

# MMBT3904WT1, NPN MMBT3906WT1, PNP



ON Semiconductor®

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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

- Pb-Free Packages are Available

#### MAXIMUM RATINGS

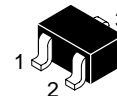
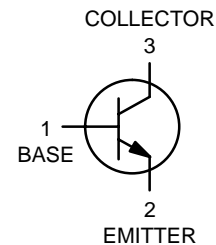
Rating	Symbol	Value	Unit
Collector-Emitter Voltage MMBT3904WT1 MMBT3906WT1	$V_{CEO}$	40 -40	Vdc
Collector-Base Voltage MMBT3904WT1 MMBT3906WT1	$V_{CBO}$	60 -40	Vdc
Emitter-Base Voltage MMBT3904WT1 MMBT3906WT1	$V_{EBO}$	6.0 -5.0	Vdc
Collector Current - Continuous MMBT3904WT1 MMBT3906WT1	$I_C$	200 -200	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	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

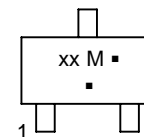
Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

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



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

#### MARKING DIAGRAM



- xx = AM for MMBT3904WT1  
= 2A for MMBT3906WT1
- 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†
MMBT3904WT1	SC-70/ SOT-323	3000/Tape & Reel
MMBT3904WT1G	SC-70/ SOT-323 (Pb-Free)	3000/Tape & Reel
MMBT3906WT1	SC-70/ SOT-323	3000/Tape & Reel
MMBT3906WT1G	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.

# MMBT3904WT1, NPN MMBT3906WT1, 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)	MMBT3904WT1 MMBT3906WT1	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)	MMBT3904WT1 MMBT3906WT1	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)	MMBT3904WT1 MMBT3906WT1	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> )	MMBT3904WT1 MMBT3906WT1	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> )	MMBT3904WT1 MMBT3906WT1	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> )	MMBT3904WT1     MMBT3906WT1	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> )	MMBT3904WT1  MMBT3906WT1	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> )	MMBT3904WT1  MMBT3906WT1	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%.

# MMBT3904WT1, NPN MMBT3906WT1, PNP

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

Characteristic	Symbol	Min	Max	Unit
<b>SMALL-SIGNAL CHARACTERISTICS</b>				
Current-Gain – Bandwidth Product (I <sub>C</sub> = 10 mA <sub>d</sub> c, V <sub>CE</sub> = 20 V <sub>d</sub> c, f = 100 MHz) (I <sub>C</sub> = -10 mA <sub>d</sub> c, V <sub>CE</sub> = -20 V <sub>d</sub> c, f = 100 MHz)	f <sub>T</sub>	300 250	– –	MHz
Output Capacitance (V <sub>CB</sub> = 5.0 V <sub>d</sub> c, I <sub>E</sub> = 0, f = 1.0 MHz) (V <sub>CB</sub> = -5.0 V <sub>d</sub> c, I <sub>E</sub> = 0, f = 1.0 MHz)	C <sub>obo</sub>	– –	4.0 4.5	pF
Input Capacitance (V <sub>EB</sub> = 0.5 V <sub>d</sub> c, I <sub>C</sub> = 0, f = 1.0 MHz) (V <sub>EB</sub> = -0.5 V <sub>d</sub> c, I <sub>C</sub> = 0, f = 1.0 MHz)	C <sub>ibo</sub>	– –	8.0 10.0	pF
Input Impedance (V <sub>CE</sub> = 10 V <sub>d</sub> c, I <sub>C</sub> = 1.0 mA <sub>d</sub> c, f = 1.0 kHz) (V <sub>CE</sub> = -10 V <sub>d</sub> c, I <sub>C</sub> = -1.0 mA <sub>d</sub> c, f = 1.0 kHz)	h <sub>ie</sub>	1.0 2.0	10 12	k Ω
Voltage Feedback Ratio (V <sub>CE</sub> = 10 V <sub>d</sub> c, I <sub>C</sub> = 1.0 mA <sub>d</sub> c, f = 1.0 kHz) (V <sub>CE</sub> = -10 V <sub>d</sub> c, I <sub>C</sub> = -1.0 mA <sub>d</sub> c, f = 1.0 kHz)	h <sub>re</sub>	0.5 0.1	8.0 10	X 10 <sup>-4</sup>
Small-Signal Current Gain (V <sub>CE</sub> = 10 V <sub>d</sub> c, I <sub>C</sub> = 1.0 mA <sub>d</sub> c, f = 1.0 kHz) (V <sub>CE</sub> = -10 V <sub>d</sub> c, I <sub>C</sub> = -1.0 mA <sub>d</sub> c, f = 1.0 kHz)	h <sub>fe</sub>	100 100	400 400	–
Output Admittance (V <sub>CE</sub> = 10 V <sub>d</sub> c, I <sub>C</sub> = 1.0 mA <sub>d</sub> c, f = 1.0 kHz) (V <sub>CE</sub> = -10 V <sub>d</sub> c, I <sub>C</sub> = -1.0 mA <sub>d</sub> c, f = 1.0 kHz)	h <sub>oe</sub>	1.0 3.0	40 60	μmhos
Noise Figure (V <sub>CE</sub> = 5.0 V <sub>d</sub> c, I <sub>C</sub> = 100 μA <sub>d</sub> c, R <sub>S</sub> = 1.0 k Ω, f = 1.0 kHz) (V <sub>CE</sub> = -5.0 V <sub>d</sub> c, I <sub>C</sub> = -100 μA <sub>d</sub> c, R <sub>S</sub> = 1.0 k Ω, f = 1.0 kHz)	NF	– –	5.0 4.0	dB

