

MMBT4401L, SMMBT4401L

Switching Transistor

NPN Silicon

Features

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

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 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.

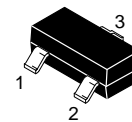
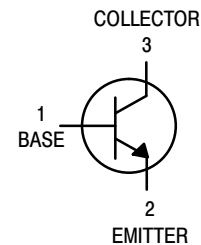
*Transient pulses must not cause the junction temperature to be exceeded.

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.



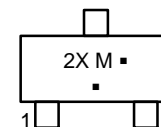
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SOT–23 (TO–236)
CASE 318
STYLE 6

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	$(V_{CE} = 35 \text{ V dc}, V_{EB} = 0.4 \text{ V dc})$	I_{BEV}	–	0.1	$\mu\text{A dc}$
Collector Cutoff Current	$(V_{CE} = 35 \text{ V dc}, V_{EB} = 0.4 \text{ V dc})$	I_{CEX}	–	0.1	$\mu\text{A dc}$

ON CHARACTERISTICS (Note 3)

DC Current Gain	$(I_C = 0.1 \text{ mA dc}, V_{CE} = 1.0 \text{ V dc})$ $(I_C = 1.0 \text{ mA dc}, V_{CE} = 1.0 \text{ V dc})$ $(I_C = 10 \text{ mA dc}, V_{CE} = 1.0 \text{ V dc})$ $(I_C = 150 \text{ mA dc}, V_{CE} = 1.0 \text{ V dc})$ $(I_C = 500 \text{ mA dc}, V_{CE} = 2.0 \text{ V dc})$	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	$(I_C = 20 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 100 \text{ MHz})$	f_T	250	–	MHz
Collector–Base Capacitance	$(V_{CB} = 5.0 \text{ V dc}, I_E = 0, f = 1.0 \text{ MHz})$	C_{cb}	–	6.5	pF
Emitter–Base Capacitance	$(V_{EB} = 0.5 \text{ V dc}, I_C = 0, f = 1.0 \text{ MHz})$	C_{eb}	–	30	pF
Input Impedance	$(I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 1.0 \text{ kHz})$	h_{ie}	1.0	15	$k\Omega$
Voltage Feedback Ratio	$(I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 1.0 \text{ kHz})$	h_{re}	0.1	8.0	$\times 10^{-4}$
Small–Signal Current Gain	$(I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 1.0 \text{ kHz})$	h_{fe}	40	500	–
Output Admittance	$(I_C = 1.0 \text{ mA dc}, V_{CE} = 10 \text{ V dc}, f = 1.0 \text{ kHz})$	h_{oe}	1.0	30	μmhos

SWITCHING CHARACTERISTICS

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

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.

