MMBT3904WT1, NPN, SMMBT3904WT1, NPN, MMBT3906WT1, PNP

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

- AEC−Q101 Qualified and PPAP Capable
- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

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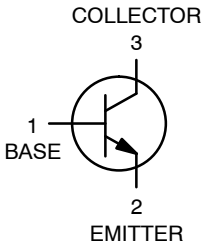
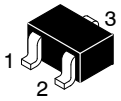
http://onsemi.com





SC−70 (SOT−323)
CASE 419
STYLE 3

MAXIMUM RATINGS

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

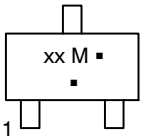
THERMAL CHARACTERISTICS

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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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
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	SC−70/ SOT−323 (Pb−Free)	3000 / Tape & Reel
SMMBT3904WT1G	SC−70/ SOT−323 (Pb−Free)	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.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector – Emitter Breakdown Voltage (Note 2)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MMBT3904WT1, SMMBT3904WT1		40	–	
(I_C = –1.0 mAdc, I_B = 0)	MMBT3906WT1		–40	–	
Collector – Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	MMBT3904WT1, SMMBT3904WT1		60	–	
(I_C = –10 μAdc, I_E = 0)	MMBT3906WT1		–40	–	
Emitter – Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	MMBT3904WT1, SMMBT3904WT1		6.0	–	
(I_E = –10 μAdc, I_C = 0)	MMBT3906WT1		–5.0	–	
Base Cutoff Current		I_{BL}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904WT1, SMMBT3904WT1		–	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906WT1		–	–50	
Collector Cutoff Current		I_{CEX}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904WT1, SMMBT3904WT1		–	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906WT1		–	–50	
ON CHARACTERISTICS (Note 2)					
DC Current Gain		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MMBT3904WT1, SMMBT3904WT1		40	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			70	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			30	–	
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)	MMBT3906WT1		60	–	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)			80	–	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)			100	300	
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)			60	–	
(I_C = –100 mAdc, V_{CE} = –1.0 Vdc)			30	–	
Collector – Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MMBT3904WT1, SMMBT3904WT1		–	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.3	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906WT1		–	–0.25	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			–	–0.4	
Base – Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MMBT3904WT1, SMMBT3904WT1		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.95	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906WT1		–0.65	–0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			–	–0.95	

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		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT3904WT1, SMMBT3904WT1		300	−	
(I_C = −10 mAdc, V_{CE} = −20 Vdc, f = 100 MHz)	MMBT3906WT1		250	−	
Output Capacitance		C_{obo}			pF
(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3904WT1, SMMBT3904WT1		−	4.0	
(V_{CB} = −5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3906WT1		−	4.5	
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3904WT1, SMMBT3904WT1		−	8.0	
(V_{EB} = −0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3906WT1		−	10.0	
Input Impedance		h_{ie}			k Ω
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1, SMMBT3904WT1		1.0	10	
(V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		2.0	12	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1, SMMBT3904WT1		0.5	8.0	
(V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		0.1	10	
Small−Signal Current Gain		h_{fe}			−
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1, SMMBT3904WT1		100	400	
(V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		100	400	
Output Admittance		h_{oe}			μmhos
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1, SMMBT3904WT1		1.0	40	
(V_{CE} = −10 Vdc, I_C = −1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		3.0	60	
Noise Figure		NF			dB
(V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	MMBT3904WT1, SMMBT3904WT1		−	5.0	
(V_{CE} = −5.0 Vdc, I_C = −100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	MMBT3906WT1		−	4.0	

