

# MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP



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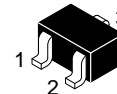
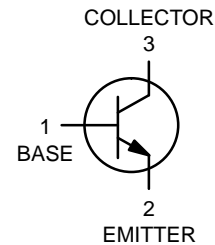
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## General Purpose Transistors NPN and PNP Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT-323/SC-70 package which is designed for low power surface mount applications.

### 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



SC-70 (SOT-323)  
CASE 419  
STYLE 3

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	$V_{CEO}$	40 -40	Vdc
Collector-Base Voltage MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	$V_{CBO}$	60 -40	Vdc
Emitter-Base Voltage MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	$V_{EBO}$	6.0 -5.0	Vdc
Collector Current - Continuous MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	$I_C$	200 -200	mAdc

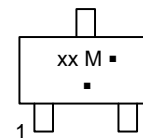
### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation (Note 1) @ $T_A = 25^\circ\text{C}$	$P_D$	150	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	833	$^\circ\text{C/W}$
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.

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

### MARKING DIAGRAM



- xx = AM for MMBT3904WT1,  
SMMBT3904WT  
= 2A for MMBT3906WT1,  
SMMBT3906WT1  
M = Date Code\*  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation may vary depending upon manufacturing location.

### ORDERING INFORMATION

Device	Package	Shipping†
MMBT3904WT1G, SMMBT3904WT1G	SC-70/ SOT-323 (Pb-Free)	3000 / Tape & Reel
MMBT3906WT1G, SMMBT3906WT1G	SC-70/ SOT-323 (Pb-Free)	3000 / 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.

# MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Breakdown Voltage (Note 2) (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , I <sub>B</sub> = 0) (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	40 –40	– –	V <sub>dc</sub>
Collector–Base Breakdown Voltage (I <sub>C</sub> = 10 μA <sub>dc</sub> , I <sub>E</sub> = 0) (I <sub>C</sub> = –10 μA <sub>dc</sub> , I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	60 –40	– –	V <sub>dc</sub>
Emitter–Base Breakdown Voltage (I <sub>E</sub> = 10 μA <sub>dc</sub> , I <sub>C</sub> = 0) (I <sub>E</sub> = –10 μA <sub>dc</sub> , I <sub>C</sub> = 0)	V <sub>(BR)EBO</sub>	6.0 –5.0	– –	V <sub>dc</sub>
Base Cutoff Current (V <sub>CE</sub> = 30 V <sub>dc</sub> , V <sub>EB</sub> = 3.0 V <sub>dc</sub> ) (V <sub>CE</sub> = –30 V <sub>dc</sub> , V <sub>EB</sub> = –3.0 V <sub>dc</sub> )	I <sub>BL</sub>	– –	50 –50	nA <sub>dc</sub>
Collector Cutoff Current (V <sub>CE</sub> = 30 V <sub>dc</sub> , V <sub>EB</sub> = 3.0 V <sub>dc</sub> ) (V <sub>CE</sub> = –30 V <sub>dc</sub> , V <sub>EB</sub> = –3.0 V <sub>dc</sub> )	I <sub>CEX</sub>	– –	50 –50	nA <sub>dc</sub>
<b>ON CHARACTERISTICS (Note 2)</b>				
DC Current Gain (I <sub>C</sub> = 0.1 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (I <sub>C</sub> = 50 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (I <sub>C</sub> = 100 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (I <sub>C</sub> = –0.1 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> ) (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> ) (I <sub>C</sub> = –10 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> ) (I <sub>C</sub> = –50 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> ) (I <sub>C</sub> = –100 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> )	h <sub>FE</sub>	40 70 100 60 30 60 80 100 60 30	– – 300 – – – – 300 – –	–
Collector–Emitter Saturation Voltage (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 50 mA <sub>dc</sub> , I <sub>B</sub> = 5.0 mA <sub>dc</sub> ) (I <sub>C</sub> = –10 mA <sub>dc</sub> , I <sub>B</sub> = –1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = –50 mA <sub>dc</sub> , I <sub>B</sub> = –5.0 mA <sub>dc</sub> )	V <sub>CE(sat)</sub>	– – – –	0.2 0.3 –0.25 –0.4	V <sub>dc</sub>
Base–Emitter Saturation Voltage (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 50 mA <sub>dc</sub> , I <sub>B</sub> = 5.0 mA <sub>dc</sub> ) (I <sub>C</sub> = –10 mA <sub>dc</sub> , I <sub>B</sub> = –1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = –50 mA <sub>dc</sub> , I <sub>B</sub> = –5.0 mA <sub>dc</sub> )	V <sub>BE(sat)</sub>	0.65 – –0.65 –	0.85 0.95 –0.85 –0.95	V <sub>dc</sub>

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

# MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP

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

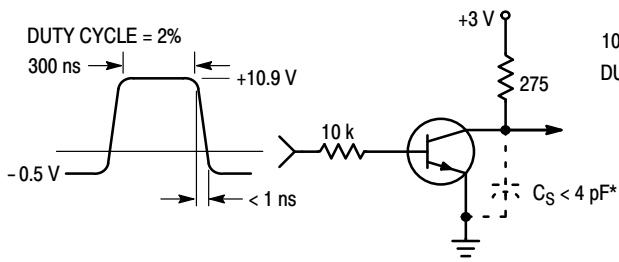
Characteristic	Symbol	Min	Max	Unit
<b>SMALL-SIGNAL CHARACTERISTICS</b>				
Current-Gain – Bandwidth Product ( $I_C = 10\text{ mAdc}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ ) ( $I_C = -10\text{ mAdc}$ , $V_{CE} = -20\text{ Vdc}$ , $f = 100\text{ MHz}$ )	$f_T$	300 250	– –	MHz
Output Capacitance ( $V_{CB} = 5.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ ) ( $V_{CB} = -5.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )	$C_{obo}$	– –	4.0 4.5	pF
Input Capacitance ( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ ) ( $V_{EB} = -0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )	$C_{ibo}$	– –	8.0 10.0	pF
Input Impedance ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -10\text{ Vdc}$ , $I_C = -1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )	$h_{ie}$	1.0 2.0	10 12	k $\Omega$
Voltage Feedback Ratio ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -10\text{ Vdc}$ , $I_C = -1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )	$h_{re}$	0.5 0.1	8.0 10	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -10\text{ Vdc}$ , $I_C = -1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )	$h_{fe}$	100 100	400 400	–
Output Admittance ( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -10\text{ Vdc}$ , $I_C = -1.0\text{ mAdc}$ , $f = 1.0\text{ kHz}$ )	$h_{oe}$	1.0 3.0	40 60	$\mu\text{mhos}$
Noise Figure ( $V_{CE} = 5.0\text{ Vdc}$ , $I_C = 100\text{ }\mu\text{Adc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ ) ( $V_{CE} = -5.0\text{ Vdc}$ , $I_C = -100\text{ }\mu\text{Adc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )	NF	– –	5.0 4.0	dB