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

SWITCHING TIME EQUIVALENT TEST CIRCUITS

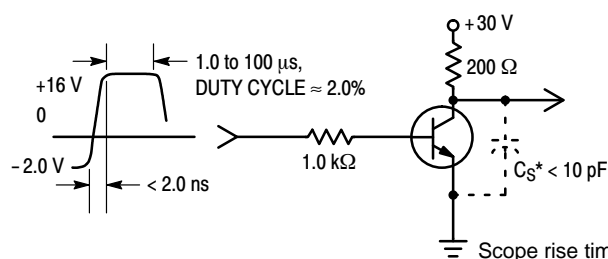


Figure 1. Turn–On Time

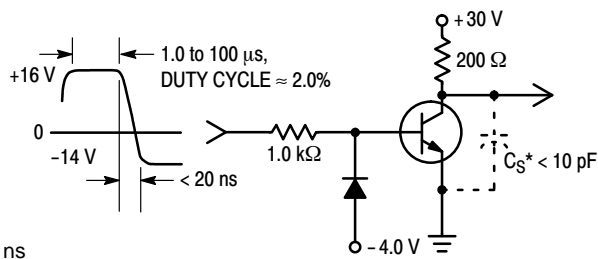


Figure 2. Turn–Off Time

MMBT4401L, SMMBT4401L

TRANSIENT CHARACTERISTICS

— 25°C - - - 100°C

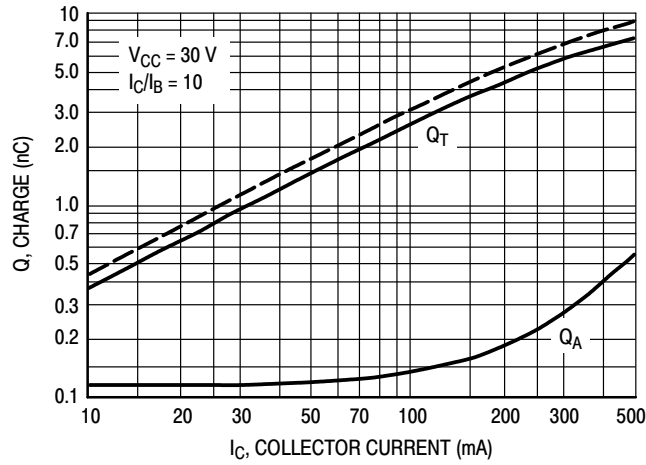


Figure 3. Charge Data

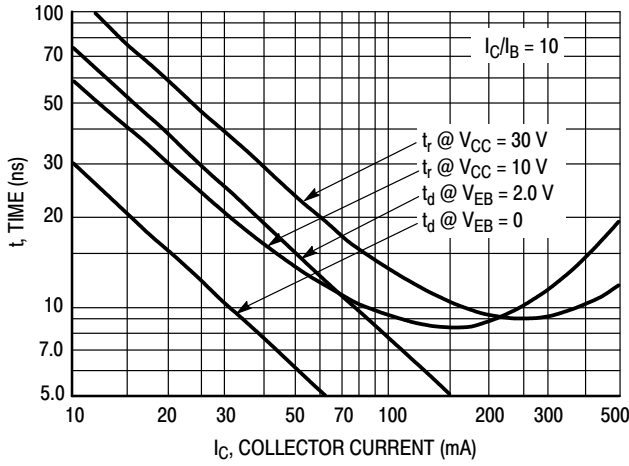


Figure 4. Turn-On Time

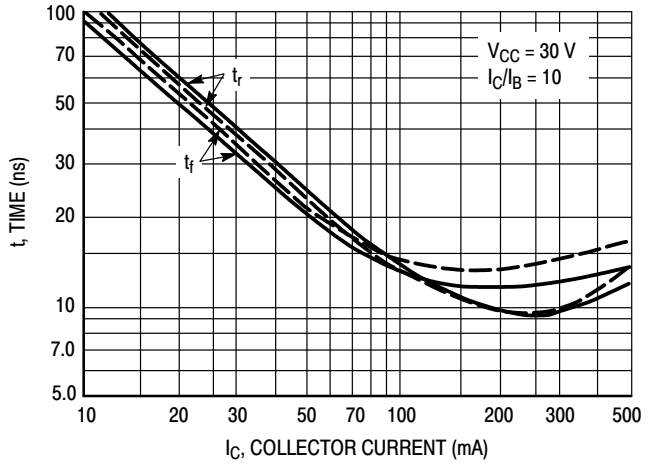


Figure 5. Rise and Fall Times

