onsemi

General Purpose Transistor

NPN Silicon

MMBT3904L, SMMBT3904L

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

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	200	mAdc
Collector Current – Peak (Note 3)	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.
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.
3. Reference SOA curve.

COLLECTOR
3
1
BASE
2
EMITTER

3
1
2
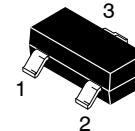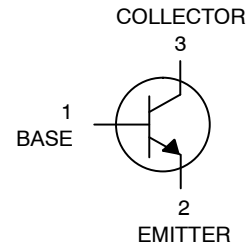
SOT−23 (TO−236)
CASE 318
STYLE 6

MARKING DIAGRAM

1AM M ■
■
1
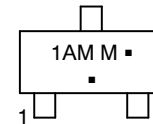
1AM = Specific Device Code
M = Date Code*
■ = Pb−Free Package
(Note: Microdot may be in either location)
*Date Code orientation and/or overbar may vary depending upon manufacturing location.

ORDERING INFORMATION

Device	Package	Shipping†
MMBT3904LT1G SMMBT3904LT1G	SOT−23 (Pb−Free)	3000 / Tape & Reel
MMBT3904LT3G SMMBT3904LT3G	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)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector – Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	Vdc
Collector – Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	Vdc
Emitter – Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	–	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	–	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	–	50	nAdc
ON CHARACTERISTICS (Note 4)				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	H_{FE}	 40 70 100 60 30	 – – 300 – –	–
Collector – Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 – –	 0.2 0.3	Vdc
Base – Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 0.65 –	 0.85 0.95	Vdc
SMALL – SIGNAL CHARACTERISTICS				
Current – Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	–	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	8.0	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{ie}	1.0	10	kΩ
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{re}	0.5	8.0	X 10^{-4}
Small – Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{fe}	100	400	–
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{oe}	1.0	40	μmhos
Noise Figure (V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k ohms, f = 1.0 kHz)	NF	–	5.0	dB

SWITCHING CHARACTERISTICS

		Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = – 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	–	35	ns
Rise Time		t_r	–	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	–	200	ns
Fall Time		t_f	–	50	

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%.

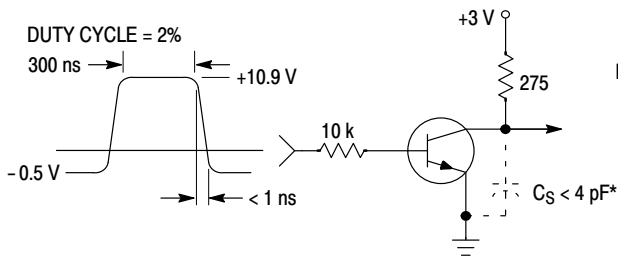* Total shunt capacitance of test jig and connectors
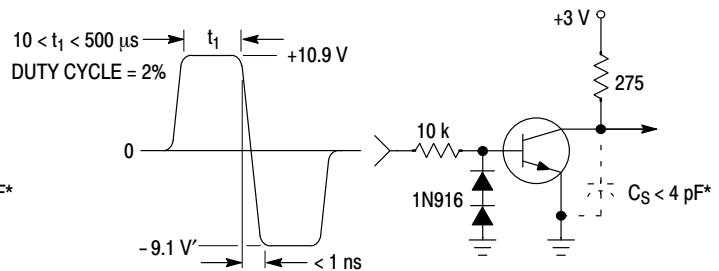
Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