## SWITCHING CHARACTERISTICS

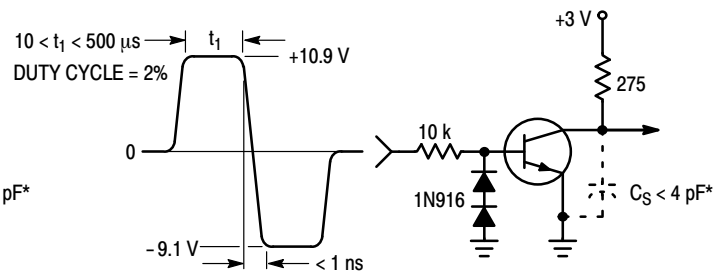
Characteristic	Condition	Symbol	Min	Max	Unit
Delay Time	( $V_{CC} = 3.0\text{ Vdc}$ , $V_{BE} = -0.5\text{ Vdc}$ ) MMBT3904WT1, SMMBT3904WT1 ( $V_{CC} = -3.0\text{ Vdc}$ , $V_{BE} = 0.5\text{ Vdc}$ ) MMBT3906WT1, SMMBT3906WT1	$t_d$	– –	35 35	ns
Rise Time	( $I_C = 10\text{ mAdc}$ , $I_{B1} = 1.0\text{ mAdc}$ ) MMBT3904WT1, SMMBT3904WT1 ( $I_C = -10\text{ mAdc}$ , $I_{B1} = -1.0\text{ mAdc}$ ) MMBT3906WT1, SMMBT3906WT1	$t_r$	– –	35 35	ns
Storage Time	( $V_{CC} = 3.0\text{ Vdc}$ , $I_C = 10\text{ mAdc}$ ) MMBT3904WT1, SMMBT3904WT1 ( $V_{CC} = -3.0\text{ Vdc}$ , $I_C = -10\text{ mAdc}$ ) MMBT3906WT1, SMMBT3906WT1	$t_s$	– –	200 225	ns
Fall Time	( $I_{B1} = I_{B2} = 1.0\text{ mAdc}$ ) MMBT3904WT1, SMMBT3904WT1 ( $I_{B1} = I_{B2} = -1.0\text{ mAdc}$ ) MMBT3906WT1, SMMBT3906WT1	$t_f$	– –	50 75	ns

**MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP,  
SMMBT3906WT1G, PNP**

**MMBT3904WT1, SMMBT3904WT1**



**Figure 1. Delay and Rise Time  
Equivalent Test Circuit**



**Figure 2. Storage and Fall Time  
Equivalent Test Circuit**

\* Total shunt capacitance of test jig and connectors

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP

MMBT3904WT1, SMMBT3904WT1

TYPICAL TRANSIENT CHARACTERISTICS

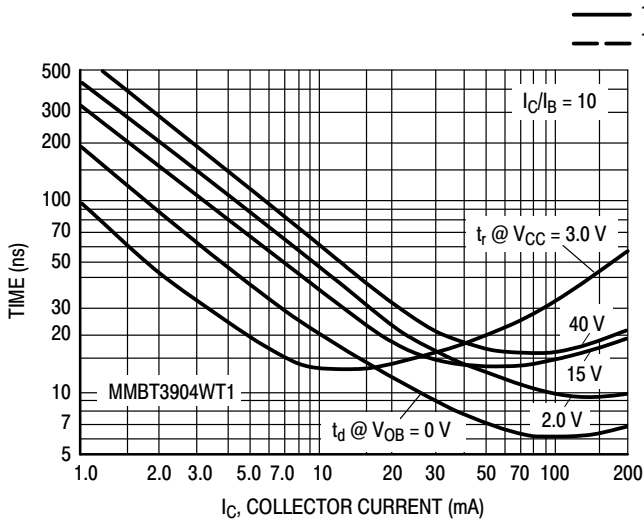


Figure 3. Turn-On Time

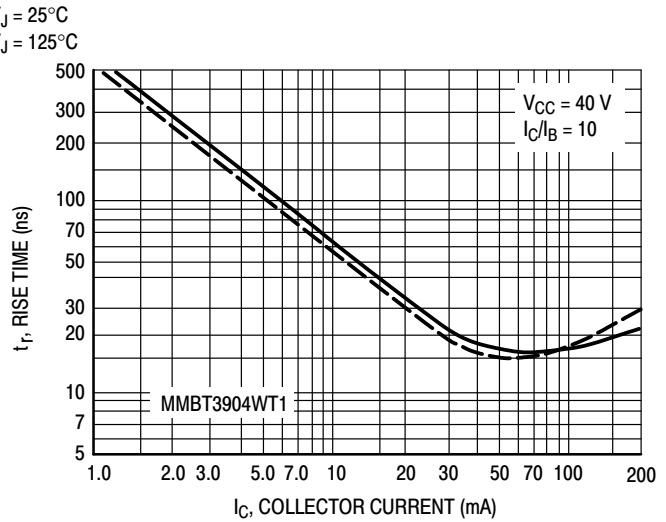


Figure 4. Rise Time

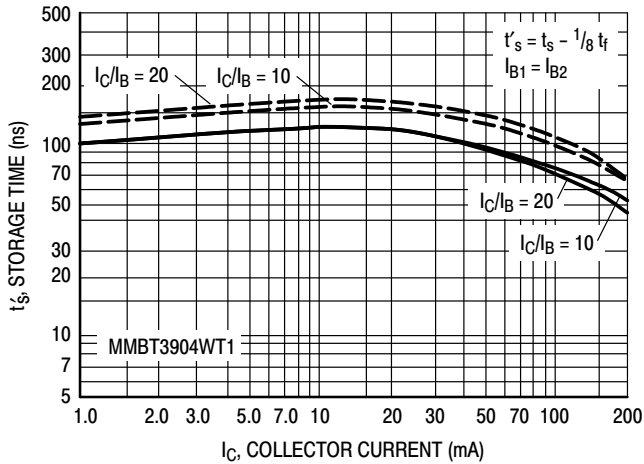


Figure 5. Storage Time

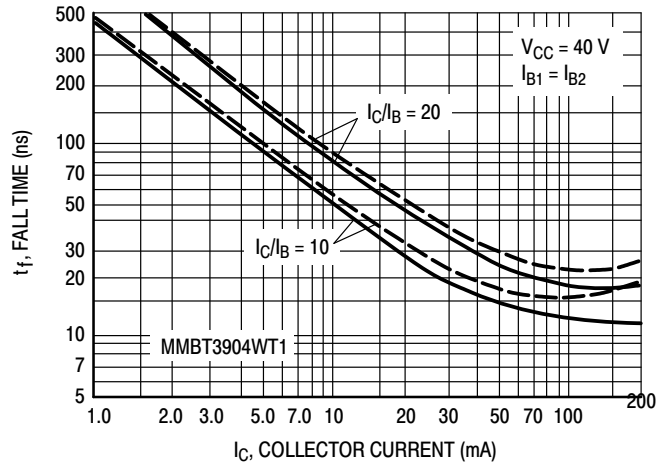


Figure 6. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

( $V_{CE} = 5.0$  Vdc,  $T_A = 25^\circ\text{C}$ , Bandwidth = 1.0 Hz)

