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

ON Semiconductor®
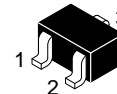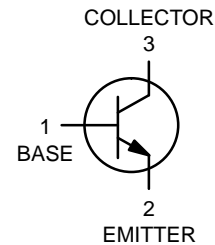
General Purpose Transistors
NPN and PNP Silicon

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

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°C	P_D	150	mW
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	833	°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. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

COLLECTOR
3

1
BASE

2
EMITTER

SC−70 (SOT−323)
CASE 419
STYLE 3

MARKING DIAGRAM

xx M ▪
▪
1
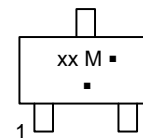
xx	= AM for MMBT3904WT1, SMMBT3904WT = 2A for MMBT3906WT1, SMMBT3906WT1
M	= Date Code*
▪	= Pb−Free Package

(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_A = 25°C unless otherwise noted)

| Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (Note 2) (I_C = 1.0 mAdc, I_B = 0) MMBT3904WT1, SMMBT3904WT1 (I_C = −1.0 mAdc, I_B = 0) MMBT3906WT1, SMMBT3906WT1		$V_{(BR)CEO}$	40 −40	− −	Vdc
Collector−Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0) MMBT3904WT1, SMMBT3904WT1 (I_C = −10 μAdc, I_E = 0) MMBT3906WT1, SMMBT3906WT1		$V_{(BR)CBO}$	60 −40	− −	Vdc
Emitter−Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0) MMBT3904WT1, SMMBT3904WT1 (I_E = −10 μAdc, I_C = 0) MMBT3906WT1, SMMBT3906WT1		$V_{(BR)EBO}$	6.0 −5.0	− −	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −30 Vdc, V_{EB} = −3.0 Vdc) MMBT3906WT1, SMMBT3906WT1		I_{BL}	− −	50 −50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −30 Vdc, V_{EB} = −3.0 Vdc) MMBT3906WT1, SMMBT3906WT1		I_{CEX}	− −	50 −50	nAdc
ON CHARACTERISTICS (Note 2)					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) MMBT3904WT1, SMMBT3904WT1 (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) (I_C = −0.1 mAdc, V_{CE} = −1.0 Vdc) MMBT3906WT1, SMMBT3906WT1 (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 60 80 100 60 30	− − 300 − − − − 300 − −	−
Collector−Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) MMBT3904WT1, SMMBT3904WT1 (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = −10 mAdc, I_B = −1.0 mAdc) MMBT3906WT1, SMMBT3906WT1 (I_C = −50 mAdc, I_B = −5.0 mAdc)		$V_{CE(sat)}$	− − − −	0.2 0.3 −0.25 −0.4	Vdc
Base−Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) MMBT3904WT1, SMMBT3904WT1 (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = −10 mAdc, I_B = −1.0 mAdc) MMBT3906WT1, SMMBT3906WT1 (I_C = −50 mAdc, I_B = −5.0 mAdc)		$V_{BE(sat)}$	0.65 − −0.65 −	0.85 0.95 −0.85 −0.95	Vdc

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

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

Characteristic	Symbol	Min	Max	Unit
SMALL−SIGNAL CHARACTERISTICS				
Current−Gain − Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) MMBT3904WT1, SMMBT3904WT1 (I_C = −10 mAdc, V_{CE} = −20 Vdc, f = 100 MHz) MMBT3906WT1, SMMBT3906WT1	f_T	300 250	– –	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz) MMBT3904WT1, SMMBT3904WT1 (V_{CB} = −5.0 Vdc, I_E = 0, f = 1.0 MHz) MMBT3906WT1, SMMBT3906WT1	C_{obo}	– –	4.0 4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz) MMBT3904WT1, SMMBT3904WT1 (V_{EB} = −0.5 Vdc, I_C = 0, f = 1.0 MHz) MMBT3906WT1, SMMBT3906WT1	C_{ibo}	– –	8.0 10.0	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz) MMBT3906WT1, SMMBT3906WT1	h_{ie}	1.0 2.0	10 12	k Ω
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz) MMBT3906WT1, SMMBT3906WT1	h_{re}	0.5 0.1	8.0 10	X 10^{-4}
Small−Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz) MMBT3906WT1, SMMBT3906WT1	h_{fe}	100 100	400 400	–
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) MMBT3904WT1, SMMBT3904WT1 (V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz) MMBT3906WT1, SMMBT3906WT1	h_{oe}	1.0 3.0	40 60	μmhos

Noise Figure
(V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)
  MMBT3904WT1, SMMBT3904WT1
(V_{CE} = −5.0 Vdc, I_C = −100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)
  MMBT3906WT1, SMMBT3906WT1
	NF	–
		–
			5.0
			4.0
				dB

SWITCHING CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Max	Unit

Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = −0.5 Vdc)
	  MMBT3904WT1, SMMBT3904WT1
	(V_{CC} = −3.0 Vdc, V_{BE} = 0.5 Vdc)
	  MMBT3906WT1, SMMBT3906WT1
		t_d	–
			–
				35
				35
					ns

Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc)
	  MMBT3904WT1, SMMBT3904WT1
	(I_C = −10 mAdc, I_{B1} = −1.0 mAdc)
	  MMBT3906WT1, SMMBT3906WT1
		t_r	–
			–
				35
				35	

Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc)
	  MMBT3904WT1, SMMBT3904WT1
	(V_{CC} = −3.0 Vdc, I_C = −10 mAdc)
	  MMBT3906WT1, SMMBT3906WT1
		t_s	–
			–
				200
				225
					ns

Fall Time	($I_{B1} = I_{B2}$ = 1.0 mAdc) MMBT3904WT1, SMMBT3904WT1 ($I_{B1} = I_{B2}$ = −1.0 mAdc) MMBT3906WT1, SMMBT3906WT1	t_f	– –	50 75	

* Total shunt capacitance of test jig and connectors
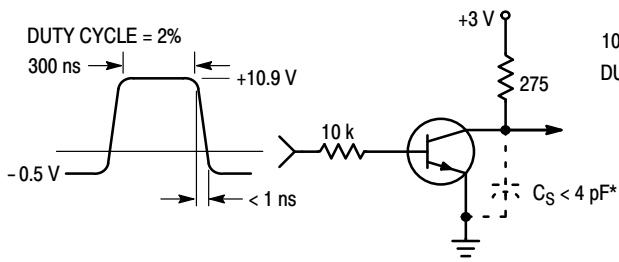
Figure 1. Delay and Rise Time Equivalent Test Circuit
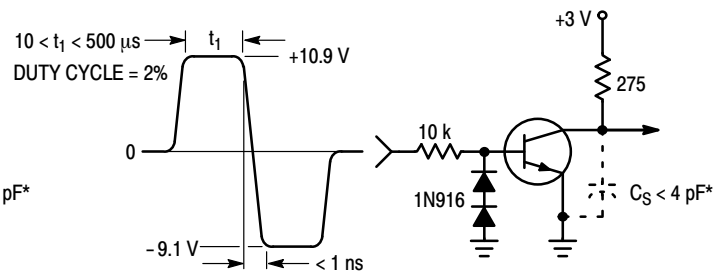
Figure 2. Storage and Fall Time Equivalent Test Circuit