MMBT3904L, SMMBT3904L

TYPICAL TRANSIENT CHARACTERISTICS

$T_J = 25°C$

$T_J = 125°C$

Figure 3. Capacitance
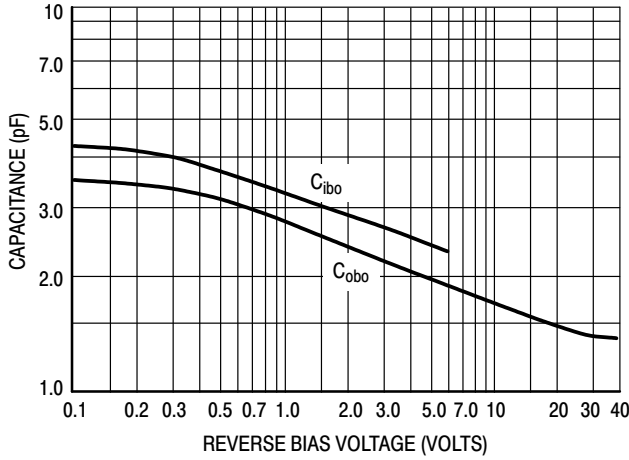
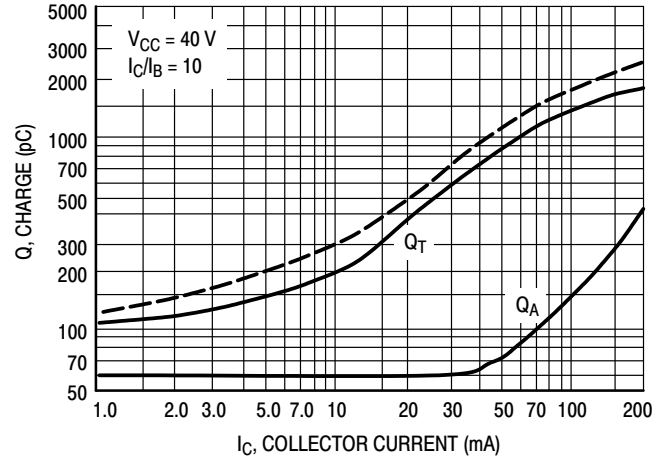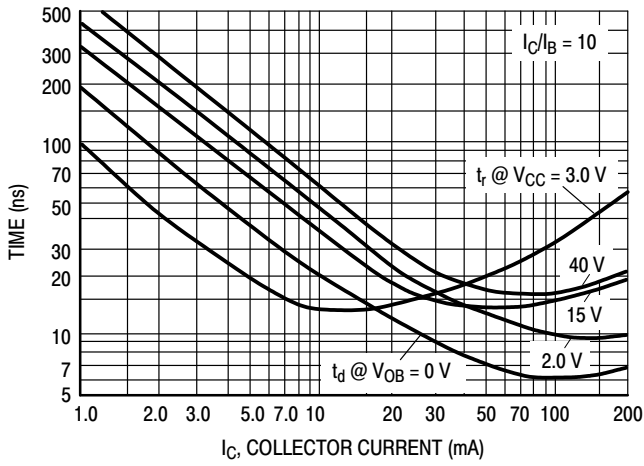Y-axis: CAPACITANCE (pF) — C_{ibo}, C_{obo}

X-axis: REVERSE BIAS VOLTAGE (VOLTS)

Figure 4. Charge Data

$V_{CC} = 40$ V, $I_C/I_B = 10$

Y-axis: Q, CHARGE (pC) — Q_T, Q_A

X-axis: I_C, COLLECTOR CURRENT (mA)

Figure 5. Turn−On Time

$I_C/I_B = 10$, t_r @ $V_{CC} = 3.0$ V, 40 V, 15 V, 2.0 V, t_d @ $V_{OB} = 0$ V

Y-axis: TIME (ns)

X-axis: I_C, COLLECTOR CURRENT (mA)

Figure 6. Rise Time

$V_{CC} = 40$ V, $I_C/I_B = 10$

Y-axis: t_r, RISE TIME (ns)

X-axis: I_C, COLLECTOR CURRENT (mA)

Figure 7. Storage Time

$t'_s = t_s - {}^1/_8\, t_f$, $I_{B1} = I_{B2}$, $I_C/I_B = 20$, $I_C/I_B = 10$

Y-axis: t'_s, STORAGE TIME (ns)

X-axis: I_C, COLLECTOR CURRENT (mA)

Figure 8. Fall Time

$V_{CC} = 40$ V, $I_{B1} = I_{B2}$, $I_C/I_B = 20$, $I_C/I_B = 10$

Y-axis: t_f, FALL TIME (ns)