## SWITCHING CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Max	Unit
Delay Time	(V <sub>CC</sub> = 3.0 V <sub>d</sub> c, V <sub>BE</sub> = -0.5 V <sub>d</sub> c) (V <sub>CC</sub> = -3.0 V <sub>d</sub> c, V <sub>BE</sub> = 0.5 V <sub>d</sub> c)	t <sub>d</sub>	– –	35 35	ns
Rise Time	(I <sub>C</sub> = 10 mA <sub>d</sub> c, I <sub>B1</sub> = 1.0 mA <sub>d</sub> c) (I <sub>C</sub> = -10 mA <sub>d</sub> c, I <sub>B1</sub> = -1.0 mA <sub>d</sub> c)	t <sub>r</sub>	– –	35 35	ns
Storage Time	(V <sub>CC</sub> = 3.0 V <sub>d</sub> c, I <sub>C</sub> = 10 mA <sub>d</sub> c) (V <sub>CC</sub> = -3.0 V <sub>d</sub> c, I <sub>C</sub> = -10 mA <sub>d</sub> c)	t <sub>s</sub>	– –	200 225	ns
Fall Time	(I <sub>B1</sub> = I <sub>B2</sub> = 1.0 mA <sub>d</sub> c) (I <sub>B1</sub> = I <sub>B2</sub> = -1.0 mA <sub>d</sub> c)	t <sub>f</sub>	– –	50 75	ns

