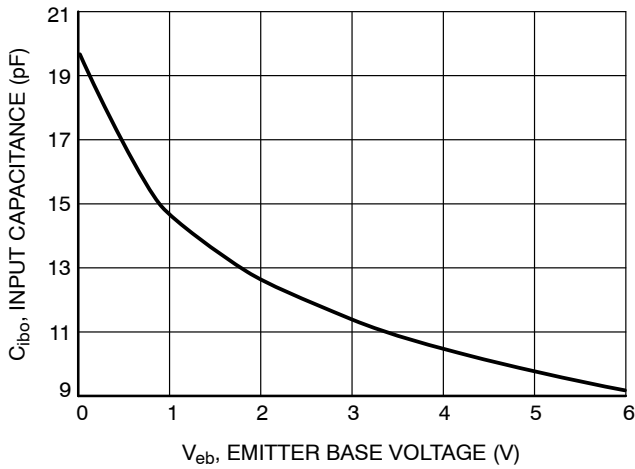


Figure 19. Input Capacitance vs. Emitter Base Voltage

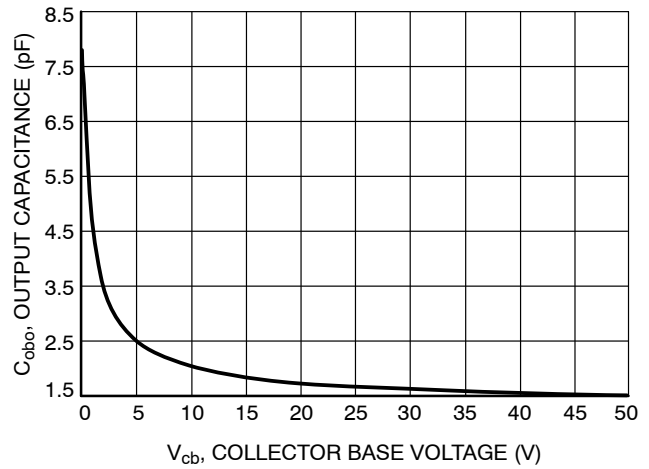


Figure 20. Output Capacitance vs. Collector Base Voltage

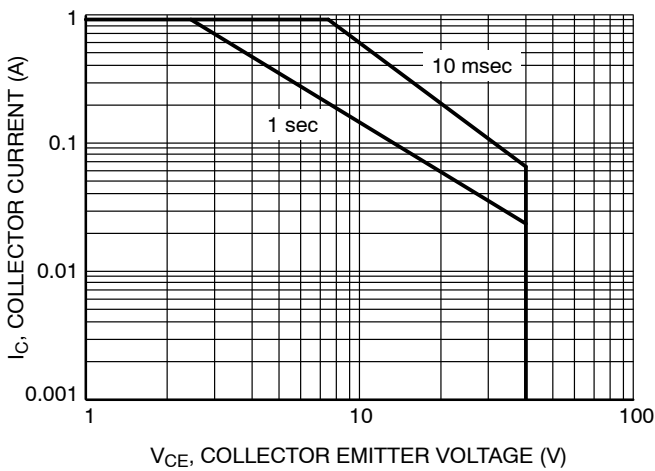


Figure 21. Safe Operating Area

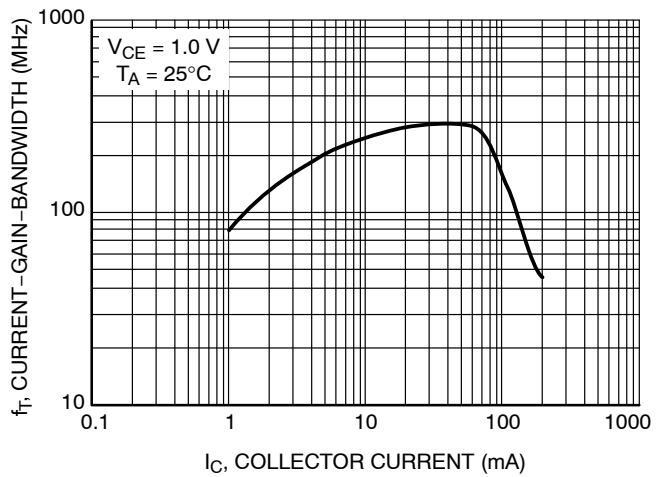
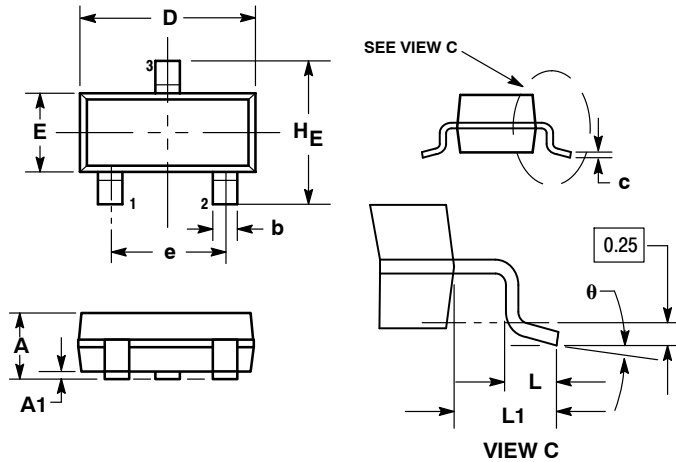


Figure 22. Current-Gain-Bandwidth Product

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PACKAGE DIMENSIONS

SOT-23 (TO-236)
CASE 318-08
ISSUE AP



NOTES:

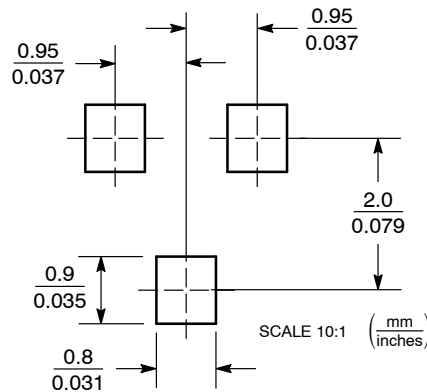
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.89	1.00	1.11	0.035	0.040	0.044
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.37	0.44	0.50	0.015	0.018	0.020
c	0.09	0.13	0.18	0.003	0.005	0.007
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	0.081
L	0.10	0.20	0.30	0.004	0.008	0.012
L1	0.35	0.54	0.69	0.014	0.021	0.029
HE	2.10	2.40	2.64	0.083	0.094	0.104
θ	0°	---	10°	0°	---	10°

STYLE 6:

1. BASE
2. EMITTER
3. COLLECTOR

SOLDERING 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.

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