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

MMBT3904WT1, SMMBT3904WT1

TYPICAL TRANSIENT CHARACTERISTICS
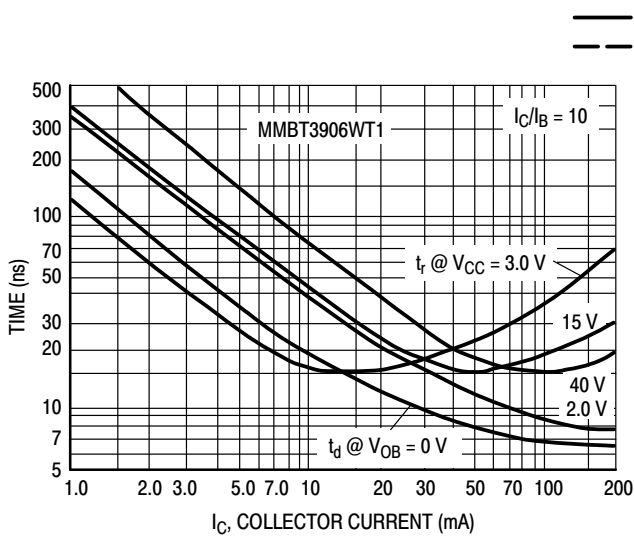
—— $T_J = 25°C$
- - - $T_J = 125°C$
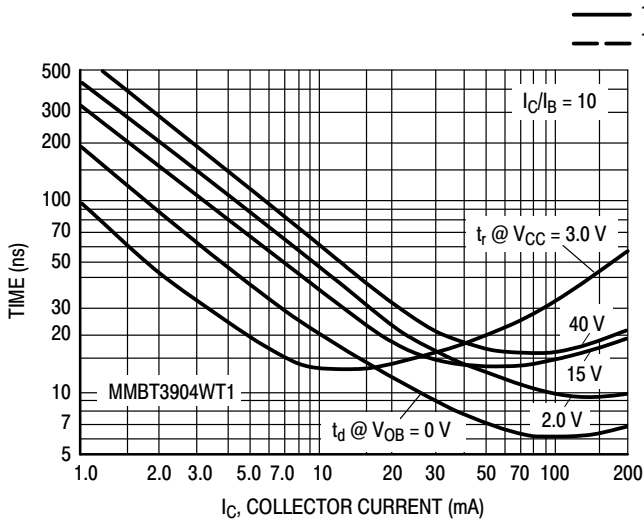
Figure 3. Turn−On Time
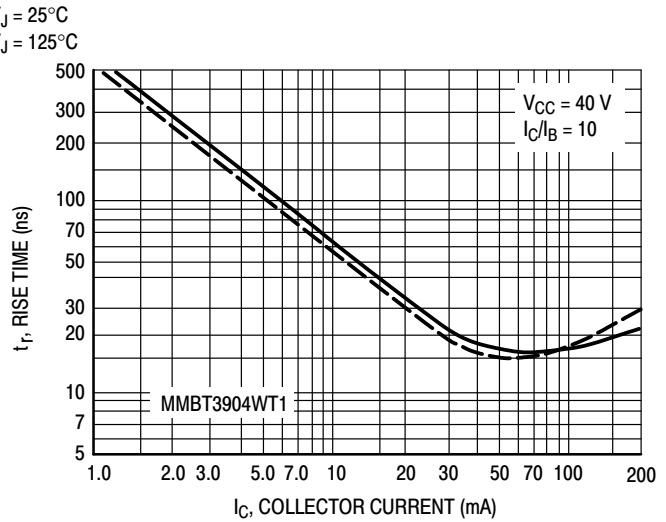
Figure 4. Rise Time
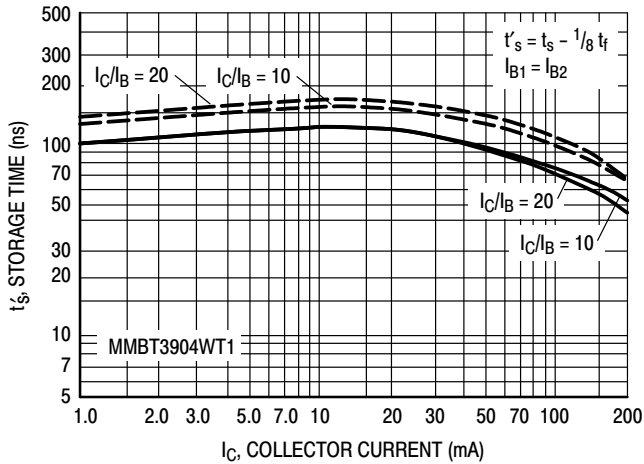
Figure 5. Storage Time
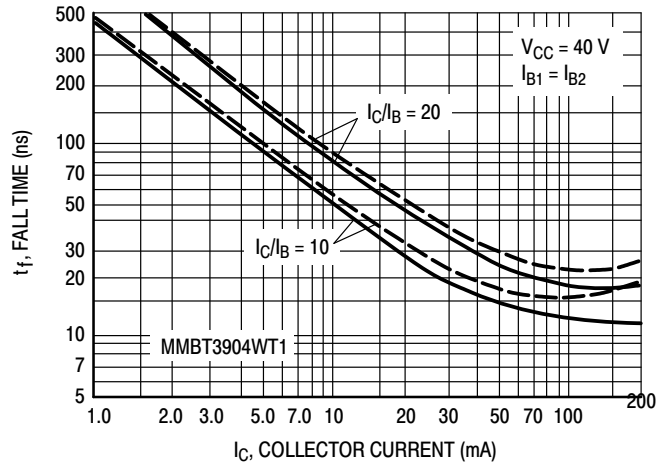
Figure 6. Fall Time

TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS
($V_{CE} = 5.0$ Vdc, $T_A = 25°C$, Bandwidth = 1.0 Hz)
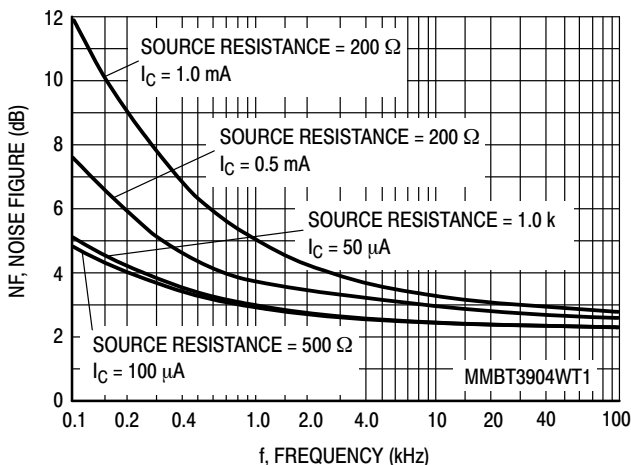
Figure 7. Noise Figure
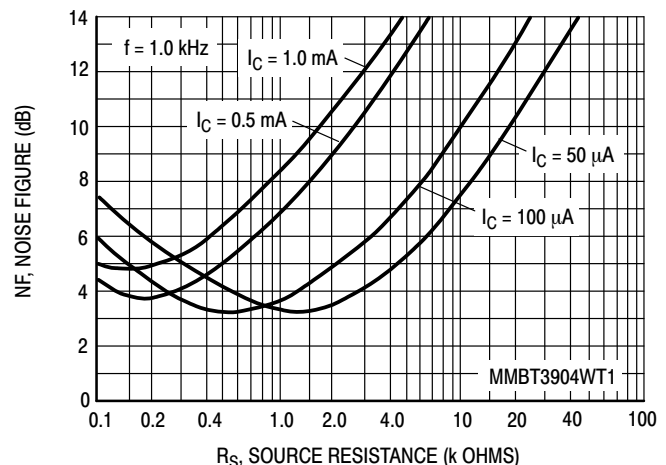
Figure 8. Noise Figure

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)
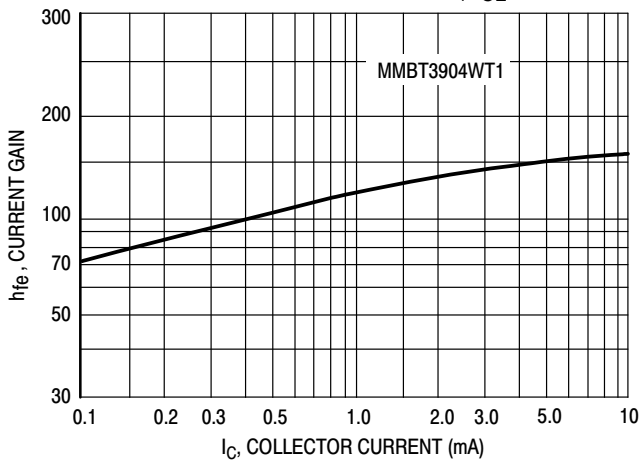
Figure 9. Current Gain
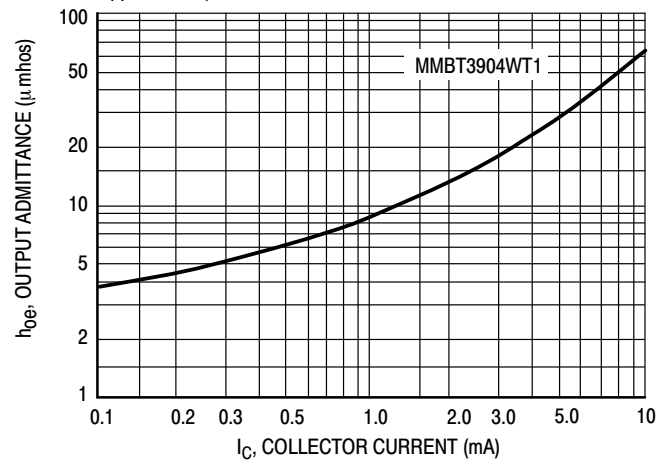
Figure 10. Output Admittance
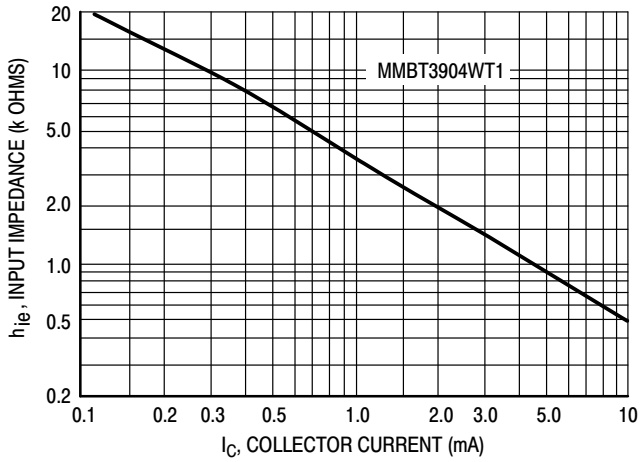
**Figure 11. Input Impedance**
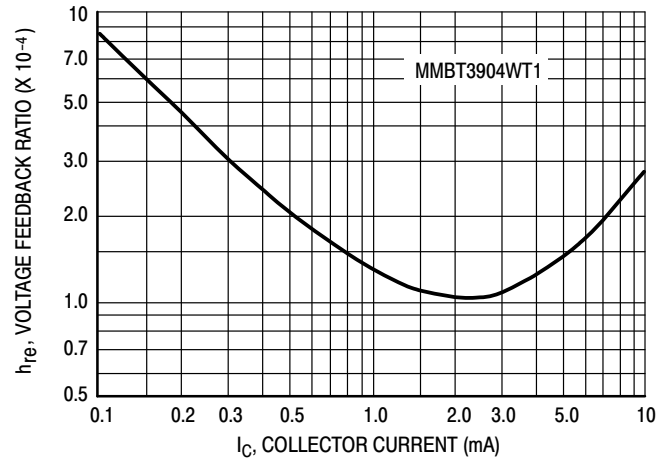
Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS
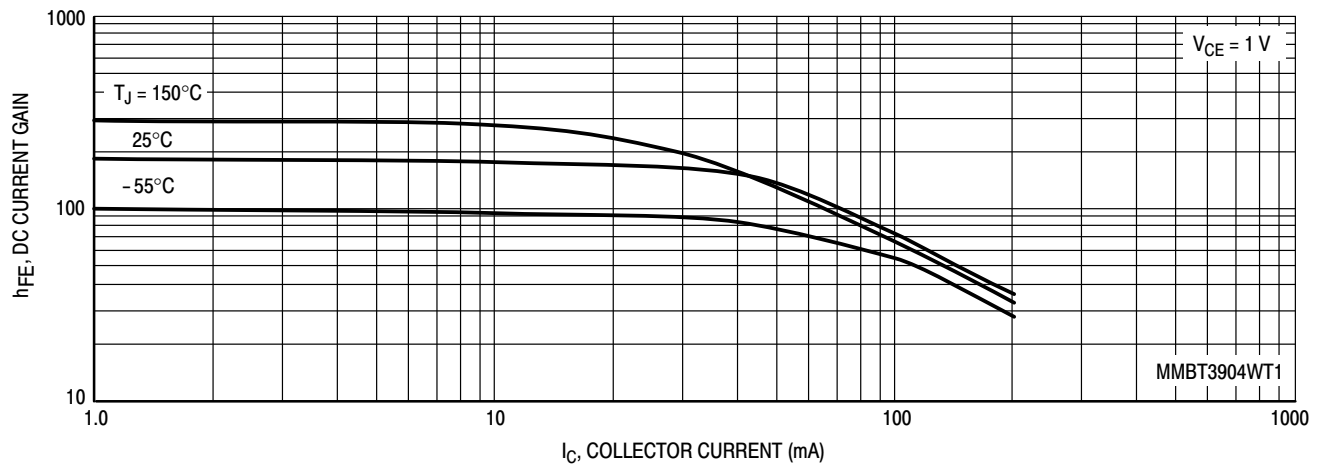
Figure 13. DC Current Gain