### MMBT3904WT1

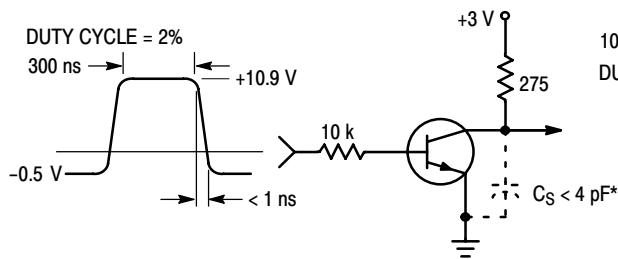


Figure 1. Delay and Rise Time Equivalent Test Circuit

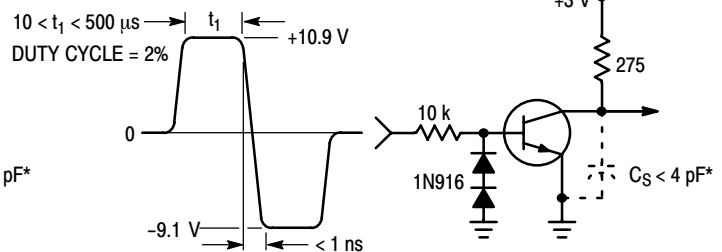


Figure 2. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## MMBT3904WT1

### TYPICAL TRANSIENT CHARACTERISTICS

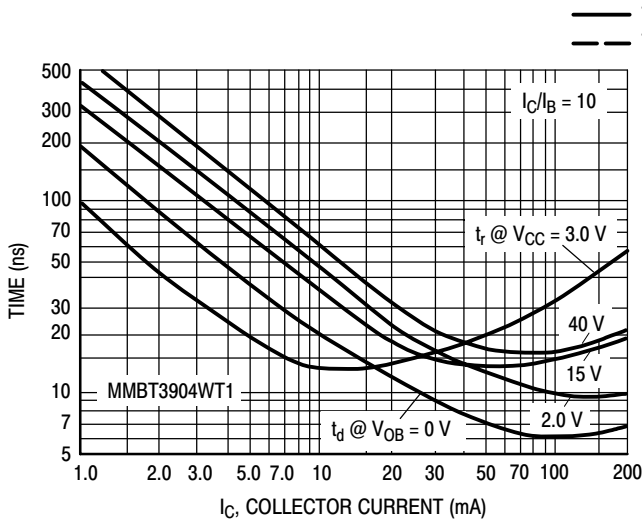


Figure 3. Turn-On Time

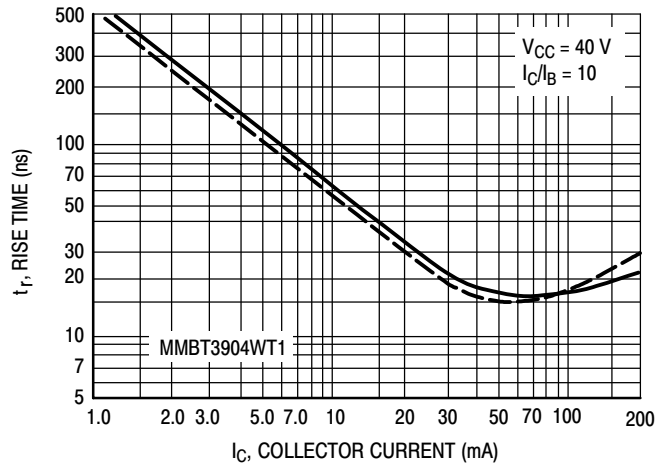


Figure 4. Rise Time

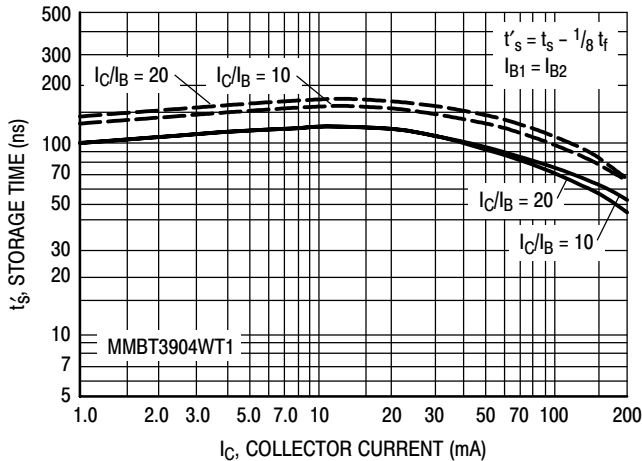


Figure 5. Storage Time

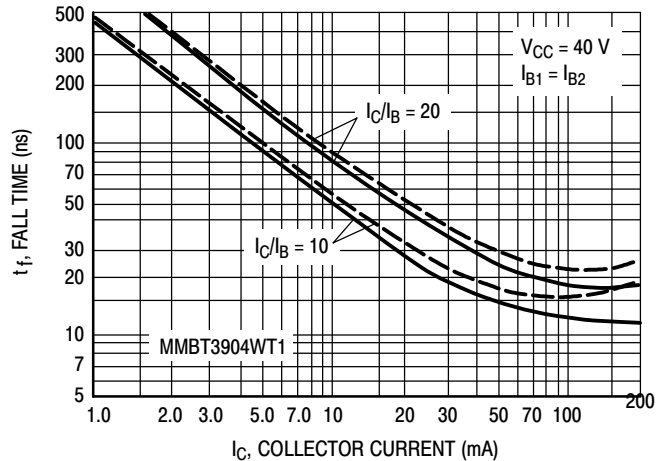


Figure 6. Fall Time

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