SWITCHING CHARACTERISTICS

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

MMBT3904WT1, SMMBT3904WT1

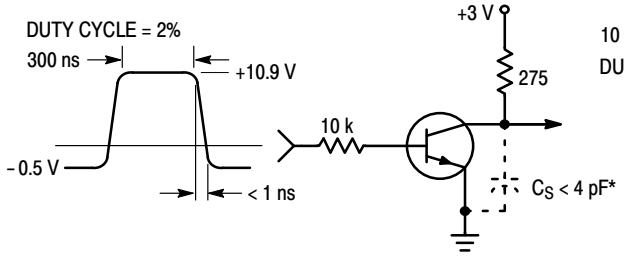


Figure 1. Delay and Rise Time Equivalent Test Circuit

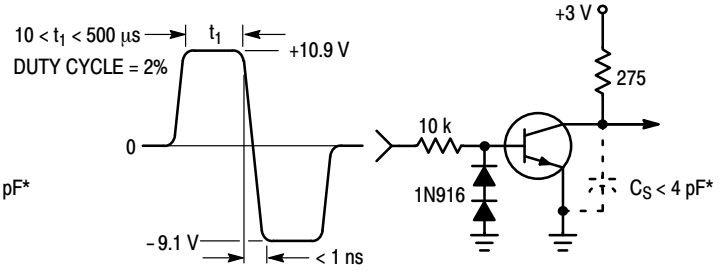


Figure 2. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

MMBT3904WT1, SMMBT3904WT1