X-axis: I_C, COLLECTOR CURRENT (mA)
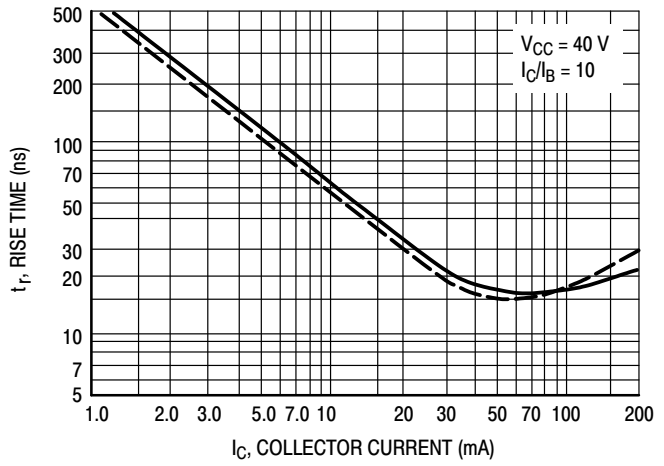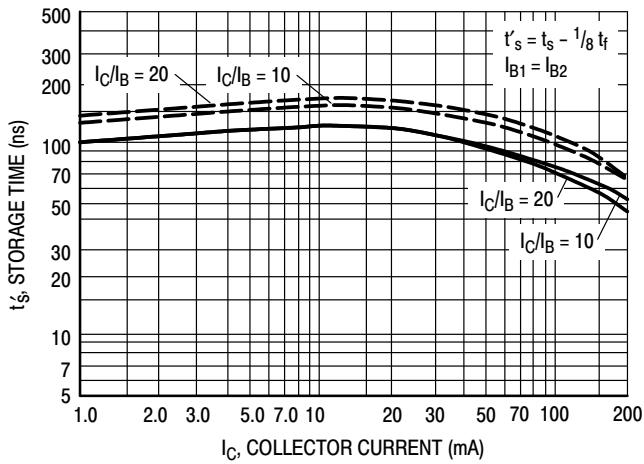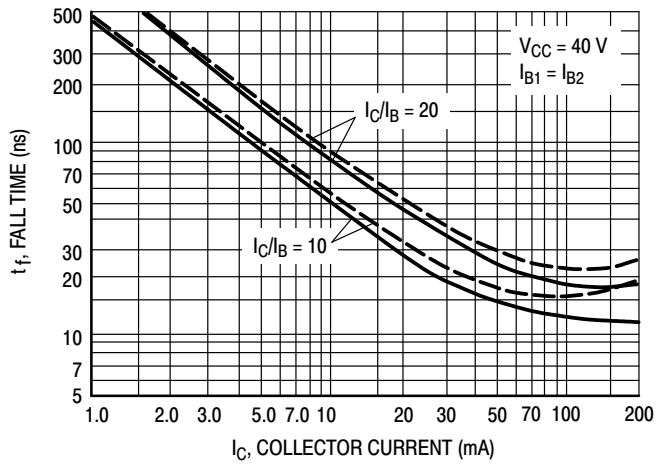
MMBT3904L, SMMBT3904L

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS
(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)
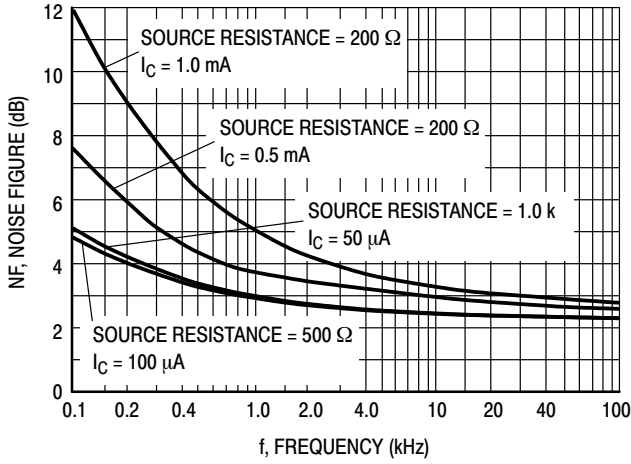
Figure 9.
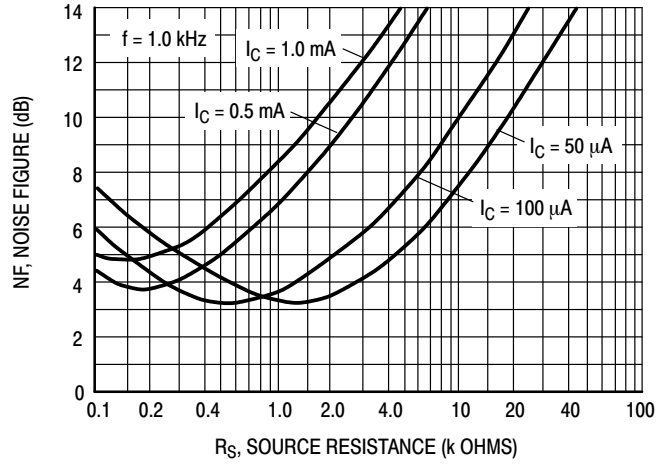
Figure 10.