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

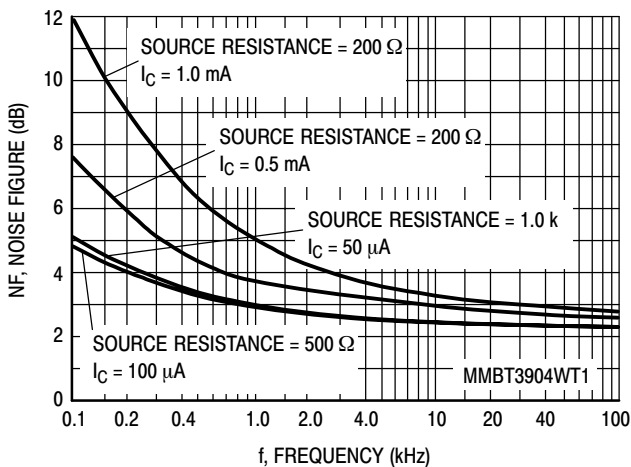


Figure 7. Noise Figure

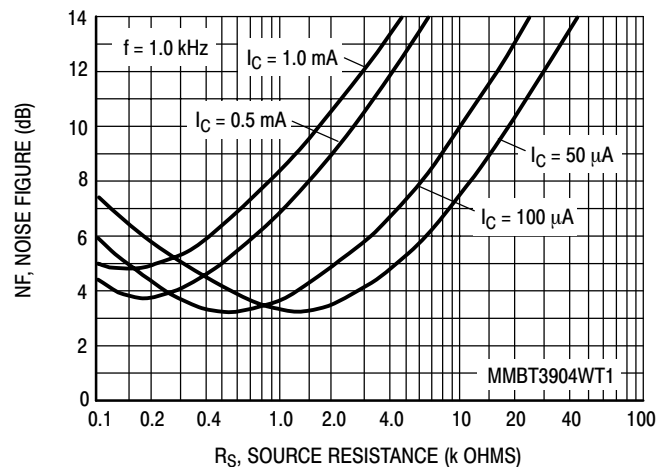


Figure 8. Noise Figure

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## MMBT3904WT1

### h PARAMETERS

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

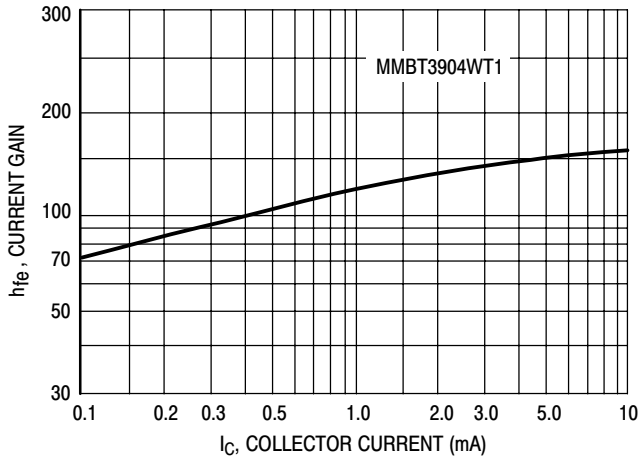


Figure 9. Current Gain

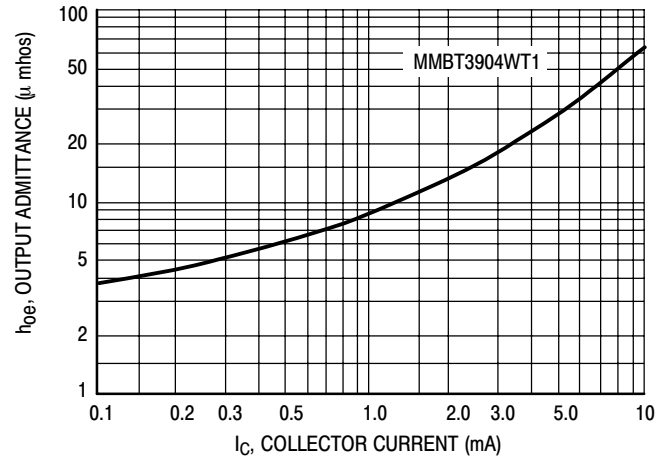


Figure 10. Output Admittance

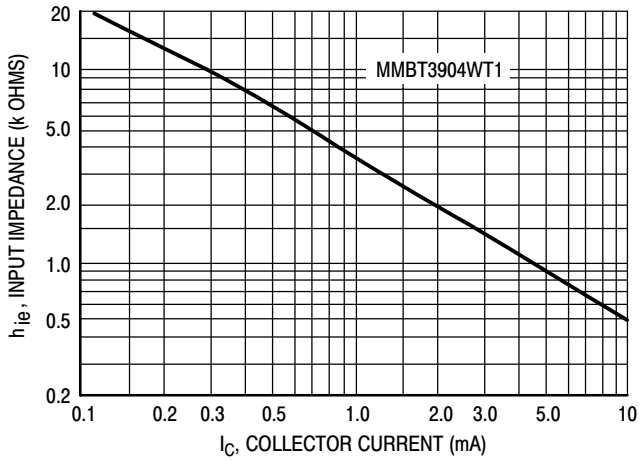


Figure 11. Input Impedance