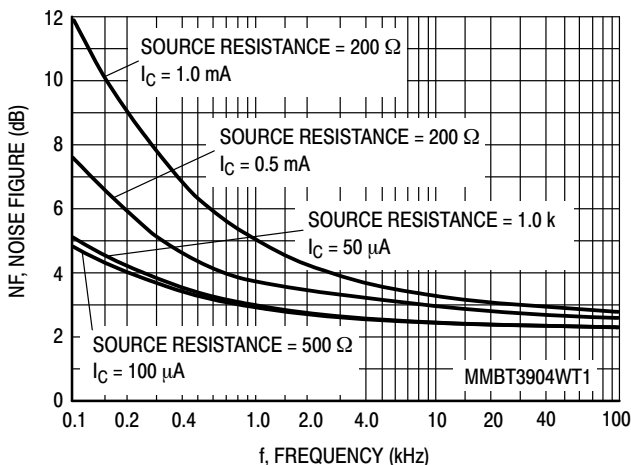


Figure 7. Noise Figure

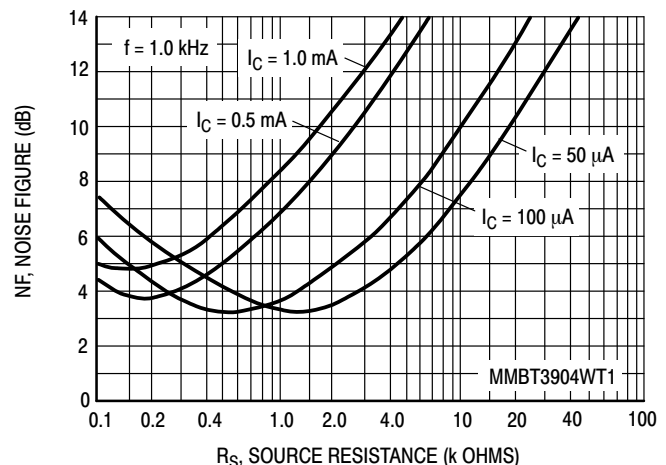


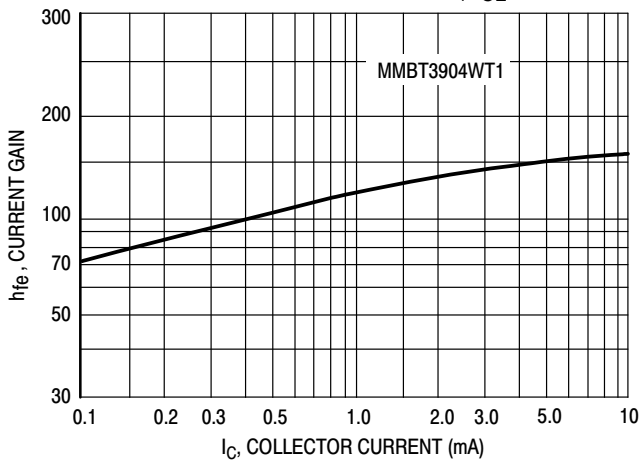
Figure 8. Noise Figure

**MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP**

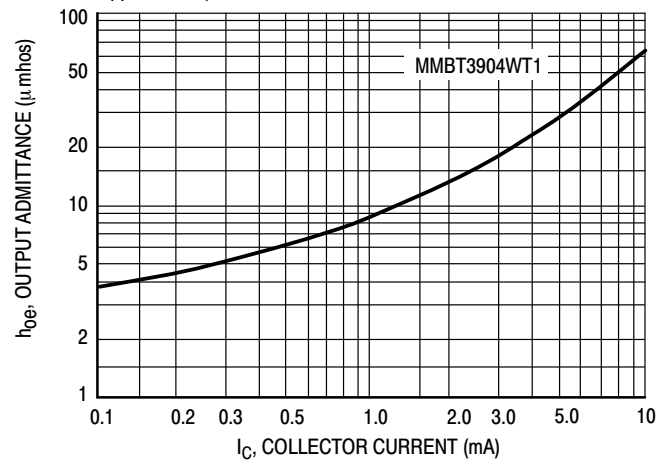
**MMBT3904WT1, SMMBT3904WT1**

**h PARAMETERS**

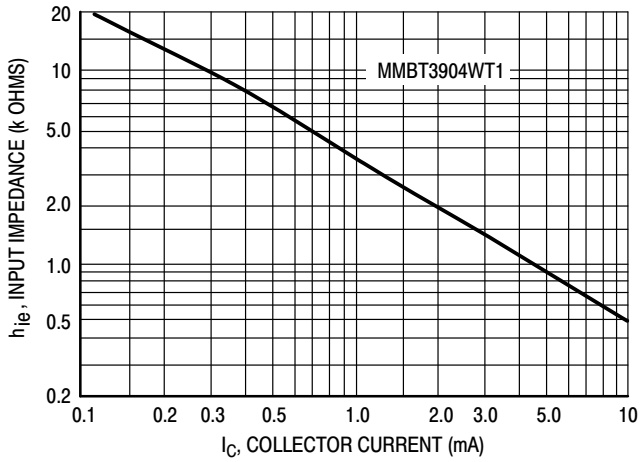
( $V_{CE} = 10 \text{ Vdc}$ ,  $f = 1.0 \text{ kHz}$ ,  $T_A = 25^\circ\text{C}$ )