TYPICAL TRANSIENT CHARACTERISTICS

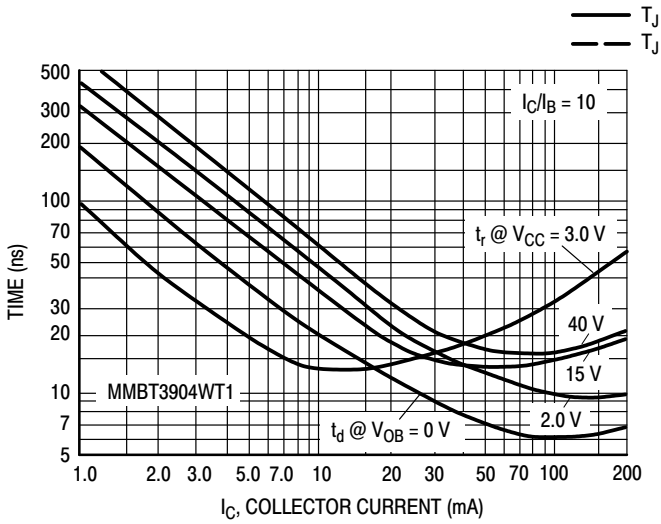


Figure 3. Turn – On Time

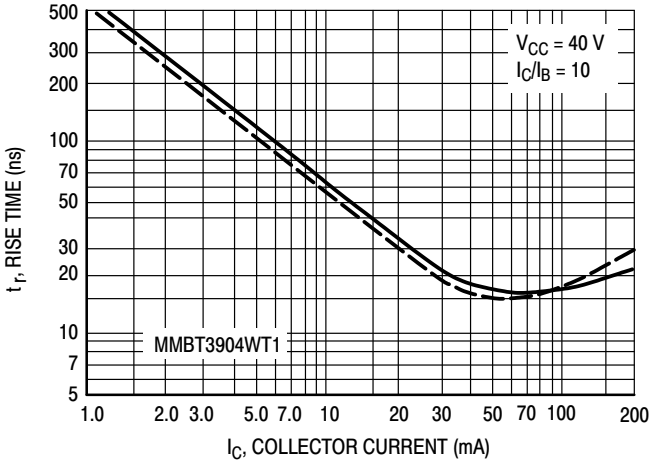


Figure 4. Rise Time

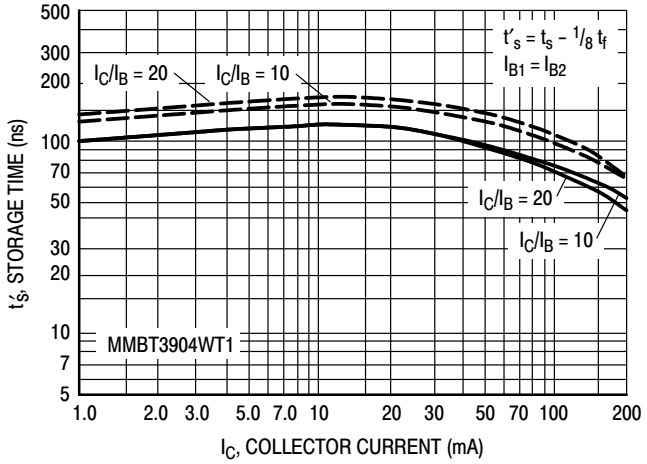


Figure 5. Storage Time

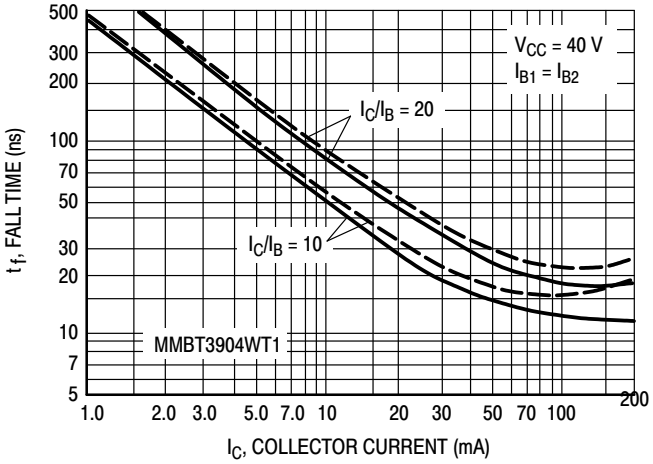


Figure 6. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