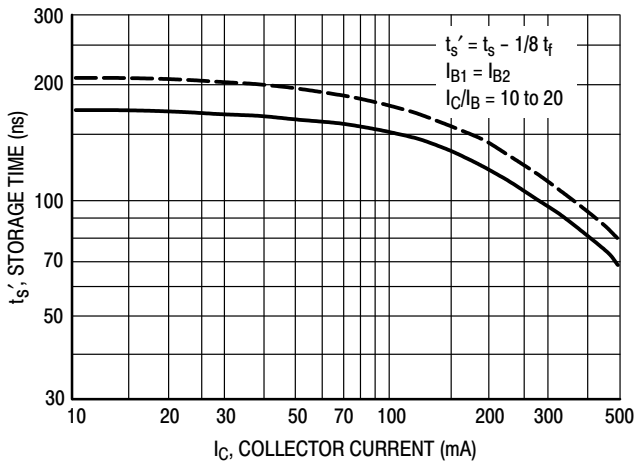


Figure 6. Storage Time

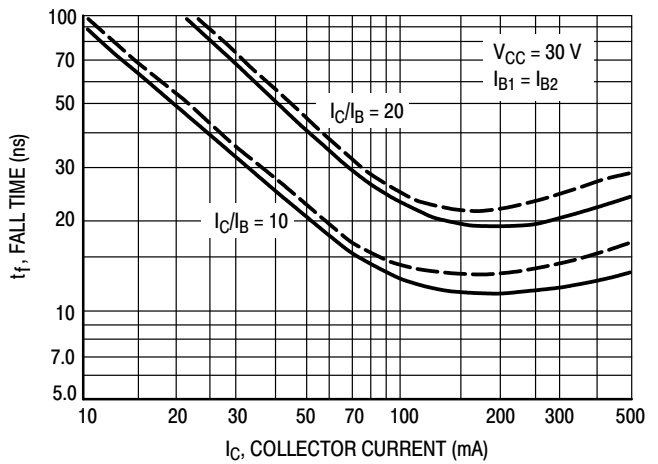


Figure 7. Fall Time

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SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

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

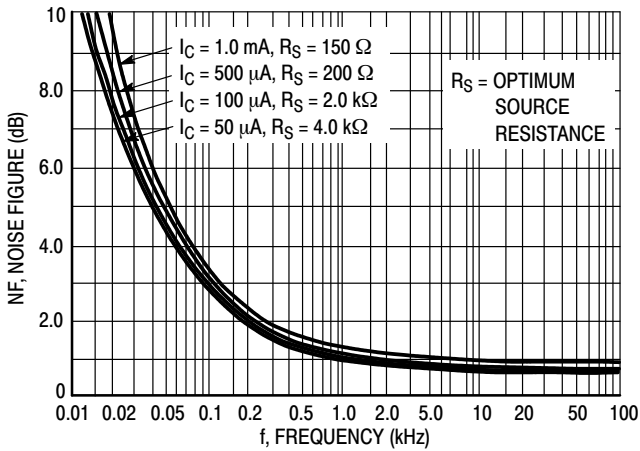


Figure 8. Frequency Effects

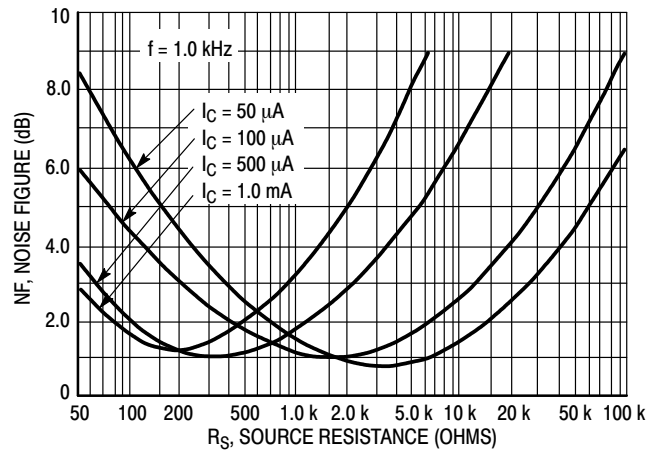


Figure 9. Source Resistance Effects

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.