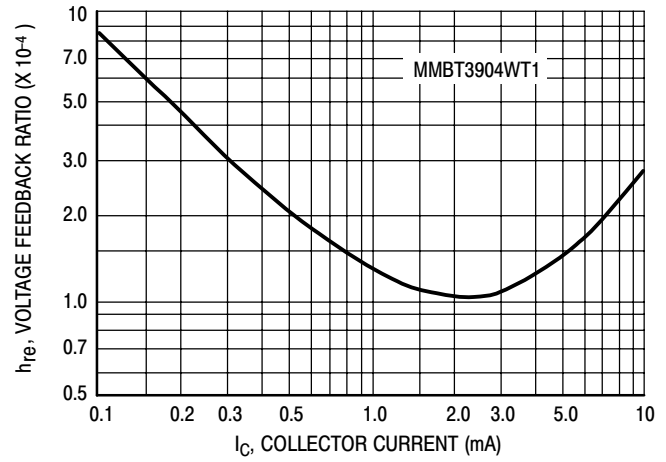


Figure 12. Voltage Feedback Ratio

### TYPICAL STATIC CHARACTERISTICS

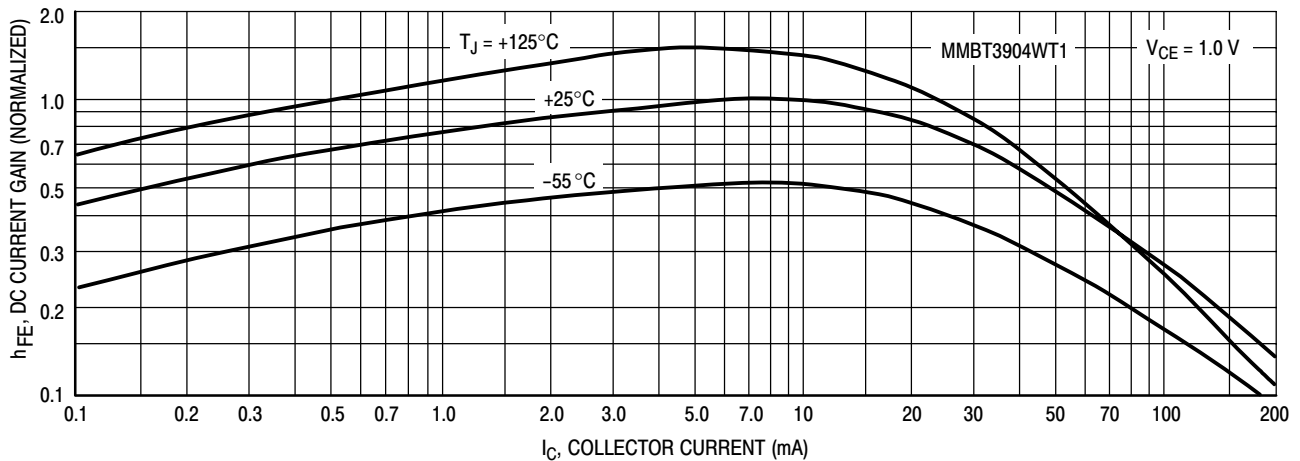


Figure 13. DC Current Gain

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## MMBT3904WT1

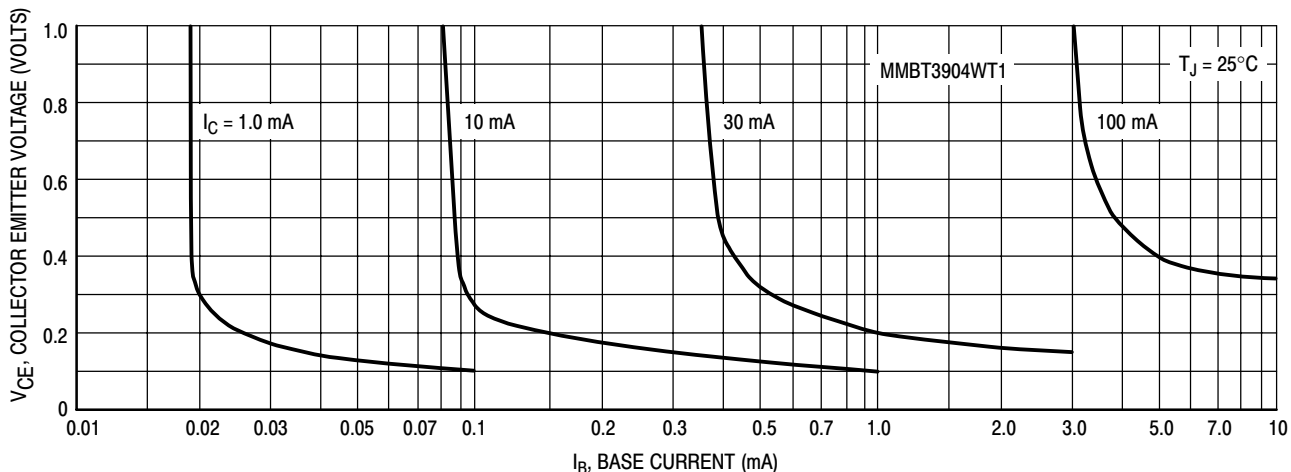


Figure 14. Collector Saturation Region

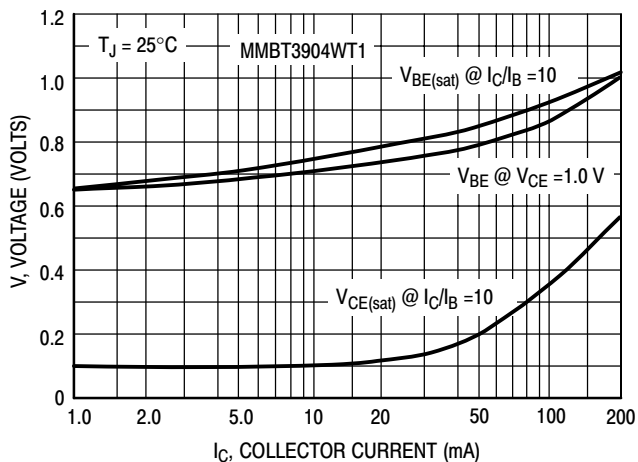


Figure 15. "ON" Voltages

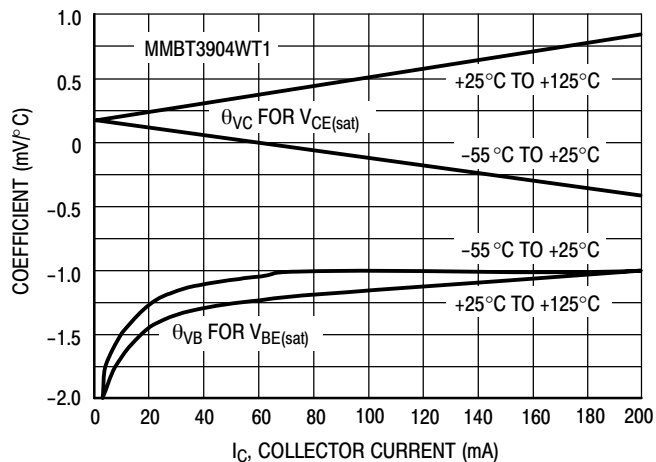


Figure 16. Temperature Coefficients

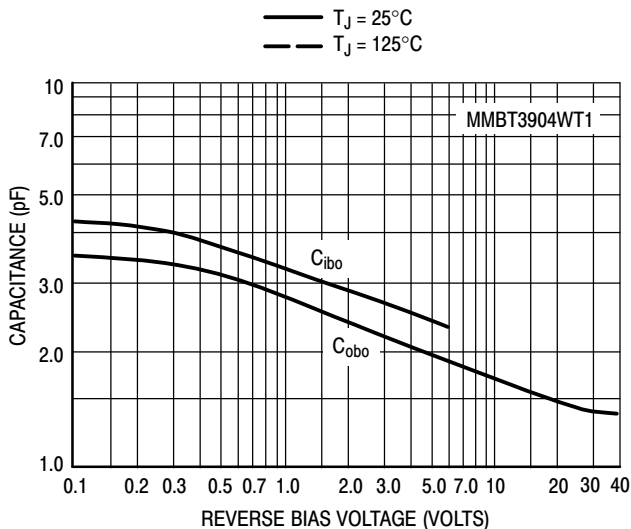


Figure 17. Capacitance