MMBT3904WT1G, NPN, SMMBT3904WT1G, NPN, MMBT3906WT1G, PNP, SMMBT3906WT1G, PNP
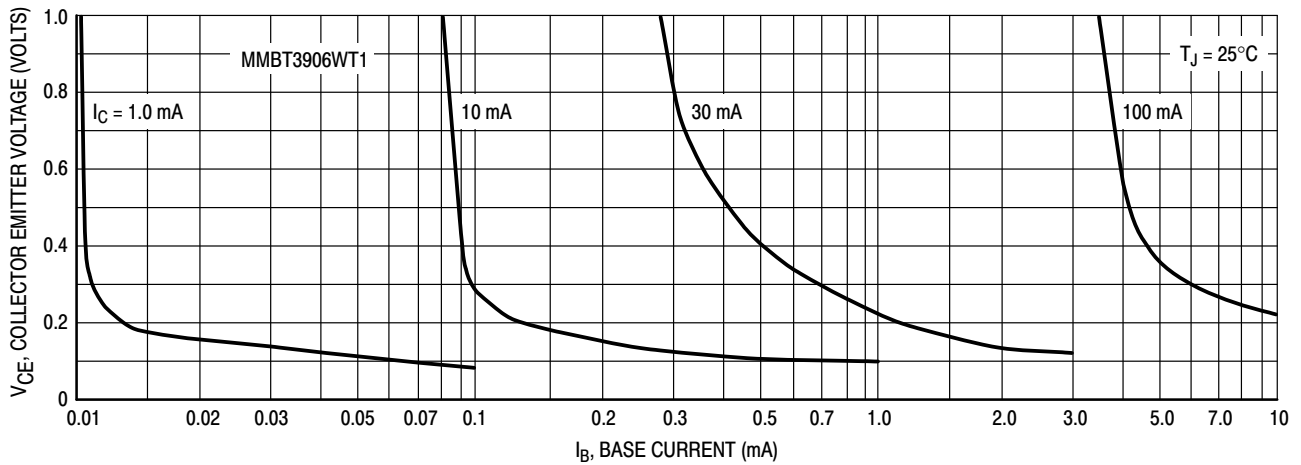
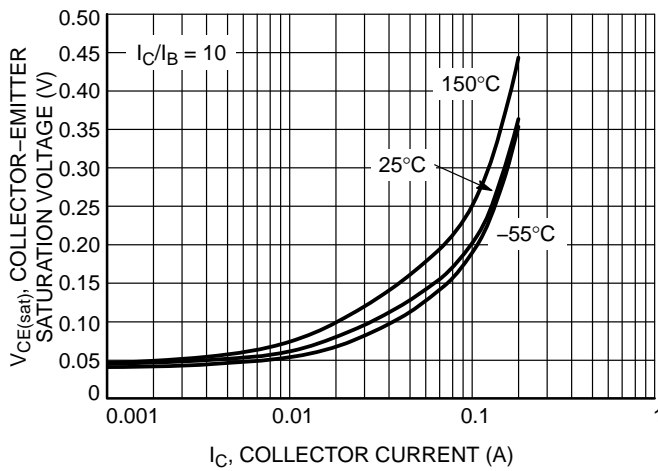## MMBT3904WT1, SMMBT3904WT1
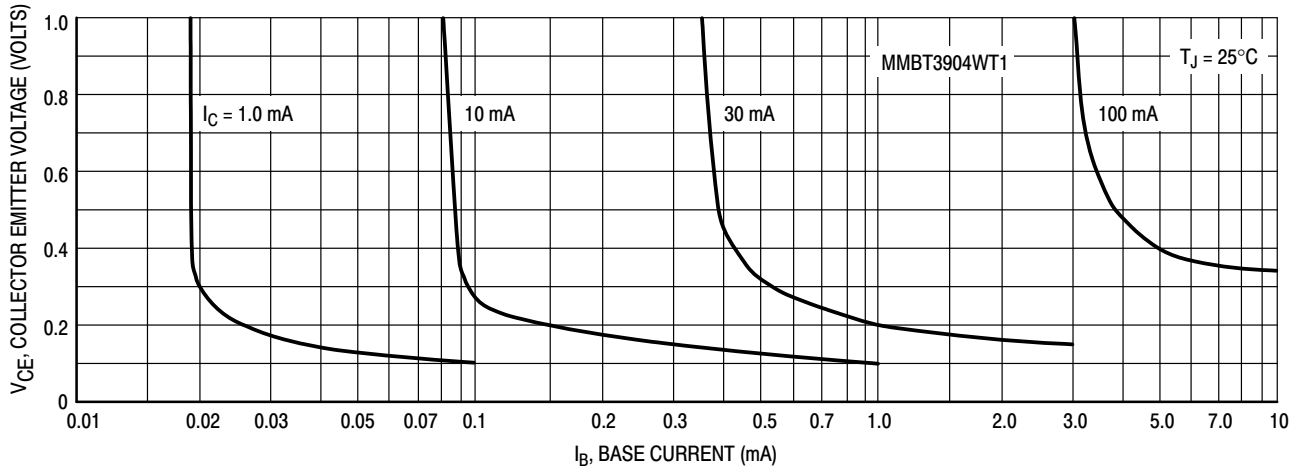
Figure 14. Collector Saturation Region
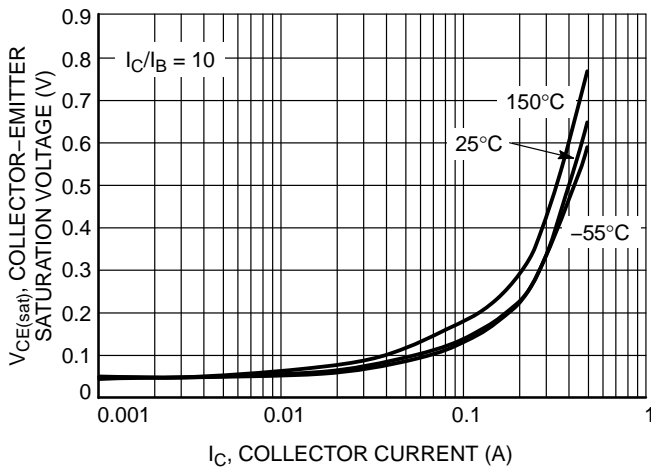
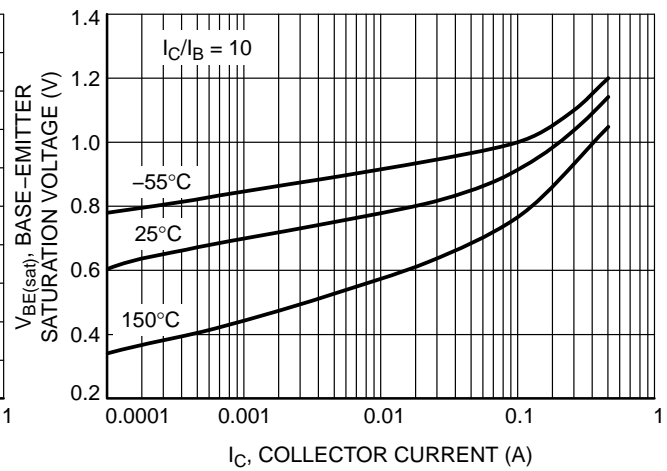**Figure 15. Collector Emitter Saturation Voltage vs. Collector Current**
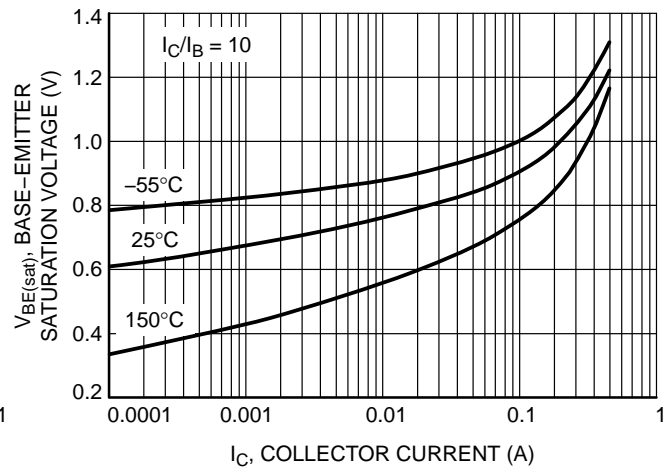