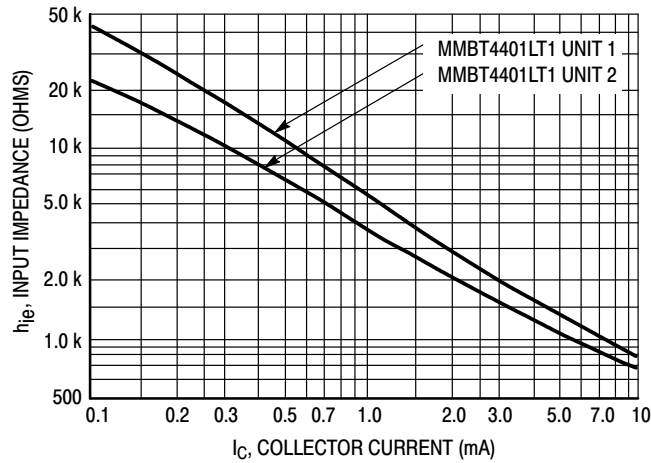


Figure 10. Input Impedance

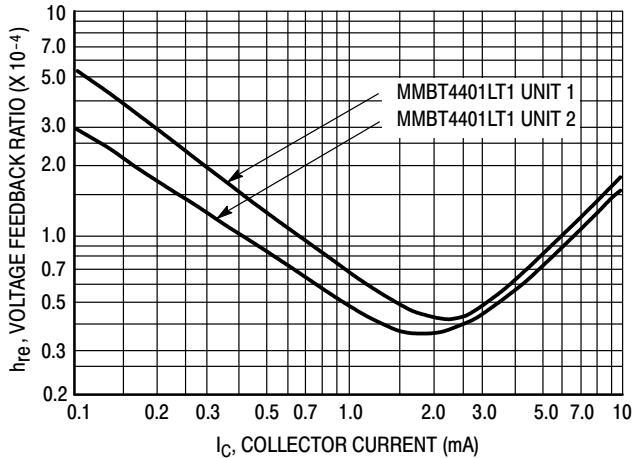


Figure 11. Voltage Feedback Ratio

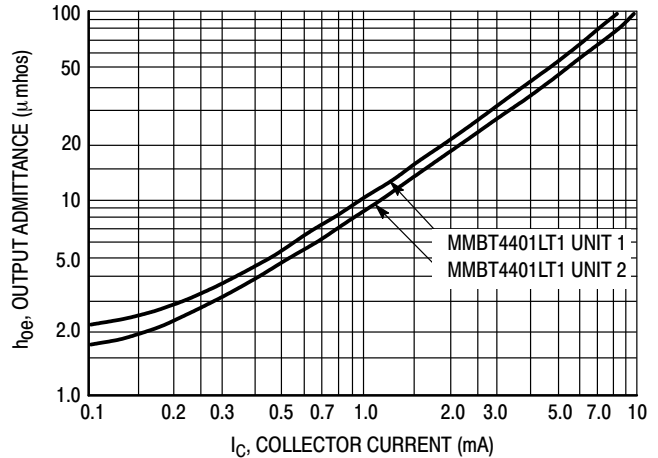


Figure 12. Output Admittance

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STATIC CHARACTERISTICS

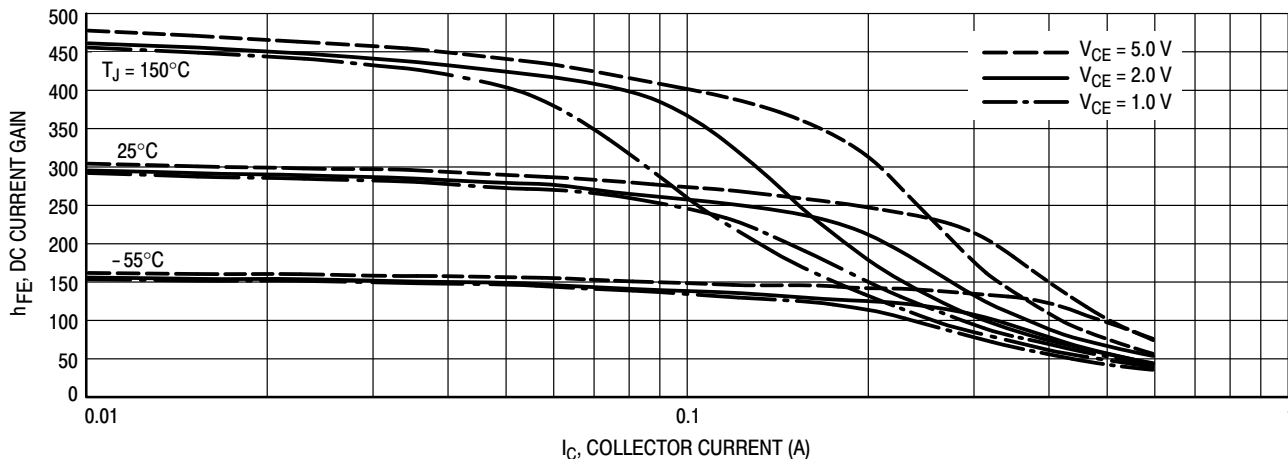


Figure 13. DC Current Gain

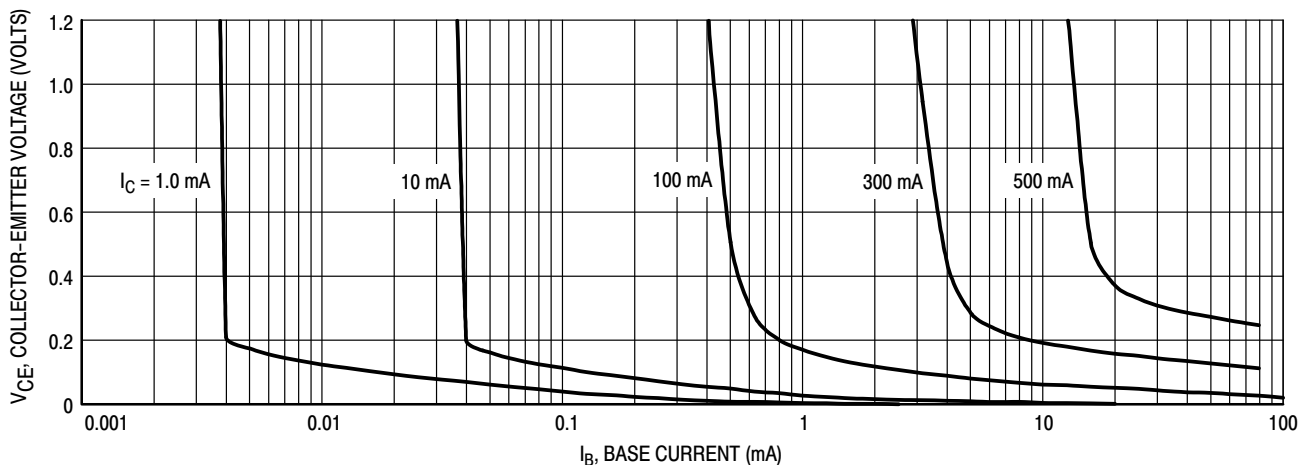


Figure 14. Collector Saturation Region