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## MMBT3906WT1

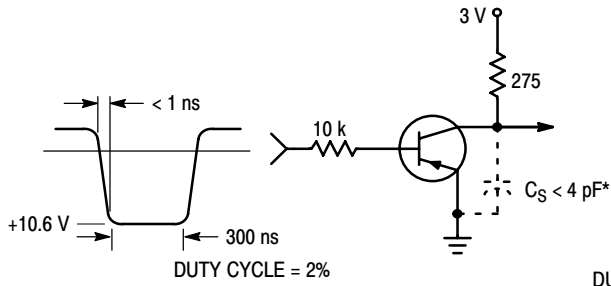


Figure 18. Delay and Rise Time Equivalent Test Circuit

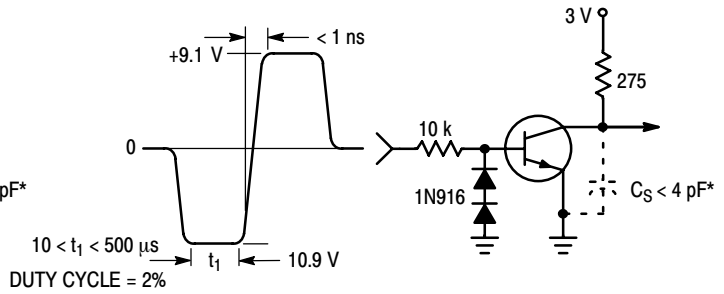


Figure 19. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

## TYPICAL TRANSIENT CHARACTERISTICS

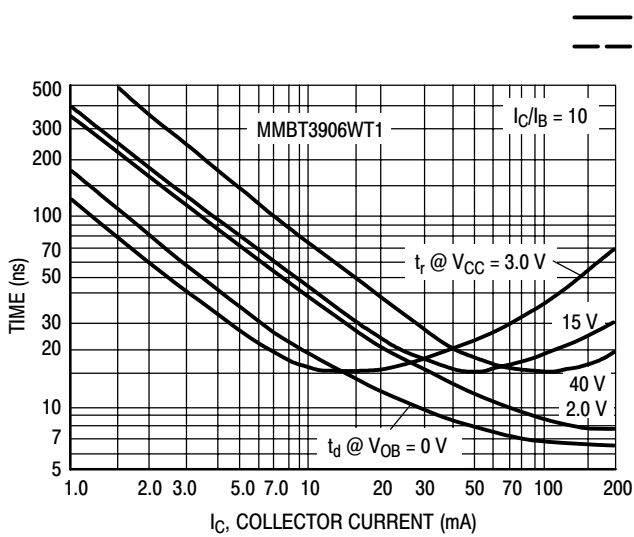


Figure 20. Turn-On Time

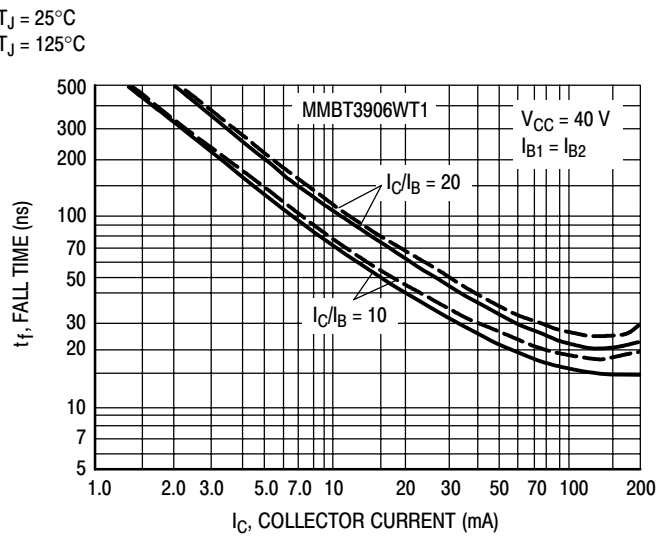


Figure 21. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

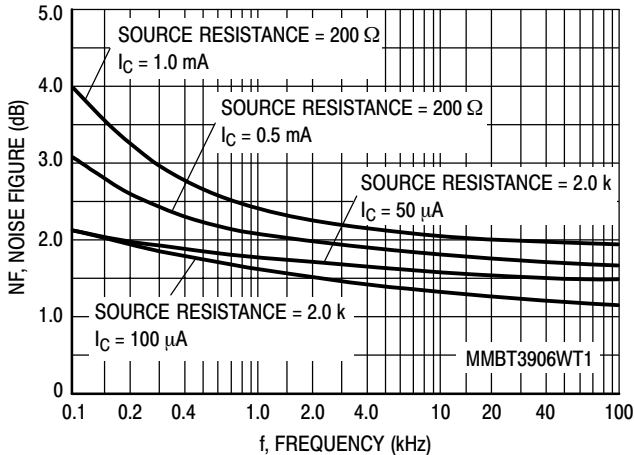


Figure 22.

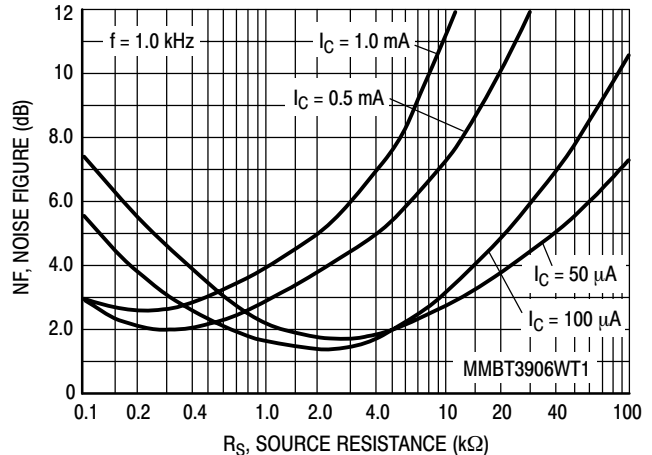


Figure 23.