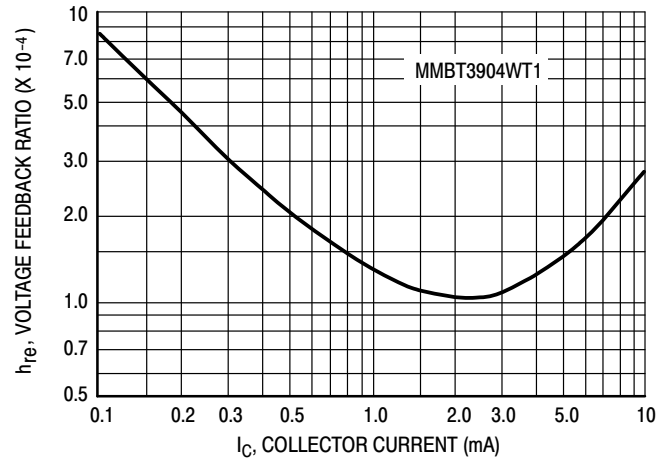
**Figure 9. Current Gain**



**Figure 10. Output Admittance**

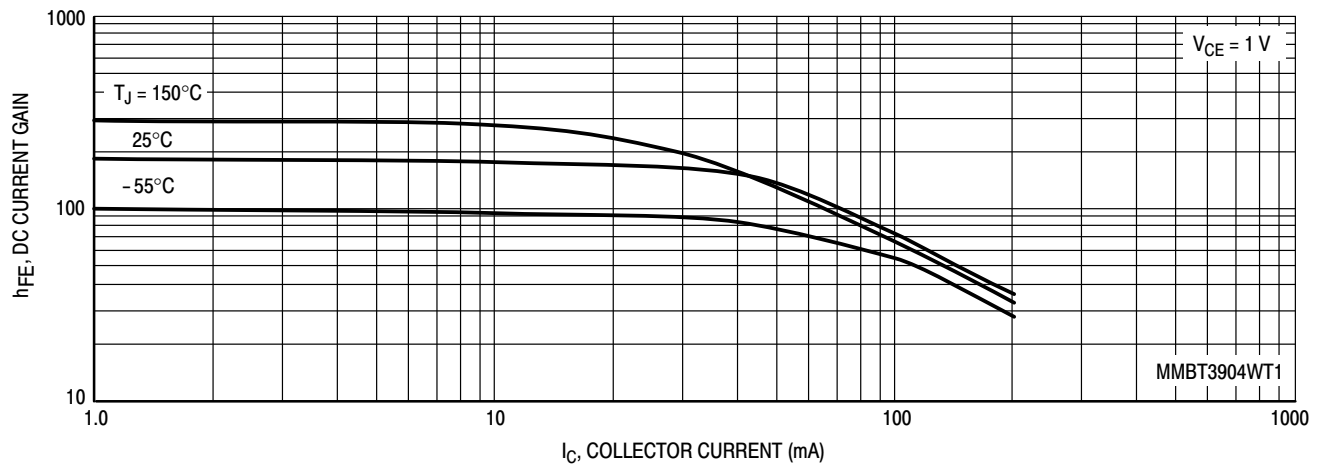


**Figure 11. Input Impedance**



**Figure 12. Voltage Feedback Ratio**

**TYPICAL STATIC CHARACTERISTICS**



**Figure 13. DC Current Gain**

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP,  
SMMBT3906WT1G, PNP

MMBT3904WT1, SMMBT3904WT1

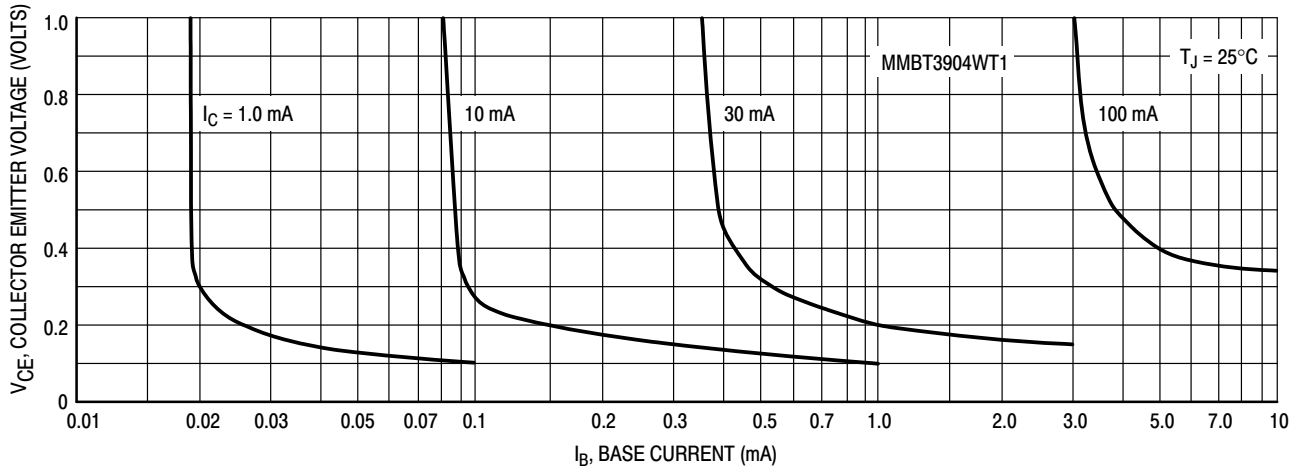


Figure 14. Collector Saturation Region

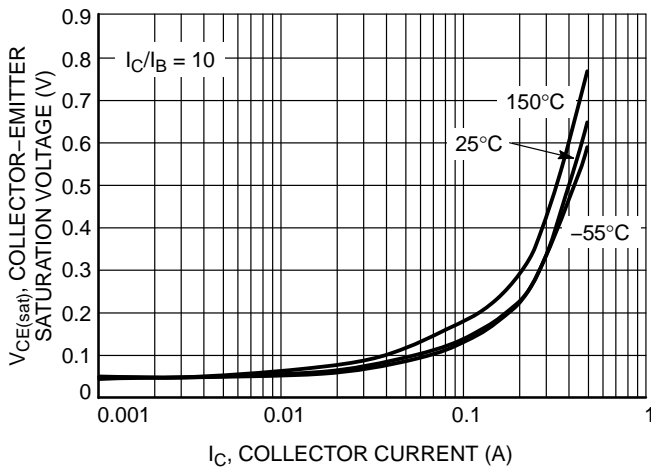


Figure 15. Collector-Emitter Saturation Voltage vs. Collector Current

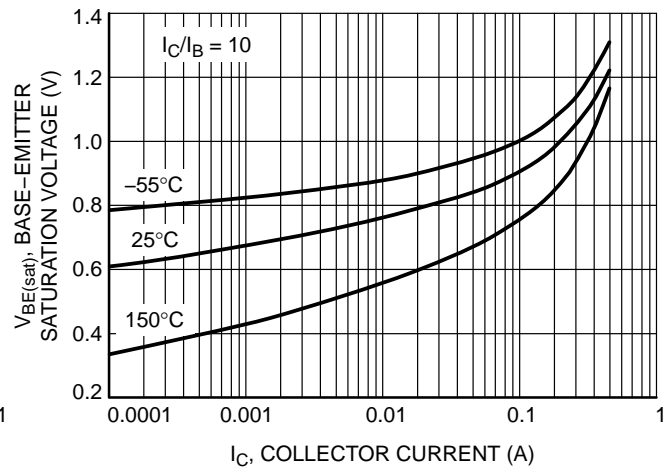


Figure 16. Base-Emitter Saturation Voltage vs. Collector Current

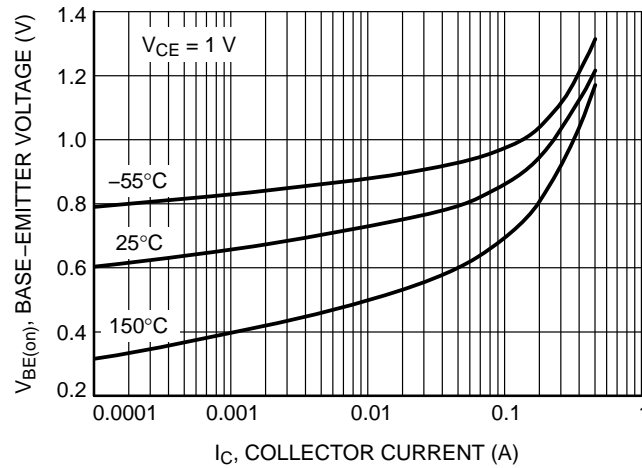


Figure 17. Base-Emitter Voltage vs. Collector Current