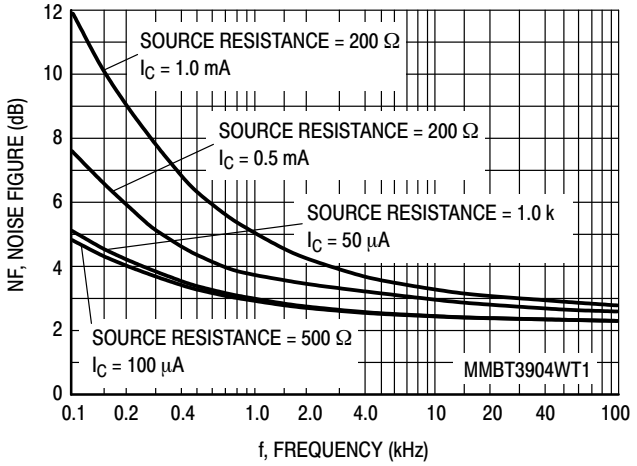


Figure 7. Noise Figure

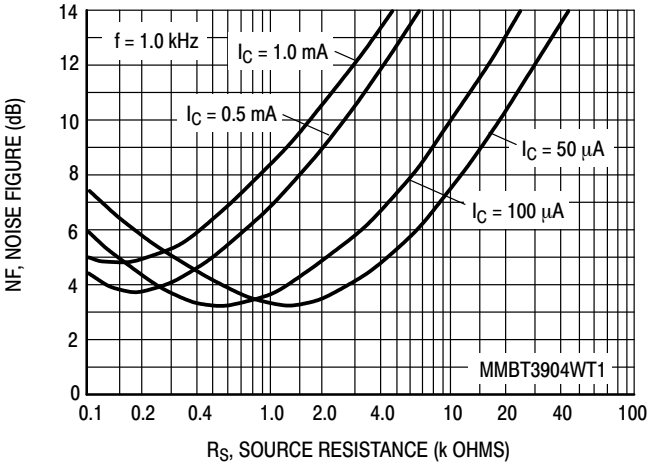


Figure 8. Noise Figure

MMBT3904WT1, SMMBT3904WT1

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

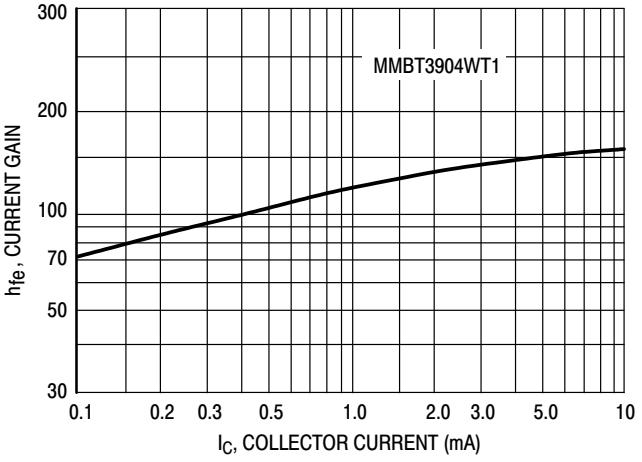


Figure 9. Current Gain

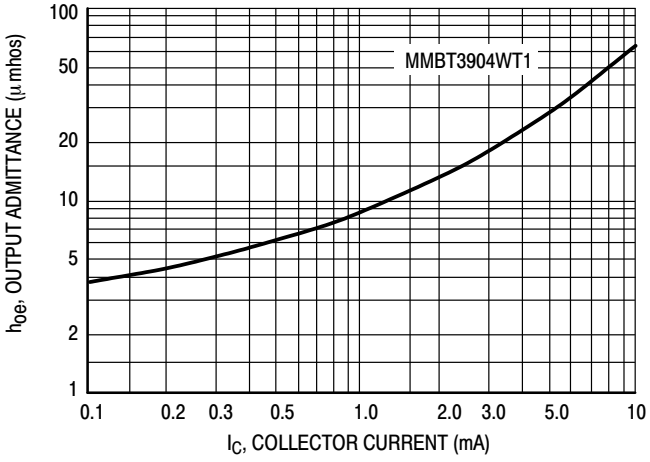


Figure 10. Output Admittance