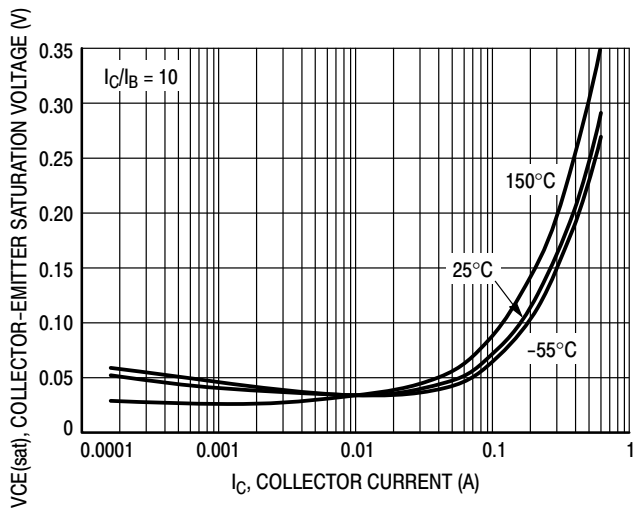


Figure 15. Collector-Emitter Saturation Voltage vs. Collector Current

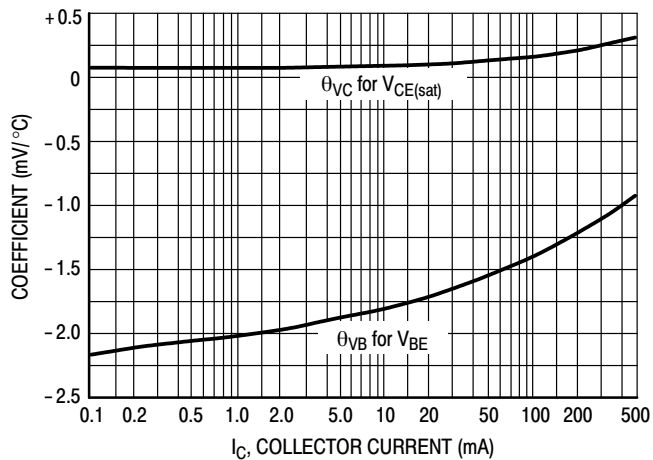


Figure 16. Temperature Coefficients

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STATIC CHARACTERISTICS

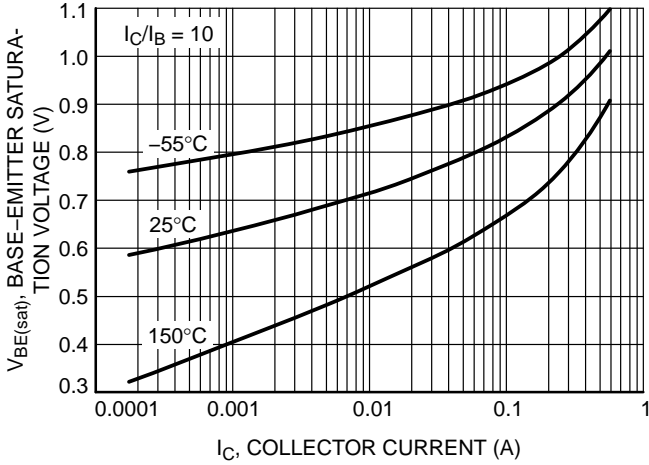


Figure 17. Base-Emitter Saturation Voltage vs. Collector Current

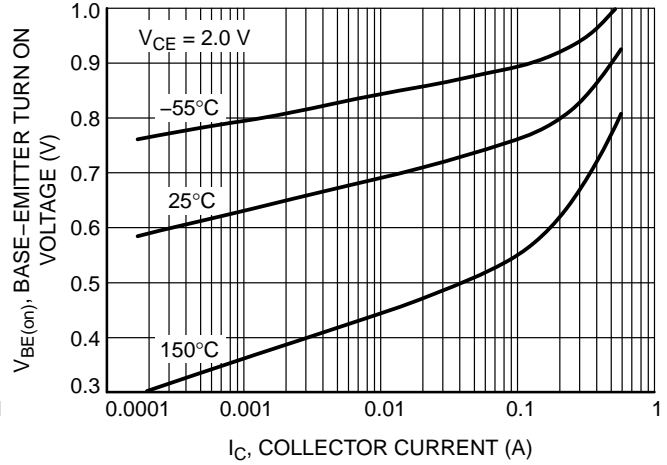


Figure 18. Base-Emitter Turn On Voltage vs. Collector Current

