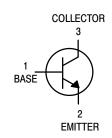


Switching Transistor NPN Silicon MMBT4401L, SMMBT4401L

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





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

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

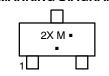
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (Note 1) @T _A = 25°C Derate above 25°C	P _D	225 1.8	mW mW/°C
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2) @T _A = 25°C Derate above 25°C	P _D	300 2.4	mW mW/°C
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	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.

*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.

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.

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

Cha	Symbol	Min	Max	Unit	
OFF CHARACTERISTICS		•	•	•	•
Collector - Emitter Breakdown Voltage	V _{(BR)CEO}	40	_	Vdc	
Collector - Base Breakdown Voltage	$(I_C = 0.1 \text{ mAdc}, I_E = 0)$	V _{(BR)CBO}	60	-	Vdc
Emitter – Base Breakdown Voltage	$(I_E = 0.1 \text{ mAdc}, I_C = 0)$	V _{(BR)EBO}	6.0	-	Vdc
Base Cutoff Current	(V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc)	I _{BEV}	-	0.1	μAdc
Collector Cutoff Current	(V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc)	I _{CEX}	-	0.1	μAdc
ON CHARACTERISTICS (Note 3)		•	•	•	•
DC Current Gain	$ \begin{array}{l} (I_{C}=0.1 \text{ mAdc, V}_{CE}=1.0 \text{ Vdc}) \\ (I_{C}=1.0 \text{ mAdc, V}_{CE}=1.0 \text{ Vdc}) \\ (I_{C}=10 \text{ mAdc, V}_{CE}=1.0 \text{ Vdc}) \\ (I_{C}=150 \text{ mAdc, V}_{CE}=1.0 \text{ Vdc}) \\ (I_{C}=500 \text{ mAdc, V}_{CE}=2.0 \text{ Vdc}) \end{array} $		20 40 80 100 40	- - - 300 -	-
Collector - Emitter Saturation Voltage	$(I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc})$ $(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$		- -	0.4 0.75	Vdc
Base – Emitter Saturation Voltage	$(I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc})$ $(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$		0.75 -	0.95 1.2	Vdc
SMALL-SIGNAL CHARACTERISTIC	cs		•		
Current - Gain - Bandwidth Product	$(I_C = 20 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz})$	f _T	250	_	MHz
Collector-Base Capacitance	(V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz)	C _{cb}	-	6.5	pF
Emitter-Base Capacitance	(V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	C _{eb}	-	30	pF
Input Impedance	$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	h _{ie}	1.0	15	kΩ
Voltage Feedback Ratio	$(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ kHz})$	h _{re}	0.1	8.0	X 10 ⁻⁴
Small - Signal Current Gain	nal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz)		40	500	_
Output Admittance ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)		h _{oe}	1.0	30	μmhos
SWITCHING CHARACTERISTICS					
Delay Time	(V _{CC} = 30 Vdc, V _{EB} = 2.0 Vdc,	t _d	_	15	ne
Rise Time	I _C = 150 mAdc, I _{B1} = 15 mAdc)	t _r	_	20	ns
Storage Time	(V _{CC} = 30 Vdc, I _C = 150 mAdc,	t _s	_	225	ns
Fall Time	$I_{B1} = I_{B2} = 15 \text{ mAdc}$	t _f	_	30	1115

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 ≤ 300 µs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