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## MMBT3906WT1

### h PARAMETERS

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

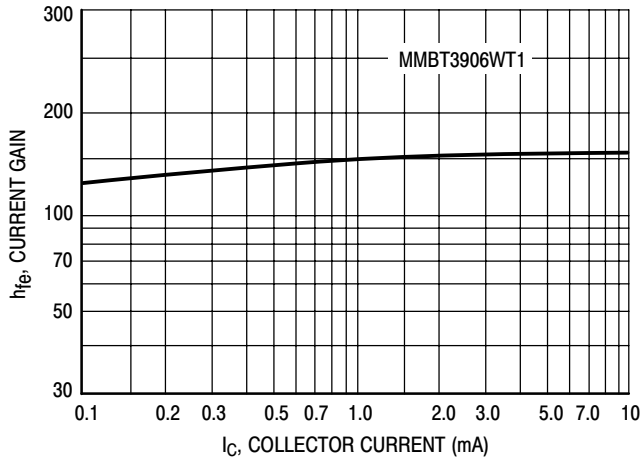


Figure 24. Current Gain

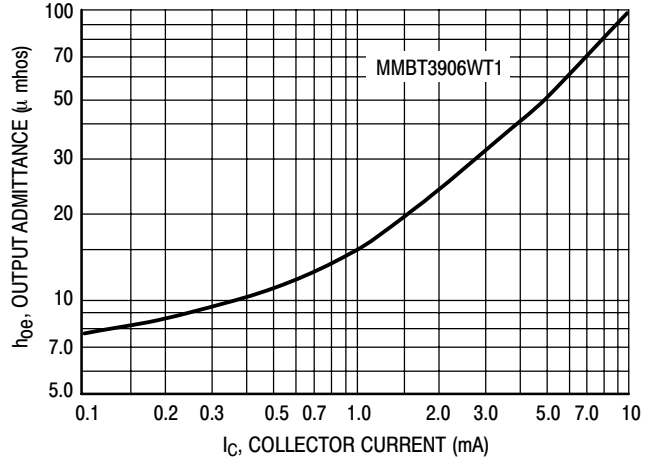


Figure 25. Output Admittance

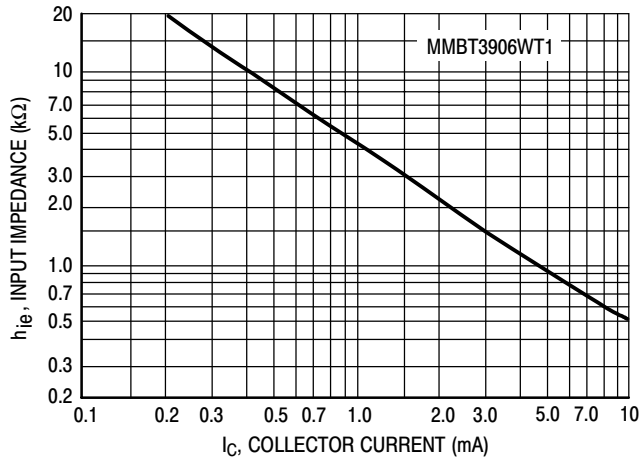


Figure 26. Input Impedance

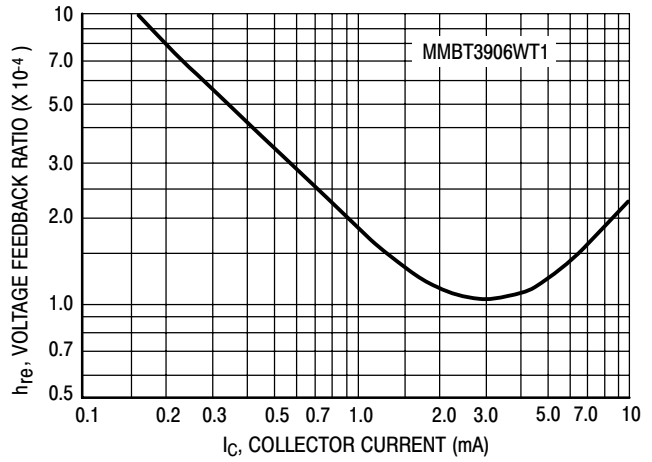


Figure 27. Voltage Feedback Ratio

### STATIC CHARACTERISTICS

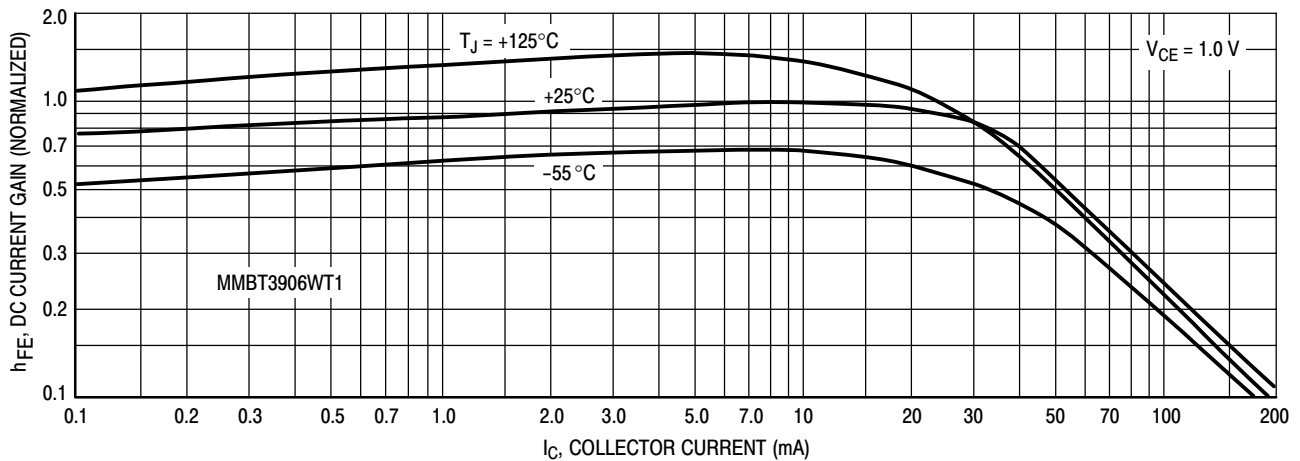


Figure 28. DC Current Gain



MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3906WT1

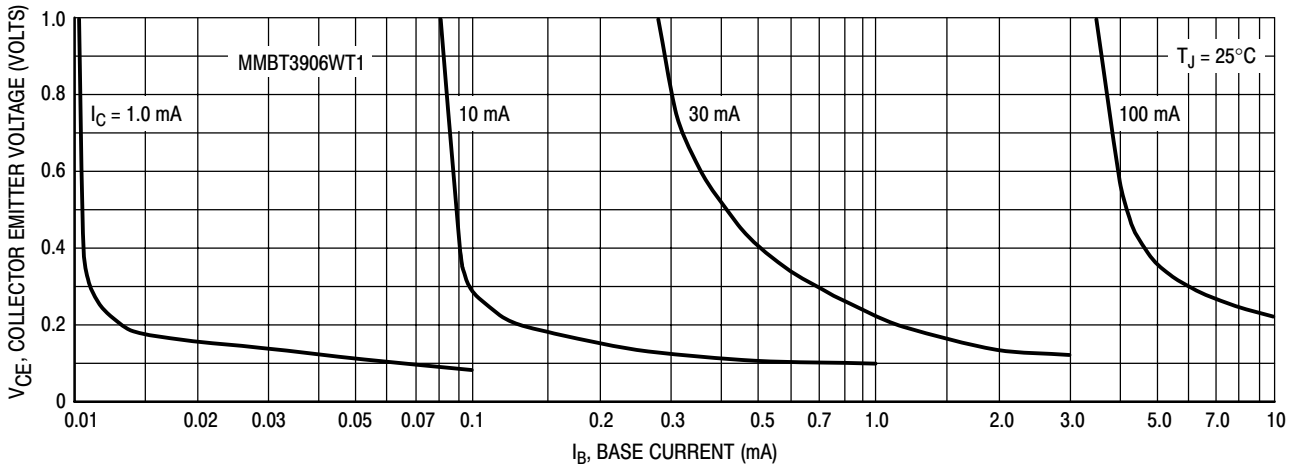


Figure 29. Collector Saturation Region

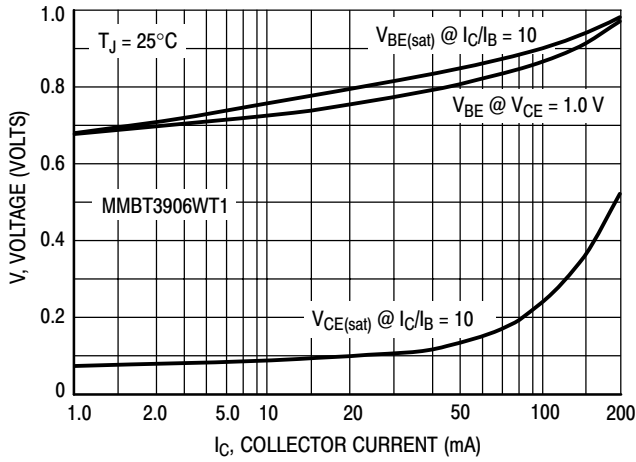


Figure 30. "ON" Voltages