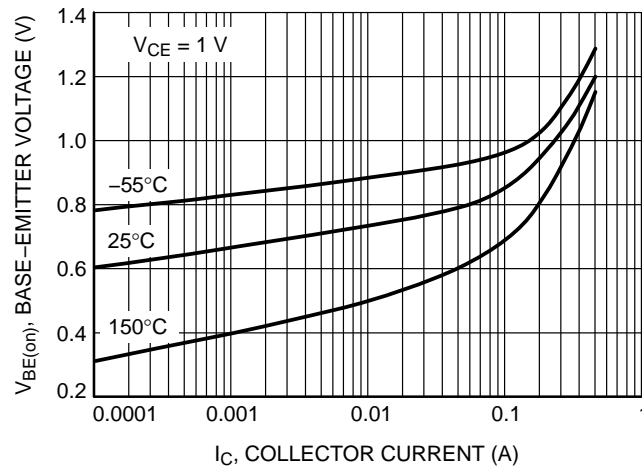**Figure 16. Base Emitter Saturation Voltage vs. Collector Current**
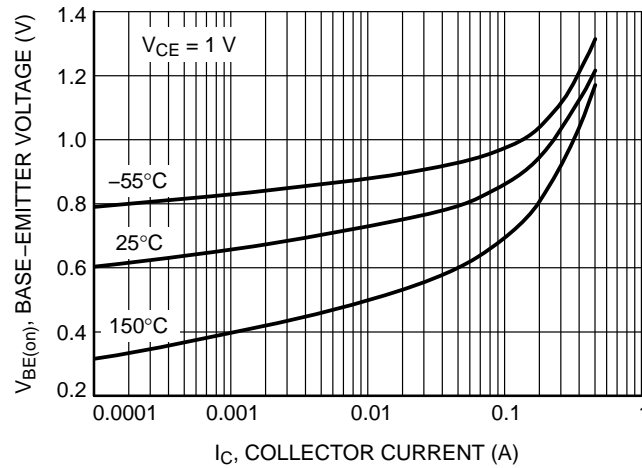
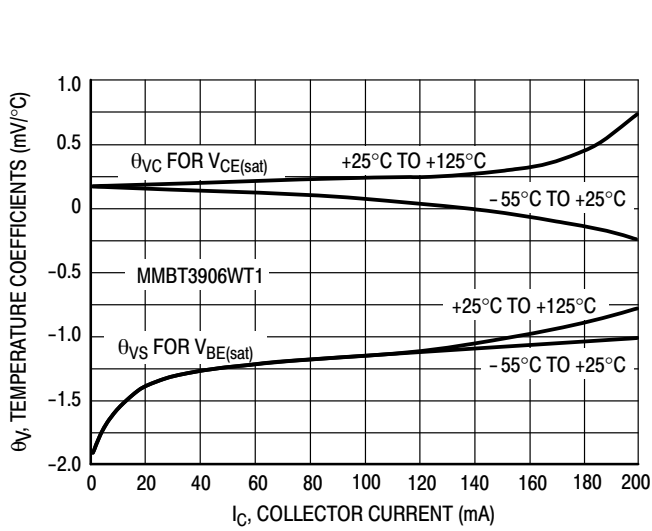**Figure 17. Base Emitter Voltage vs. Collector Current**
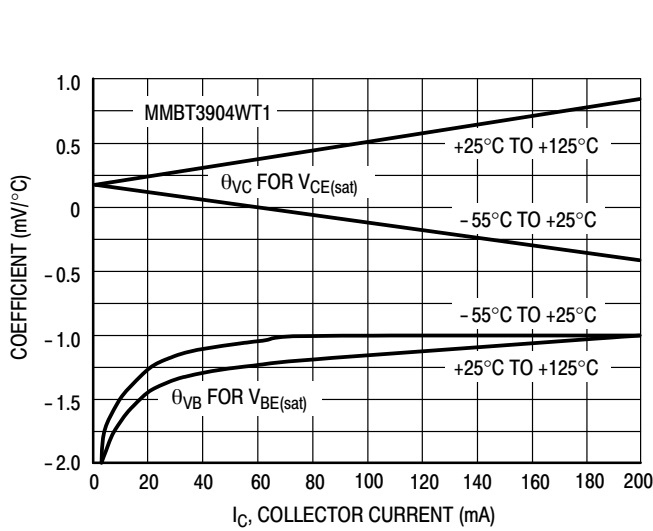
Figure 18. Temperature Coefficients
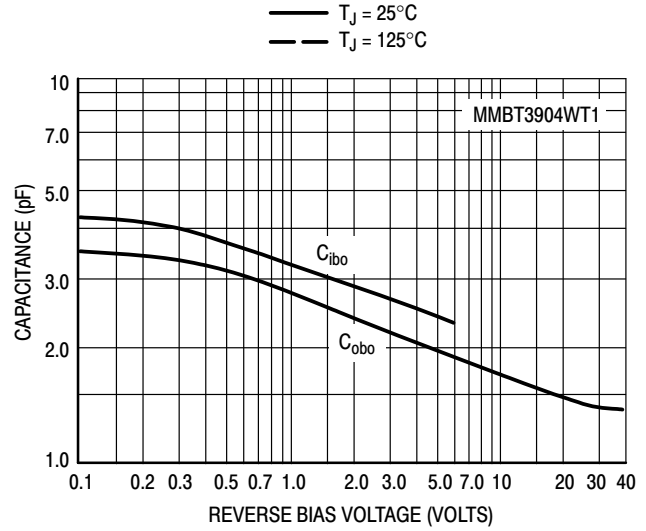
Figure 19. Capacitance
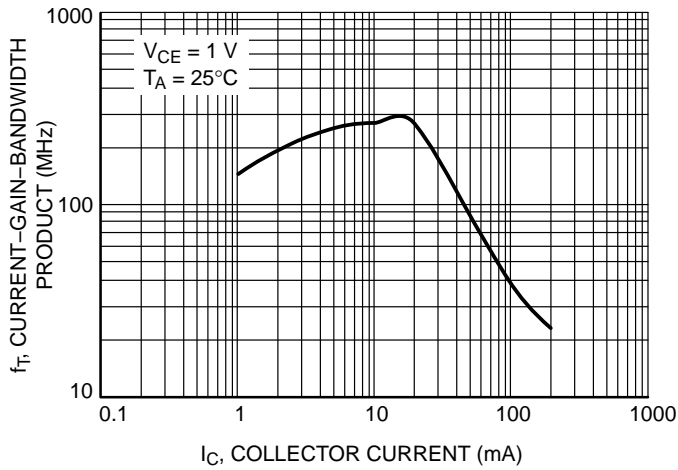
**Figure 20. Current Gain Bandwidth Product
vs. Collector Current**
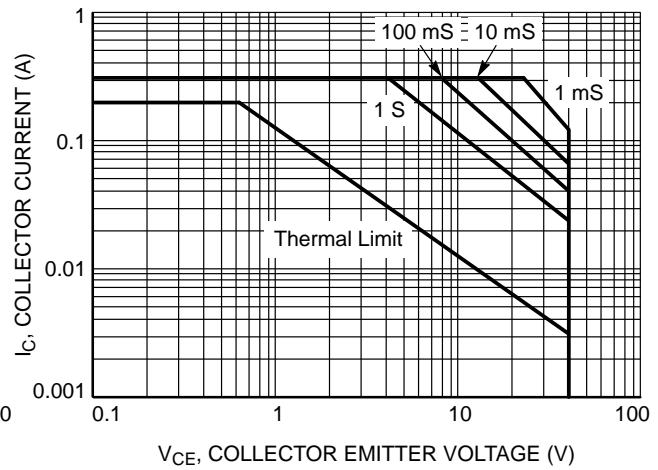
Figure 21. Safe Operating Area