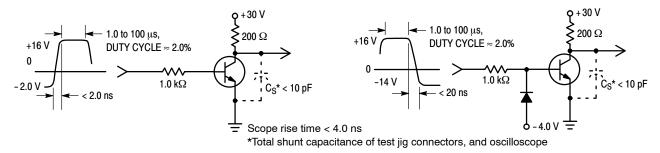


Figure 1. Turn-On Time

Figure 2. Turn-Off Time

TRANSIENT CHARACTERISTICS

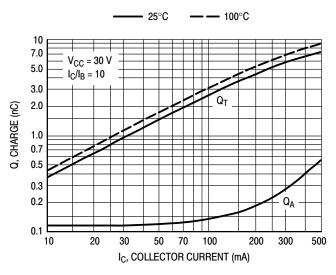


Figure 3. Charge Data

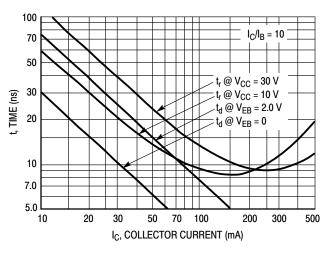


Figure 4. Turn-On Time

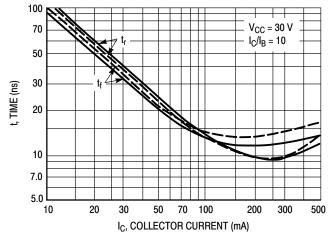


Figure 5. Rise and Fall Times

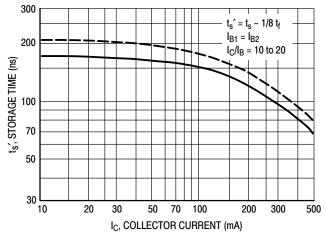


Figure 6. Storage Time

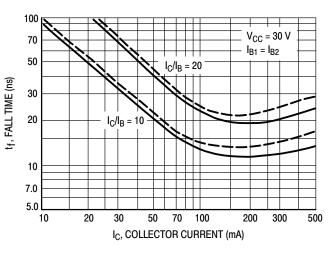


Figure 7. Fall Time

SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C; Bandwidth = 1.0 Hz

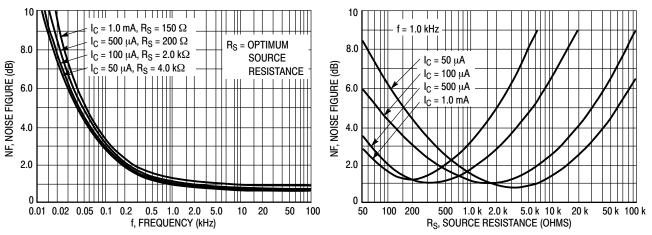


Figure 8. Frequency Effects

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.