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP

MMBT3904WT1, SMMBT3904WT1

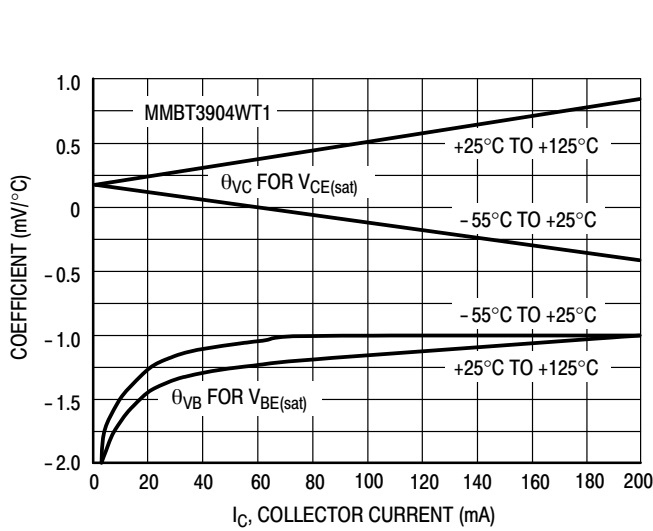


Figure 18. Temperature Coefficients

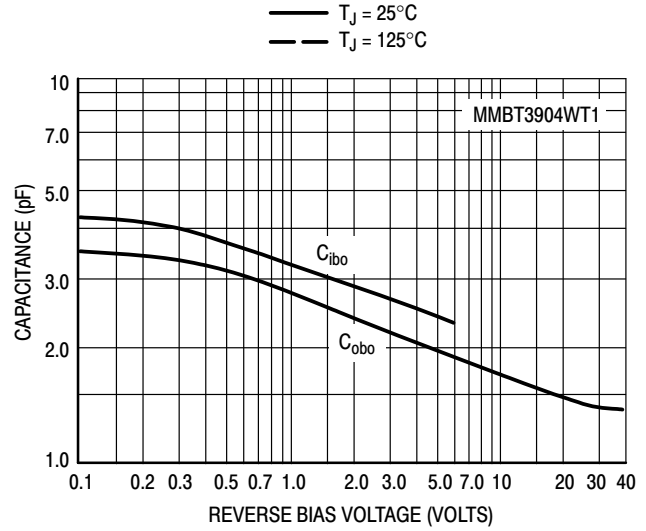


Figure 19. Capacitance

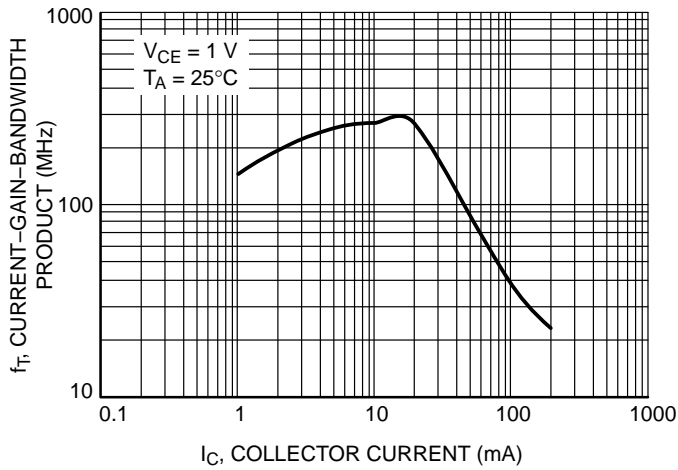


Figure 20. Current Gain Bandwidth Product vs. Collector Current

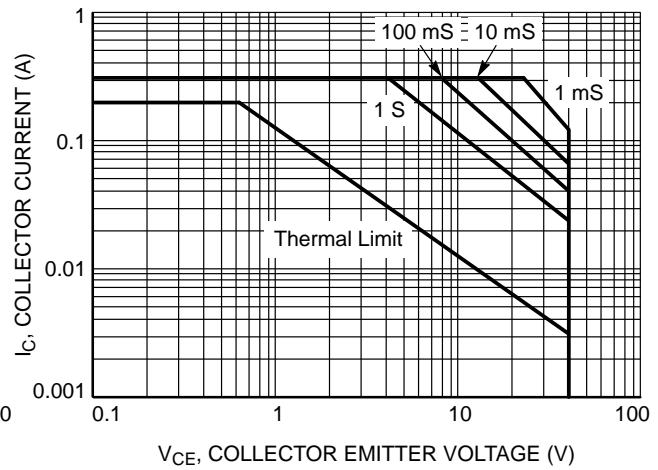
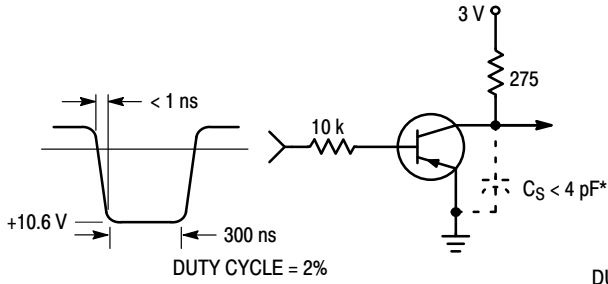


Figure 21. Safe Operating Area

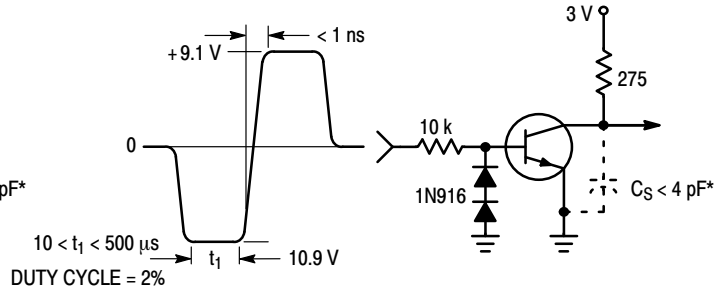


**MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP**

**MMBT3906WT1, SMMBT3906WT1**



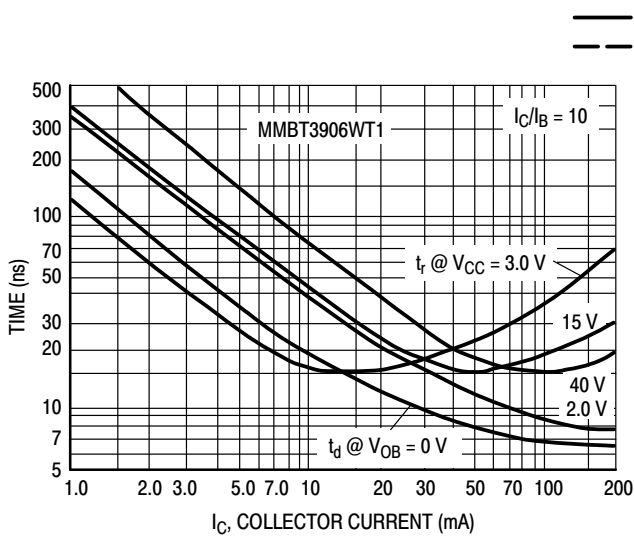
**Figure 22. Delay and Rise Time Equivalent Test Circuit**



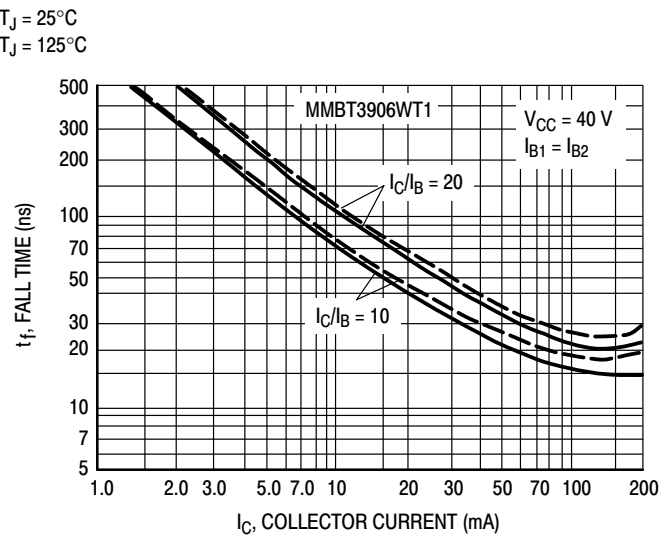
**Figure 23. Storage and Fall Time Equivalent Test Circuit**