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

MMBT3906WT1, SMMBT3906WT1

* Total shunt capacitance of test jig and connectors
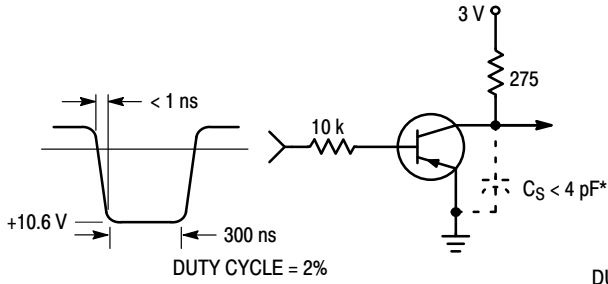
Figure 22. Delay and Rise Time Equivalent Test Circuit
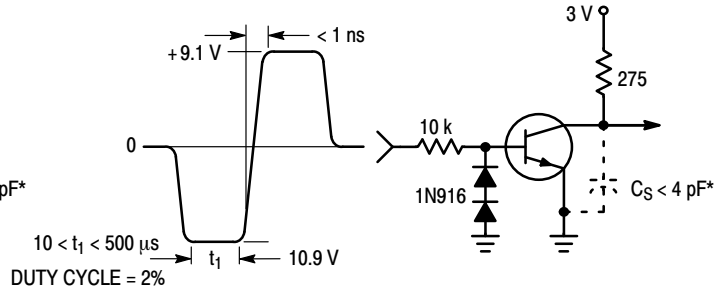
Figure 23. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

Figure 24. Turn−On Time
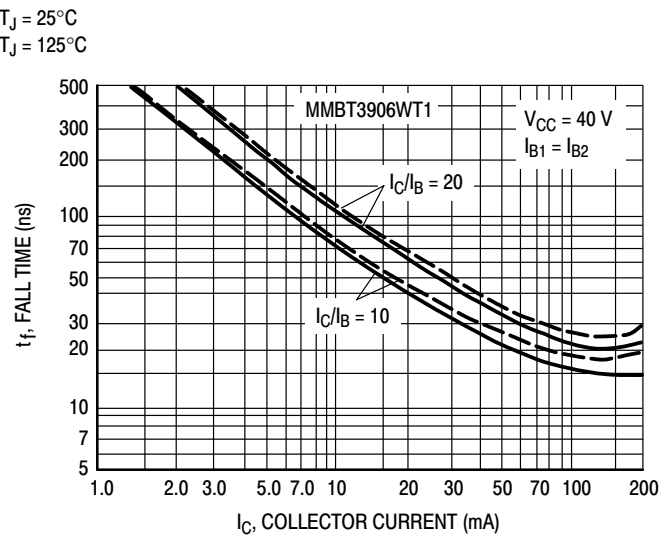
Figure 25. Fall Time

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

Figure 26.