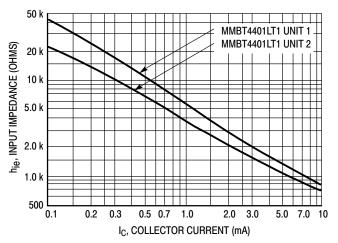


Figure 10. Input Impedance

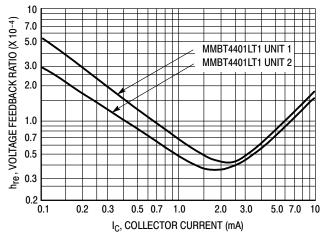


Figure 11. Voltage Feedback Ratio

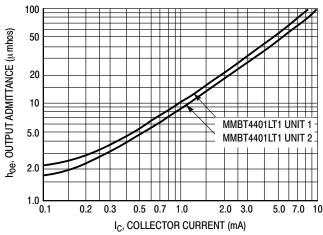


Figure 12. Output Admittance

STATIC CHARACTERISTICS

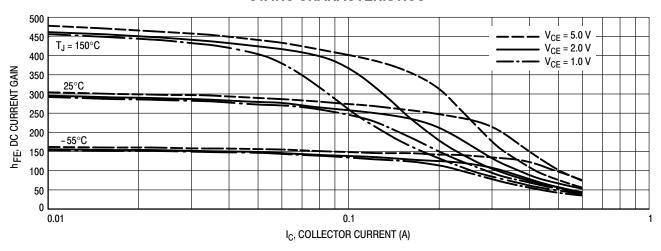


Figure 13. DC Current Gain

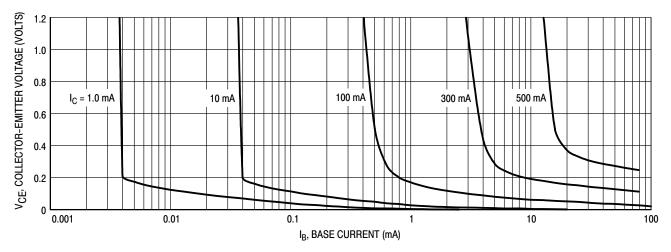


Figure 14. Collector Saturation Region

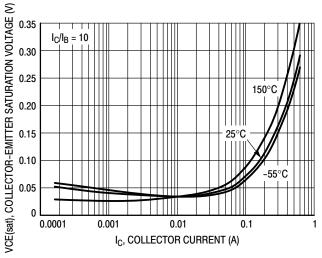


Figure 15. Collector-Emitter Saturation Voltage vs. Collector Current

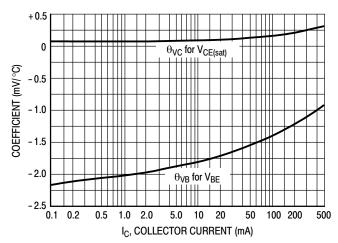


Figure 16. Temperature Coefficients

STATIC CHARACTERISTICS

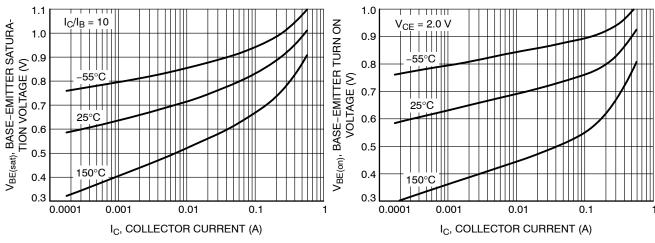


Figure 17. Base-Emitter Saturation Voltage vs. **Collector Current**



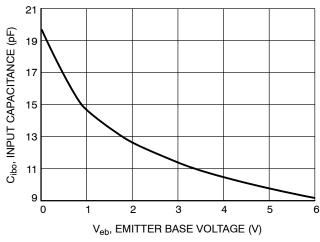


Figure 19. Input Capacitance vs. Emitter Base Voltage

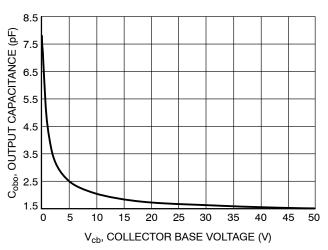


Figure 20. Output Capacitance vs. Collector **Base Voltage**

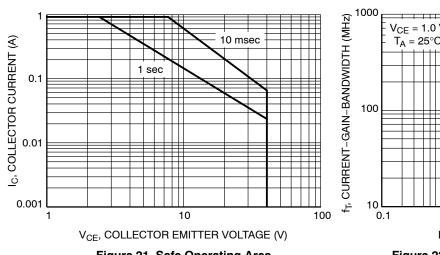


Figure 21. Safe Operating Area

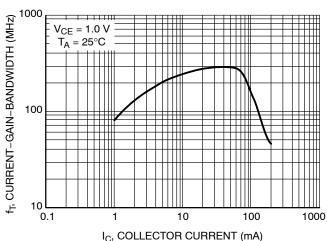


Figure 22. Current-Gain-Bandwidth Product

MILLIMETERS

MIN

0.89

0.01

0.37

0.08

2.80

1.20

1.78

0.30

0.35

2.10

O°

NOM

1.00

0.06

0.44

0.14

2.90

1.30

1.90

0.43

0.54

2.40





SOT-23 (TO-236) 2.90x1.30x1.00 1.90P **CASE 318 ISSUE AU**

DATE 14 AUG 2024

MAX

1.11

0.10

0.50

0.20

3.04

1.40

2.04

0.55

0.69

2.64

10°

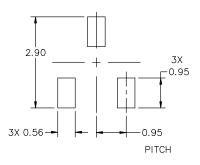




DETAIL "A" Scale 3:1







NOTES:

DIM

Α

Α1

b

С

D

Ε

е L

L1

HE

Τ

- DIMENSIONING AND TOLERANCING 1. PER ASME Y14.5M, 2018. CONTROLLING DIMENSIONS:
- MILLIMETERS.
- MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE
- BASE MATERIAL.
 DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

GENERIC MARKING DIAGRAM*



XXX = Specific Device Code

= Date Code

= Pb-Free Package

RECOMMENDED MOUNTING FOOTPRINT

* For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

STYLES ON PAGE 2

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^{*}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.

SOT-23 (TO-236) 2.90x1.30x1.00 1.90P CASE 318 ISSUE AU

DATE 14 AUG 2024

STYLE 1 THRU 5: CANCELLED	STYLE 6: PIN 1. BASE 2. EMITTER 3. COLLECTOR			
STYLE 9: PIN 1. ANODE 2. ANODE 3. CATHODE	STYLE 10: PIN 1. DRAIN 2. SOURCE 3. GATE	2. CATHODE 2.	2: STYLE 13: CATHODE PIN 1. SOURCE CATHODE 2. DRAIN ANODE 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	2. ANODE 2.	3: STYLE 19: NO CONNECTION PIN 1. CATHODE CATHODE 2. ANODE 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 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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