\* Total shunt capacitance of test jig and connectors

**TYPICAL TRANSIENT CHARACTERISTICS**



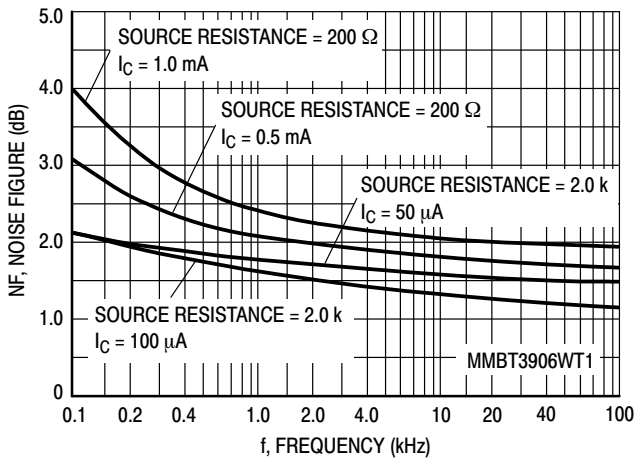
**Figure 24. Turn-On Time**



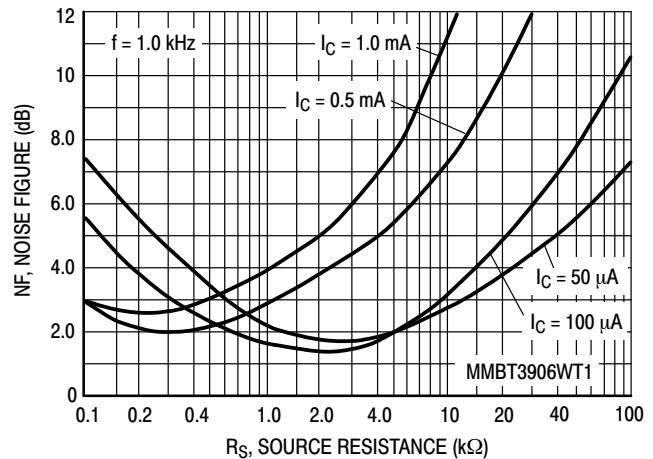
**Figure 25. Fall Time**

**TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS**

( $V_{CE} = -5.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$ , Bandwidth = 1.0 Hz)



**Figure 26.**



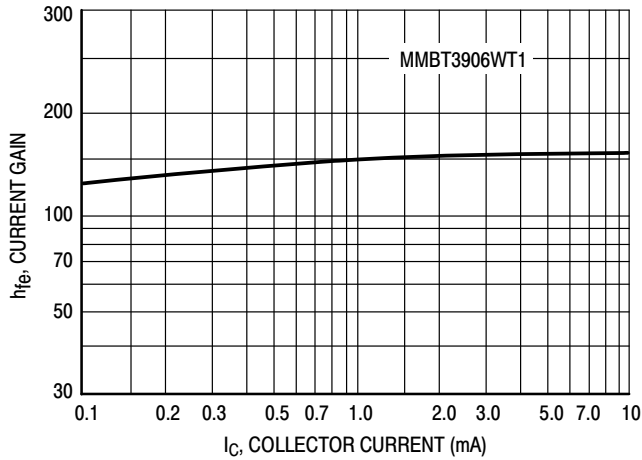
**Figure 27.**

**MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP**

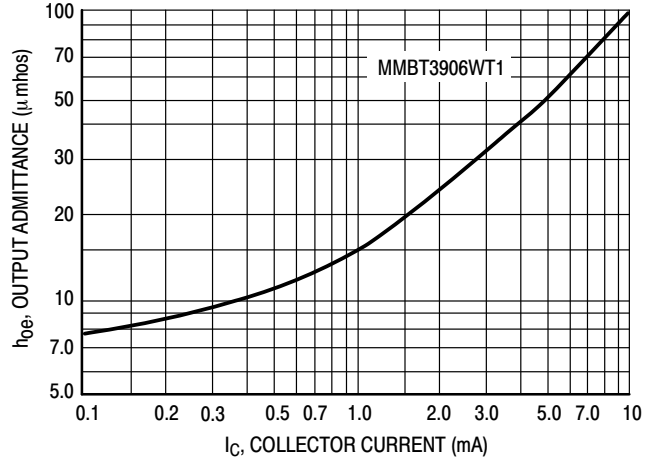
**MMBT3906WT1, SMMBT3906WT1**

**h PARAMETERS**

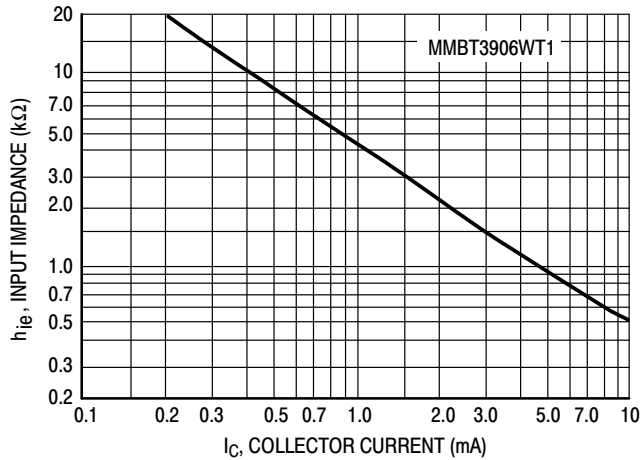
( $V_{CE} = -10$  Vdc,  $f = 1.0$  kHz,  $T_A = 25^\circ\text{C}$ )