Figure 27.

h PARAMETERS

$(V_{CE} = -10\ Vdc, f = 1.0\ kHz, T_A = 25°C)$
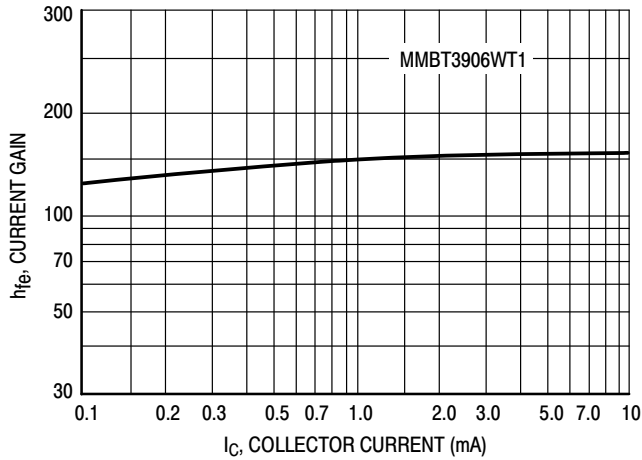
Figure 28. Current Gain
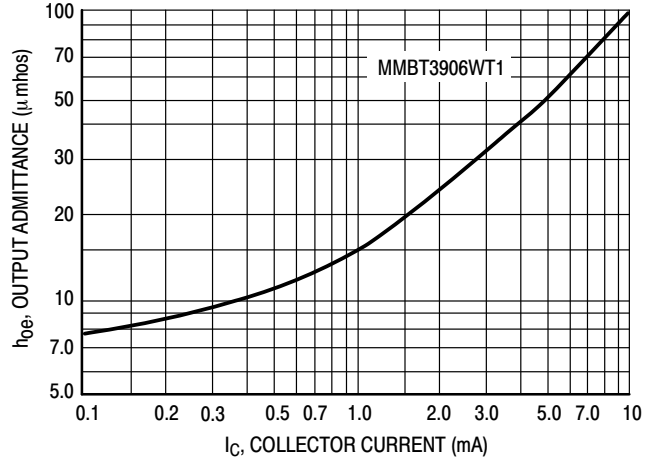
Figure 29. Output Admittance
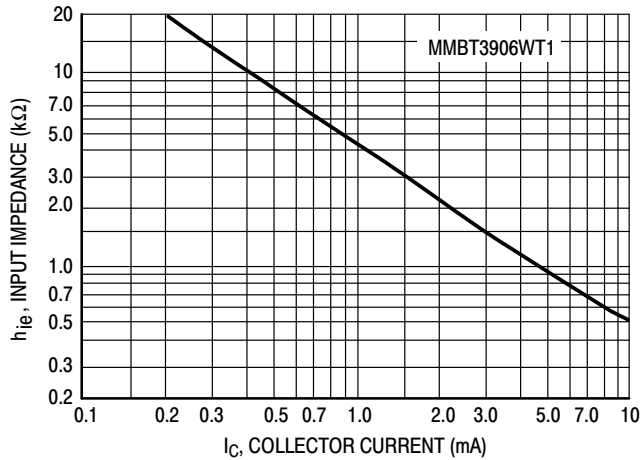
Figure 30. Input Impedance
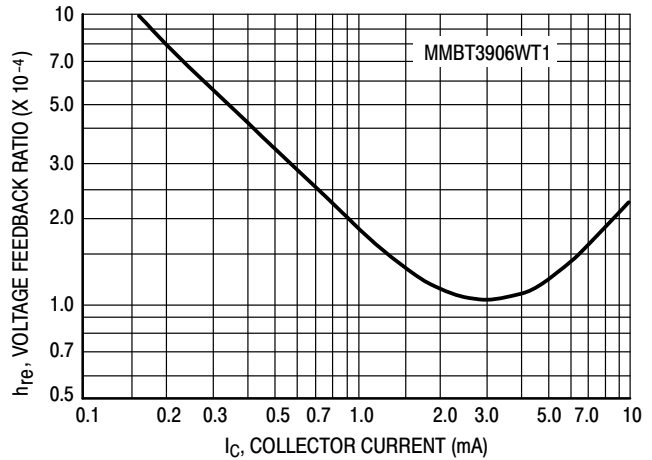
Figure 31. Voltage Feedback Ratio

STATIC CHARACTERISTICS
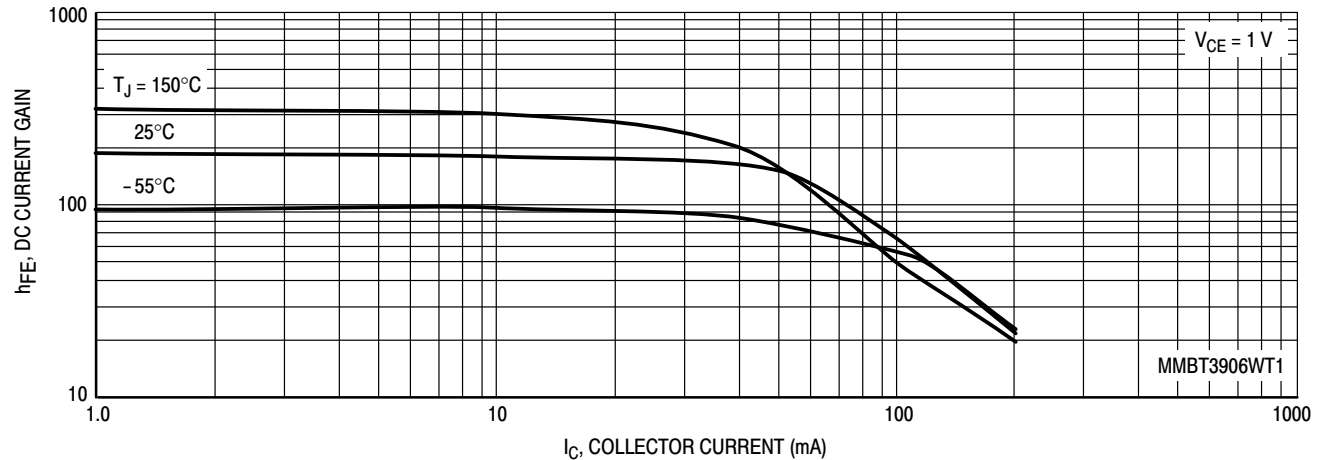
Figure 32. DC Current Gain