h PARAMETERS
(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)
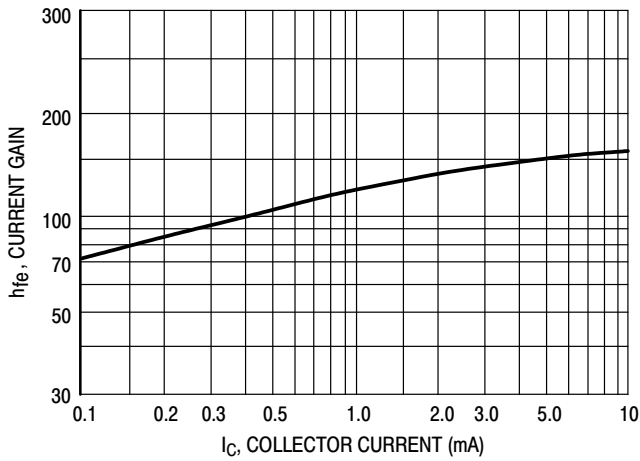
Figure 11. Current Gain
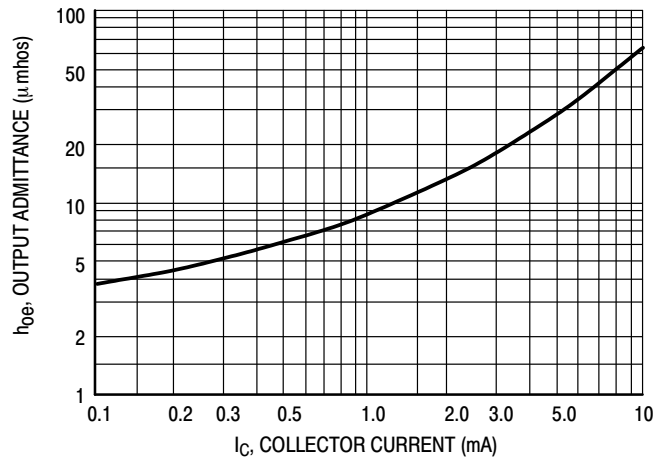
Figure 12. Output Admittance
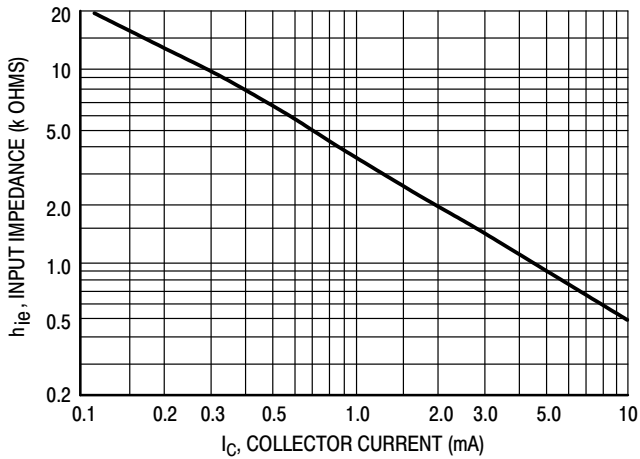
Figure 13. Input Impedance
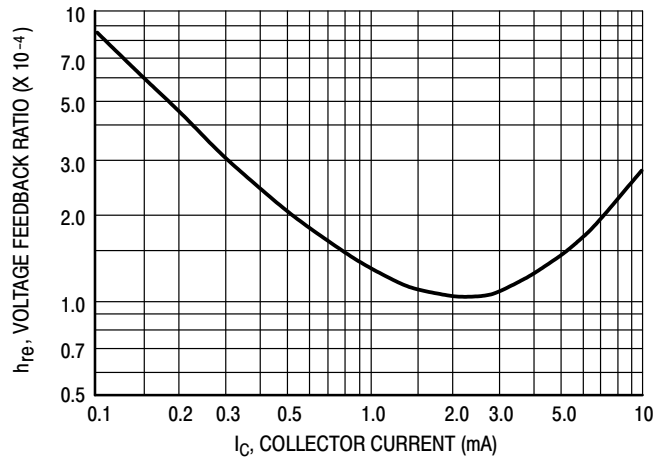
Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS
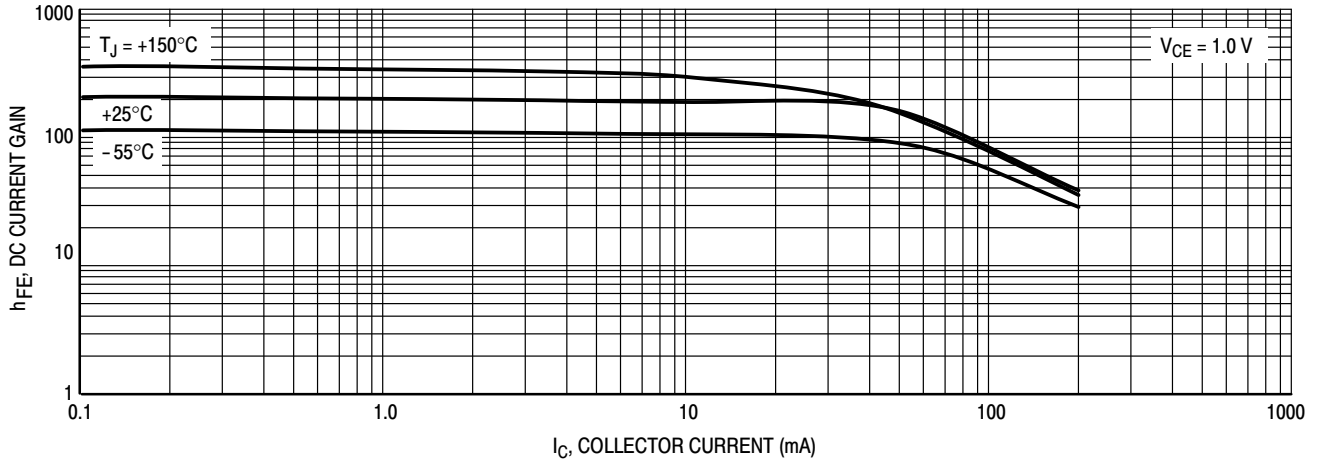
Figure 15. DC Current Gain
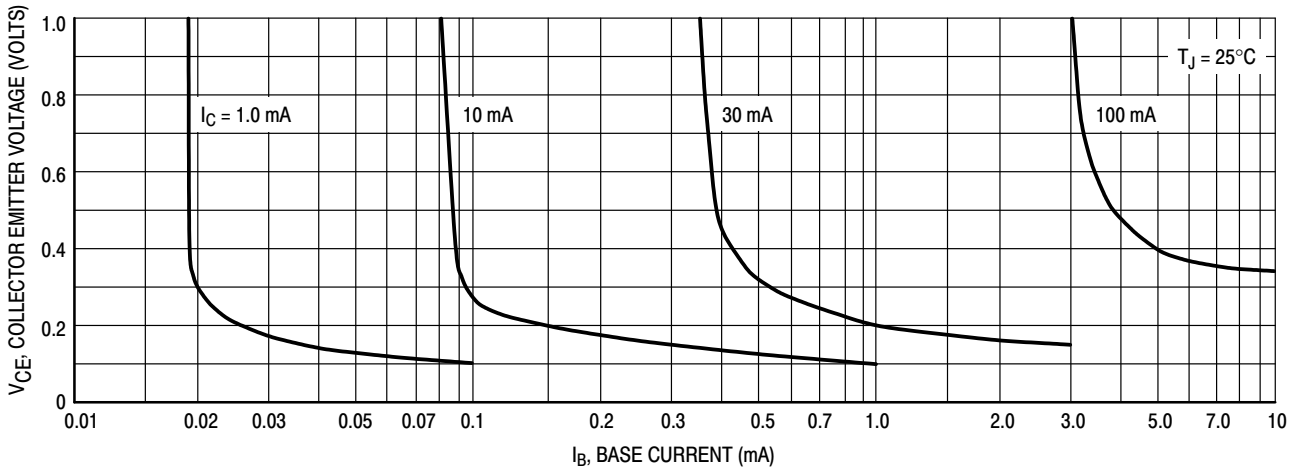
Figure 16. Collector Saturation Region
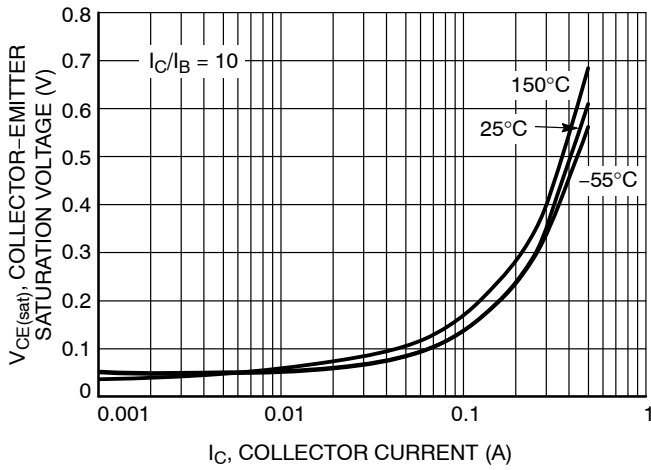
Figure 17. Collector Emitter Saturation Voltage vs. Collector Current
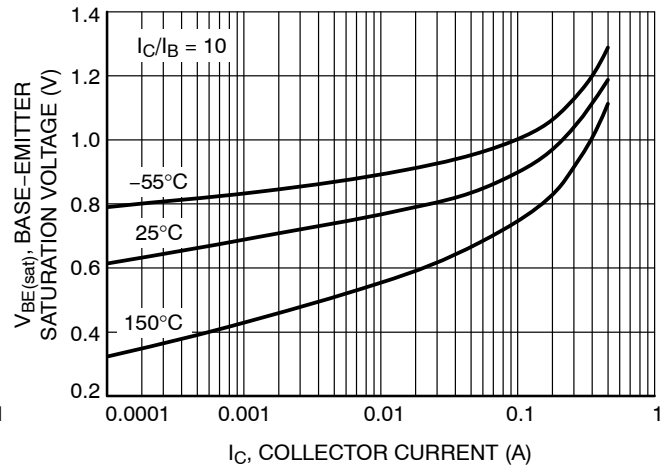
Figure 18. Base Emitter Saturation Voltage vs. Collector Current
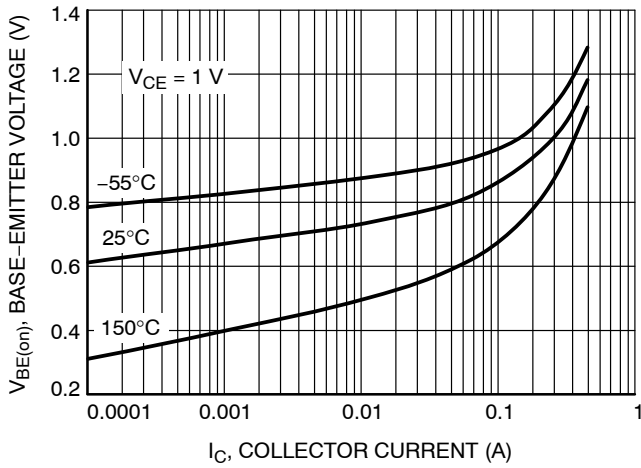