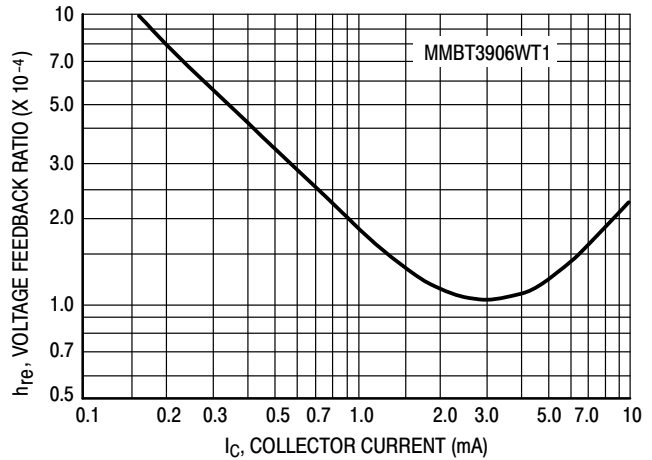
**Figure 28. Current Gain**



**Figure 29. Output Admittance**

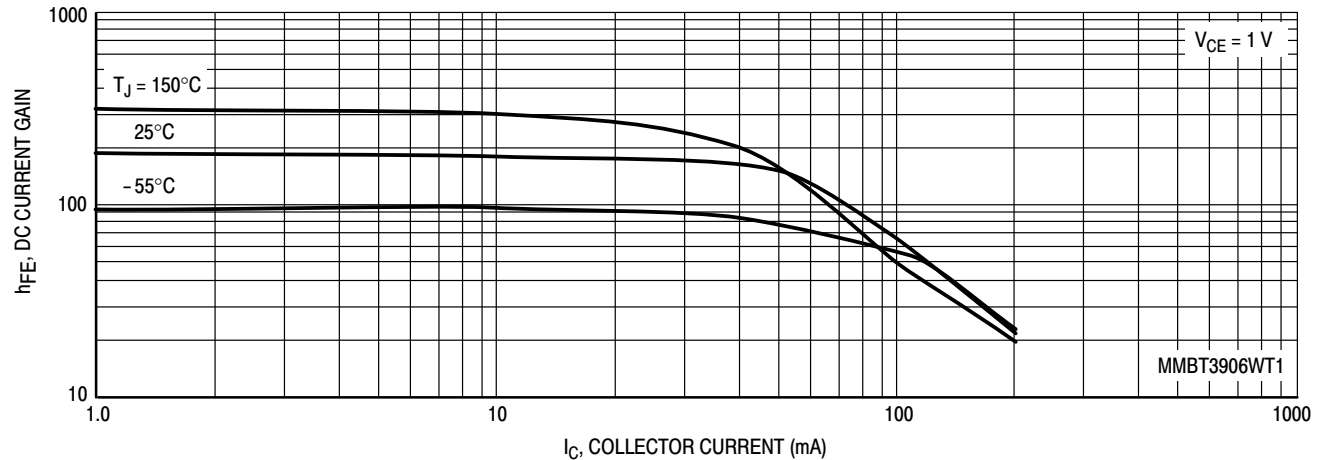


**Figure 30. Input Impedance**



**Figure 31. Voltage Feedback Ratio**

**STATIC CHARACTERISTICS**



**Figure 32. DC Current Gain**

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP,  
SMMBT3906WT1G, PNP

MMBT3906WT1, SMMBT3906WT1

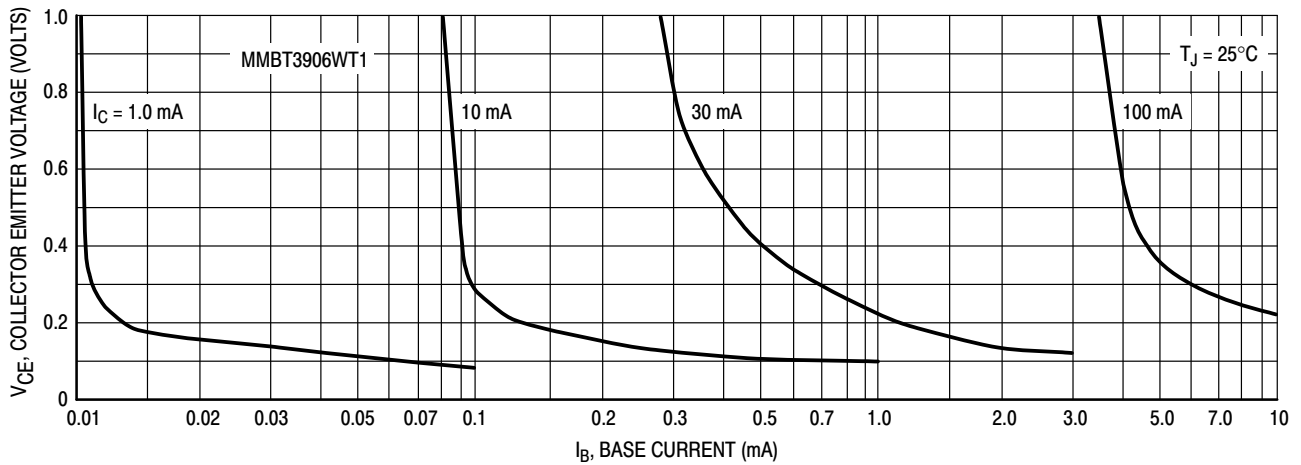


Figure 33. Collector Saturation Region

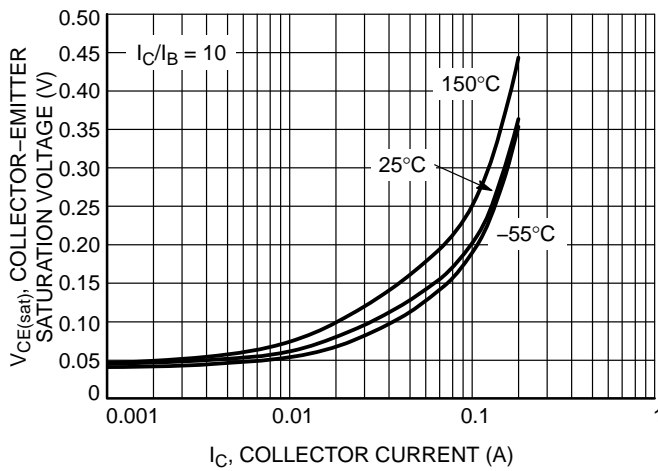


Figure 34. Collector Emitter Saturation Voltage vs. Collector Current

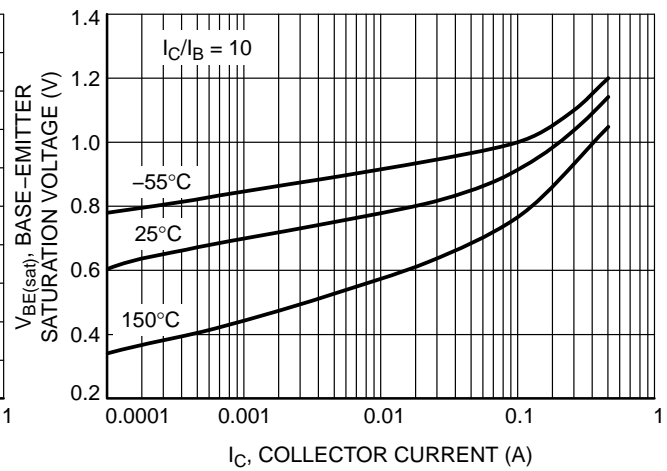


Figure 35. Base Emitter Saturation Voltage vs. Collector Current

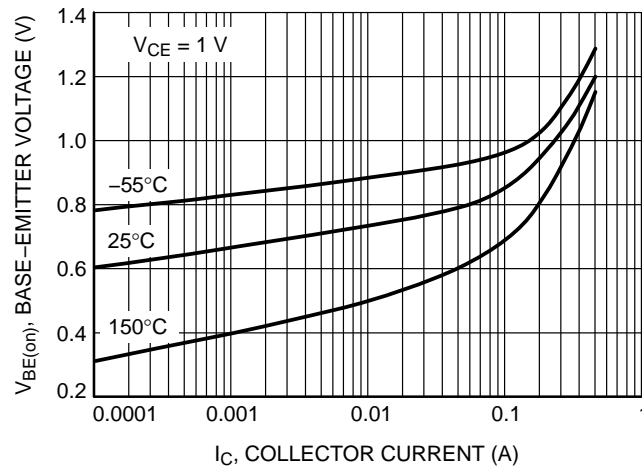


Figure 36. Base Emitter Voltage vs. Collector Current

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP,  
SMMBT3906WT1G, PNP

MMBT3906WT1, SMMBT3906WT1

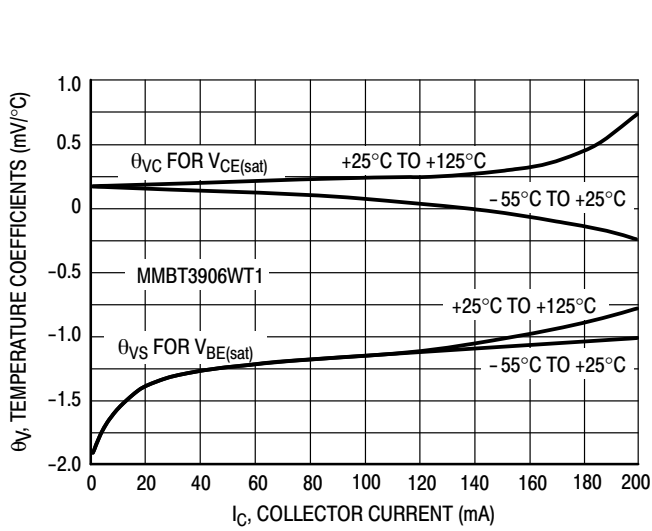


Figure 37. Temperature Coefficients

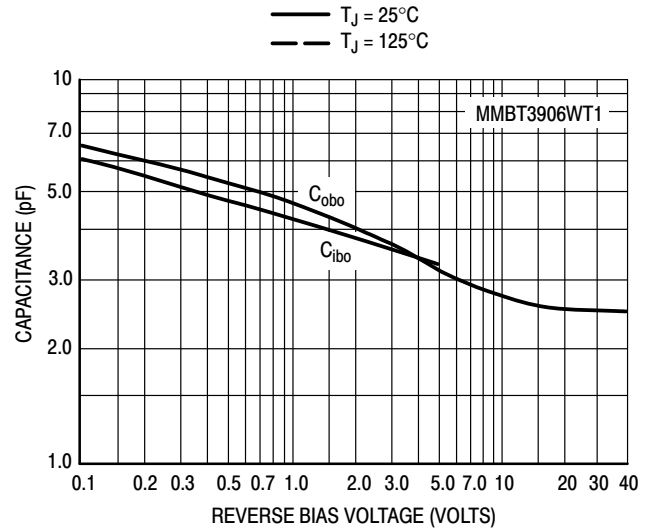


Figure 38. Capacitance

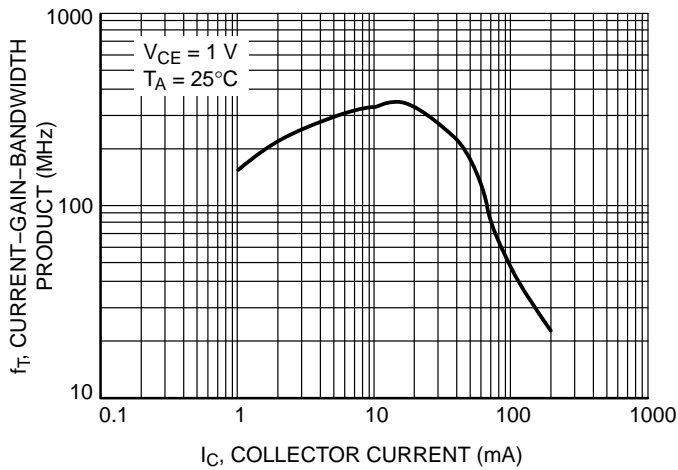


Figure 39. Current Gain Bandwidth Product vs. Collector Current

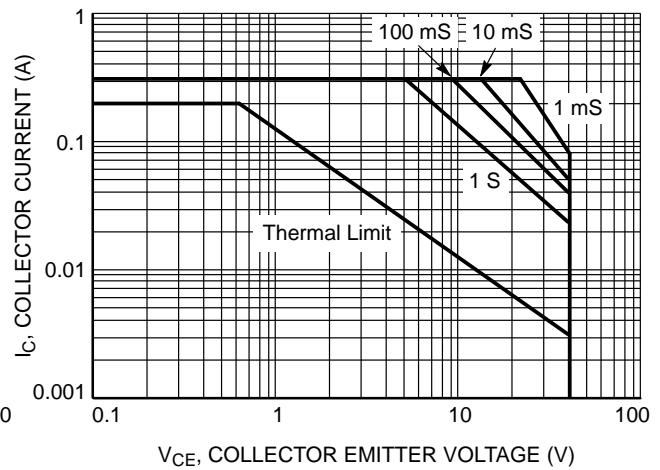
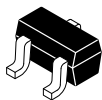


Figure 40. Safe Operating Area

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

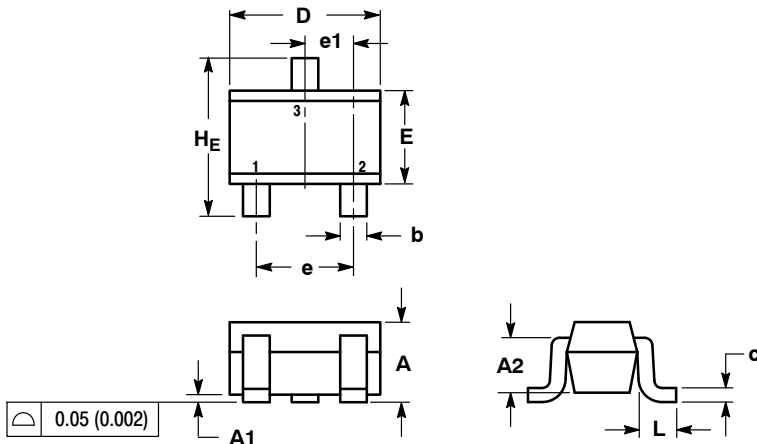
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SCALE 4:1