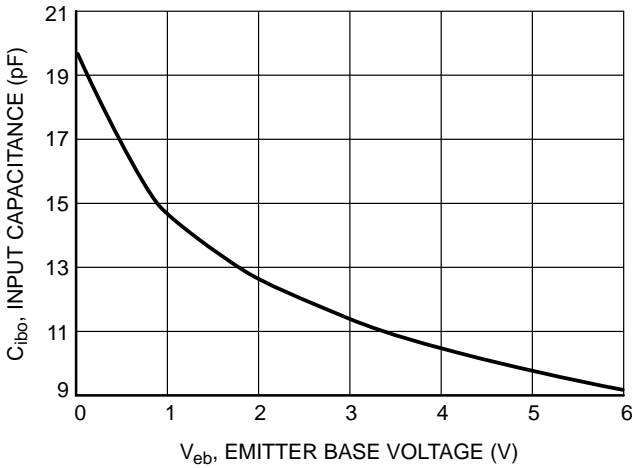


Figure 19. Input Capacitance vs. Emitter Base Voltage

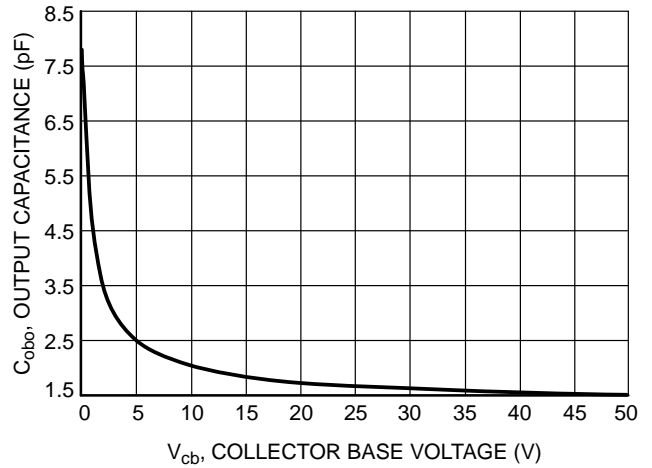


Figure 20. Output Capacitance vs. Collector Base Voltage

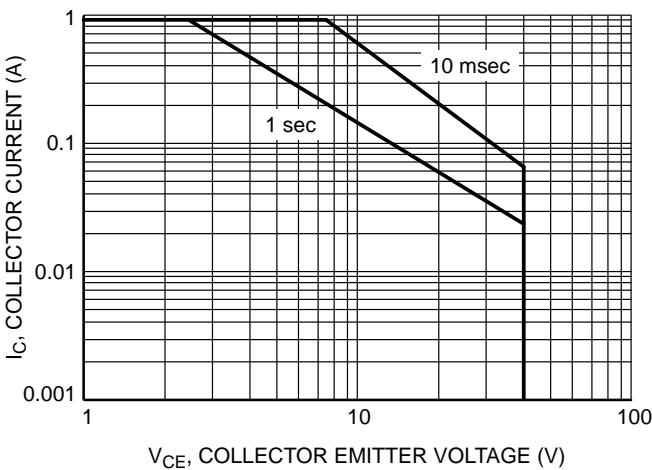


Figure 21. Safe Operating Area

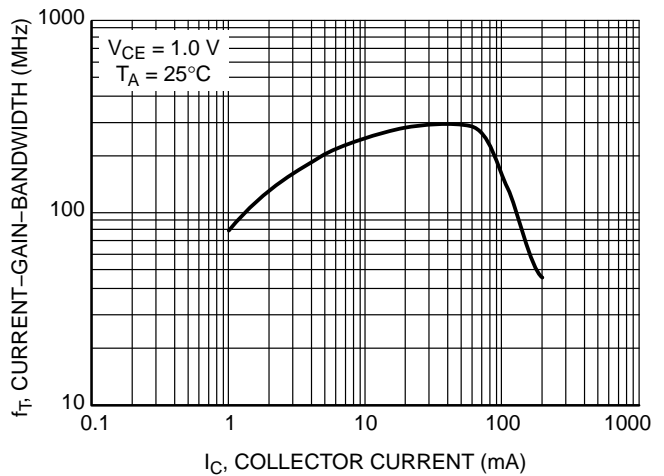


Figure 22. Current-Gain-Bandwidth Product

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SOT-23 (TO-236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

SCALE 4:1



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*



- 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.



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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MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS



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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