Figure 19. Base Emitter Voltage vs. Collector Current
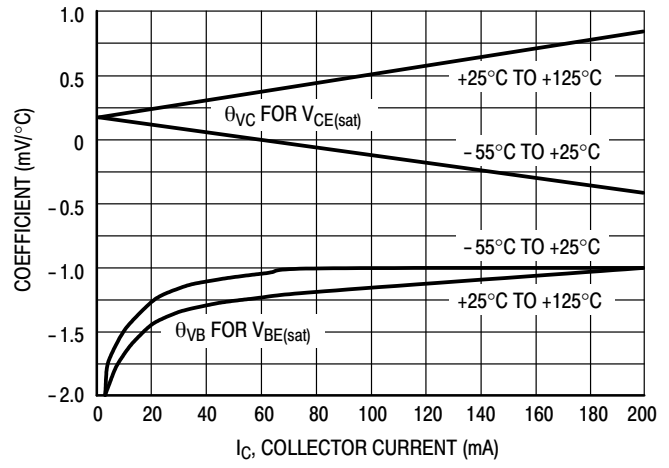
Figure 20. Temperature Coefficients
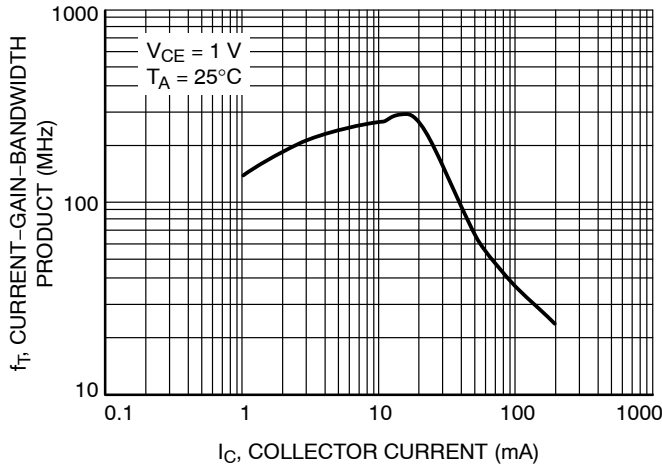
Figure 21. Current Gain Bandwidth vs. Collector Current
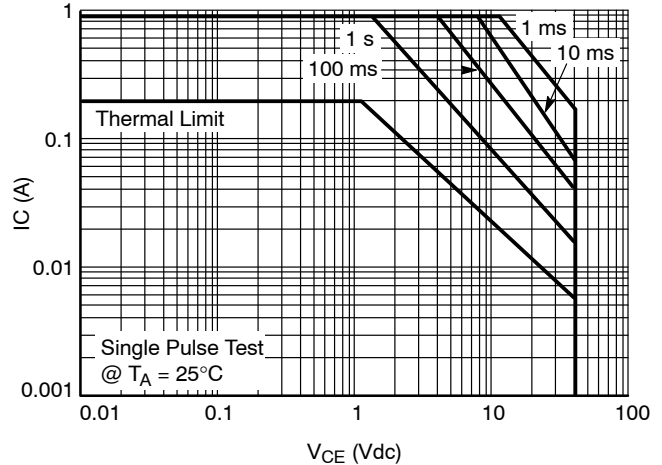
Figure 22. Safe Operating Area
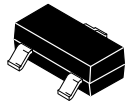
SOT−23 (TO−236)
CASE 318−08
ISSUE AS