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

$T_J = 25°C$
$T_J = 125°C$

Figure 37. Temperature Coefficients
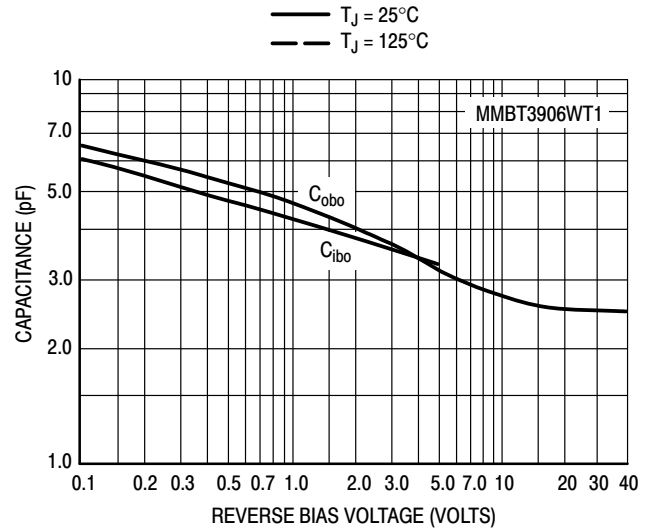
Figure 38. Capacitance
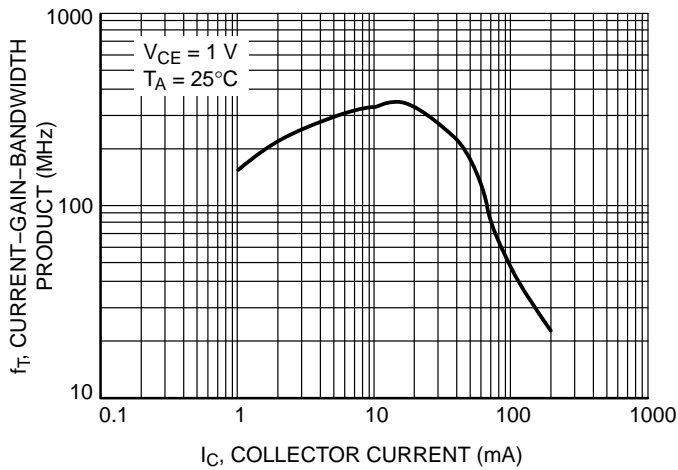
Figure 39. Current Gain Bandwidth Product vs. Collector Current
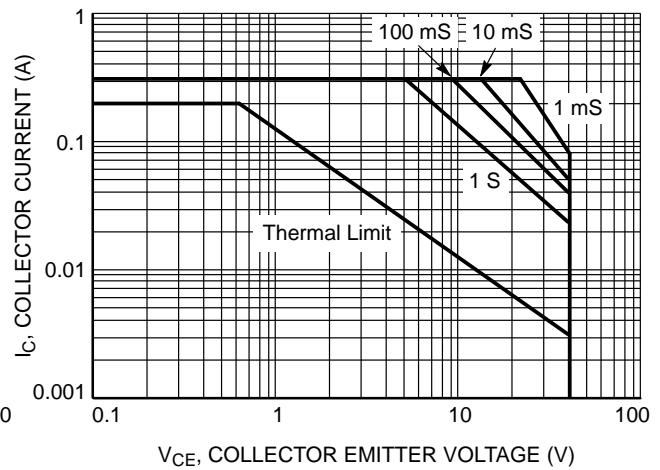
Figure 40. Safe Operating Area
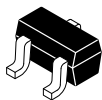
SC−70 (SOT−323)
CASE 419−04
ISSUE N

DATE 11 NOV 2008

SCALE 4:1
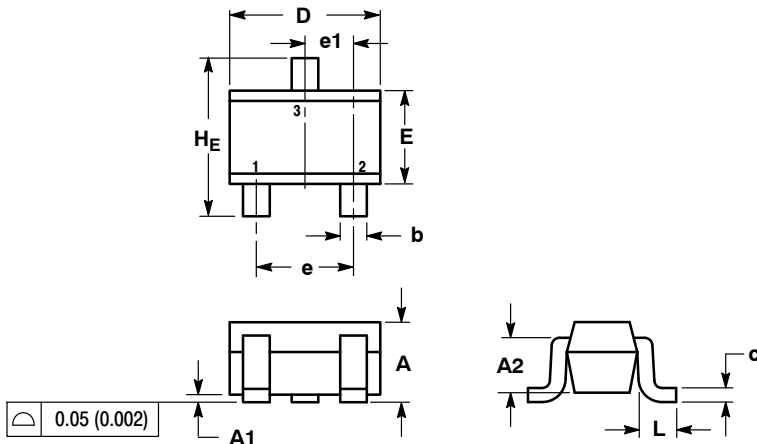
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

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
H_E	2.00	2.10	2.40	0.079	0.083	0.095

0.05 (0.002)

SOLDERING FOOTPRINT*

0.65 / 0.025
0.65 / 0.025
1.9 / 0.075
0.9 / 0.035
0.7 / 0.028

SCALE 10:1 (mm / inches)

**GENERIC
MARKING DIAGRAM**

XX M■

1
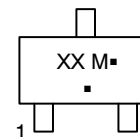
XX = Specific Device Code
M = Date Code
■ = Pb−Free Package

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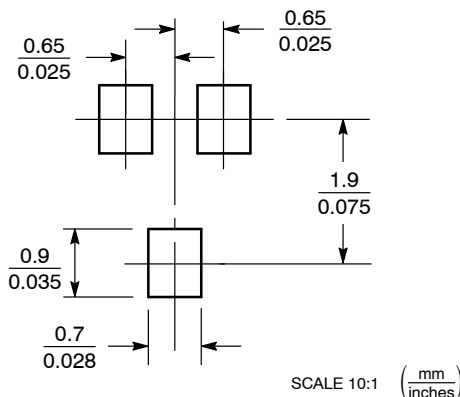
*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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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DESCRIPTION:	SC−70 (SOT−323)		PAGE 1 OF 1

PUBLICATION ORDERING INFORMATION

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