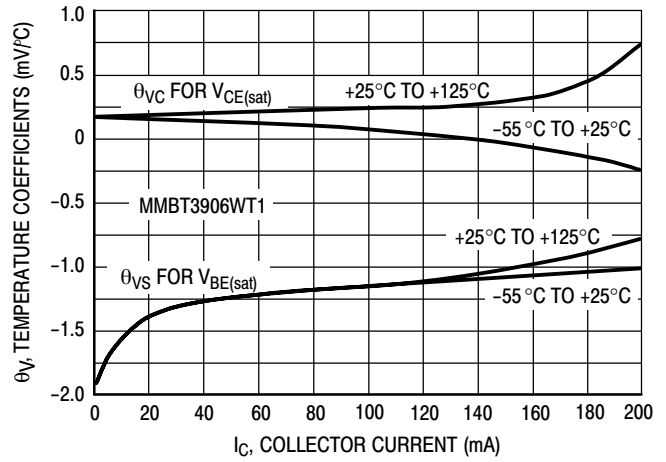


Figure 31. Temperature Coefficients

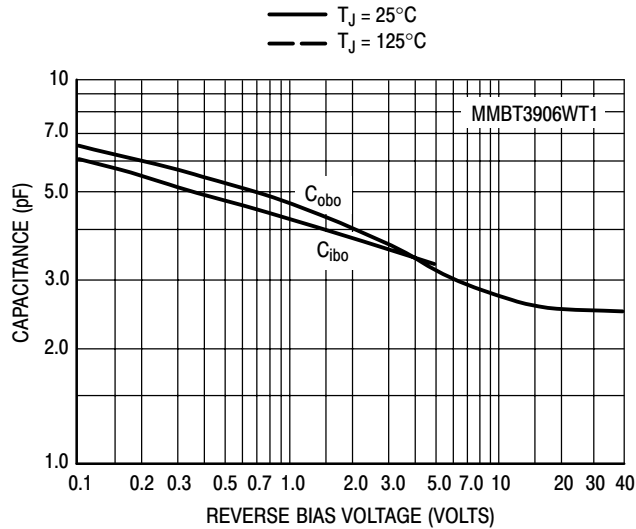
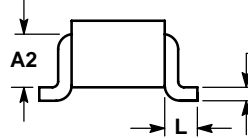
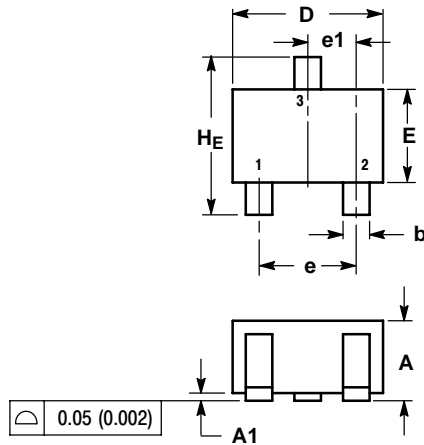


Figure 32. Capacitance

# MMBT3904WT1, NPN MMBT3906WT1, PNP

## PACKAGE DIMENSIONS

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

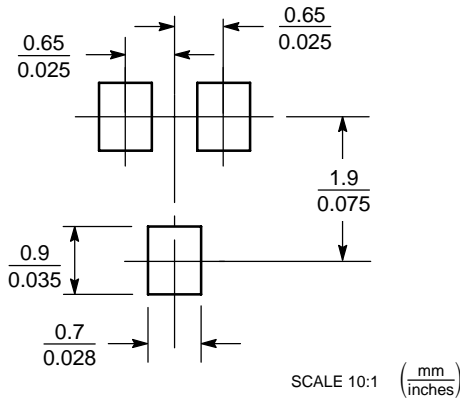


- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.

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	0.7 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	0.425 REF			0.017 REF		
HE	2.00	2.10	2.40	0.079	0.083	0.095

- STYLE 3:  
PIN 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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