SC-70 (SOT-323)  
CASE 419-04  
ISSUE N

DATE 11 NOV 2008

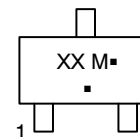


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.90	1.00	0.032	0.035	0.040
A1	0.00	0.05	0.10	0.000	0.002	0.004
A2	0.70 REF			0.028 REF		
b	0.30	0.35	0.40	0.012	0.014	0.016
c	0.10	0.18	0.25	0.004	0.007	0.010
D	1.80	2.10	2.20	0.071	0.083	0.087
E	1.15	1.24	1.35	0.045	0.049	0.053
e	1.20	1.30	1.40	0.047	0.051	0.055
e1	0.65 BSC			0.026 BSC		
L	0.20	0.38	0.56	0.008	0.015	0.022
HE	2.00	2.10	2.40	0.079	0.083	0.095

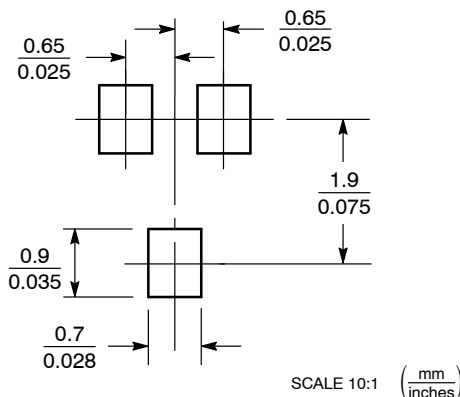
### GENERIC MARKING DIAGRAM



- XX = 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.

### 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.

STYLE 1:  
CANCELLED

STYLE 2:  
PIN 1. ANODE  
2. N.C.  
3. CATHODE

STYLE 3:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

STYLE 4:  
PIN 1. CATHODE  
2. CATHODE  
3. ANODE

STYLE 5:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

STYLE 6:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR

STYLE 7:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

STYLE 8:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN

STYLE 9:  
PIN 1. ANODE  
2. CATHODE  
3. CATHODE-ANODE

STYLE 10:  
PIN 1. CATHODE  
2. ANODE  
3. ANODE-CATHODE

STYLE 11:  
PIN 1. CATHODE  
2. CATHODE  
3. CATHODE

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