DATE 30 JAN 2018

SCALE 4:1

TOP VIEW

VIEW C

0.25

SIDE VIEW

END VIEW

SEE VIEW C

**RECOMMENDED
SOLDERING FOOTPRINT**

2.90

3X 0.90

3X 0.80

0.95
PITCH

DIMENSIONS: MILLIMETERS
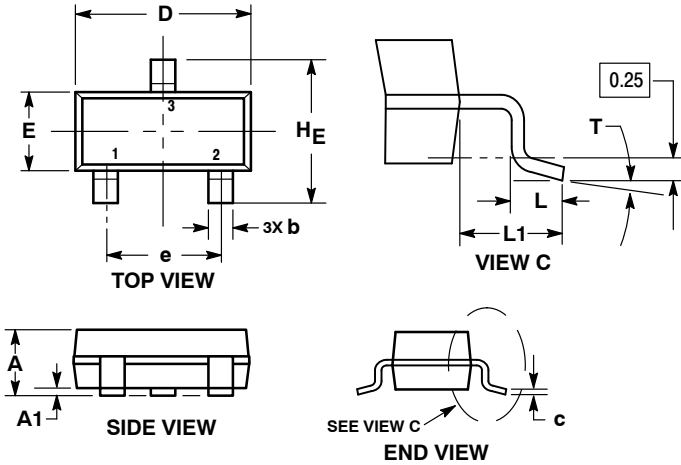
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

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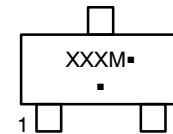
XXX = Specific Device Code
M   = Date Code
▪   = Pb−Free Package

*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.

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

DOCUMENT NUMBER:	98ASB42226B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SOT−23 (TO−236)	PAGE 1 OF 1

PUBLICATION ORDERING INFORMATION