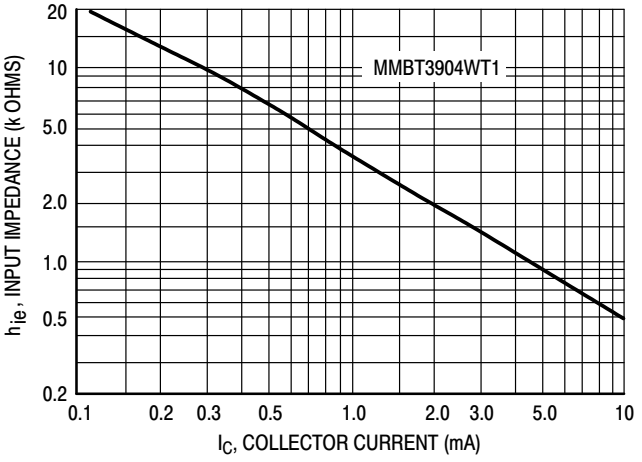


Figure 11. Input Impedance

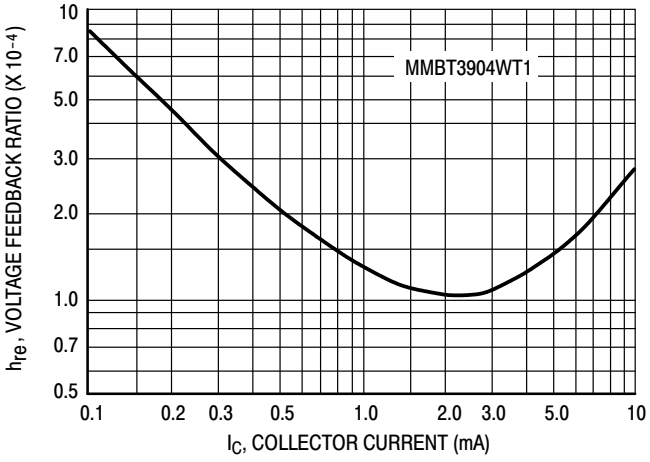


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

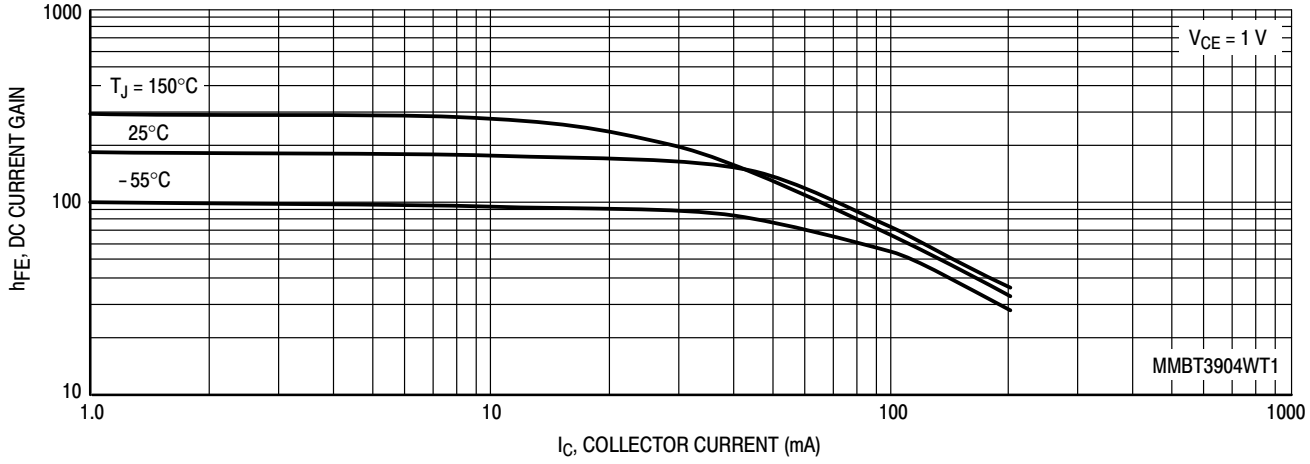


Figure 13. DC Current Gain

MMBT3904WT1, SMMBT3904WT1

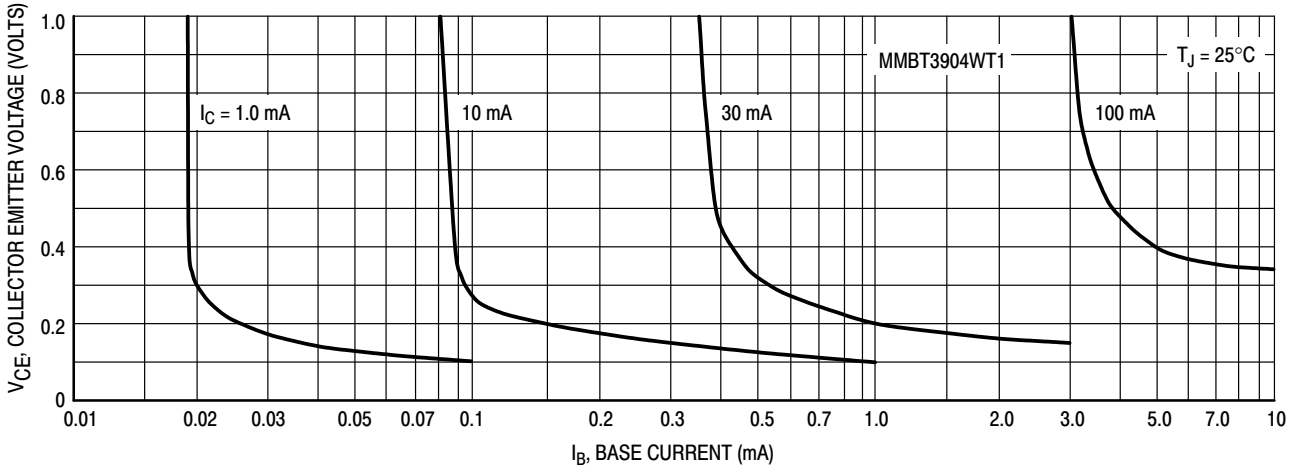


Figure 14. Collector Saturation Region

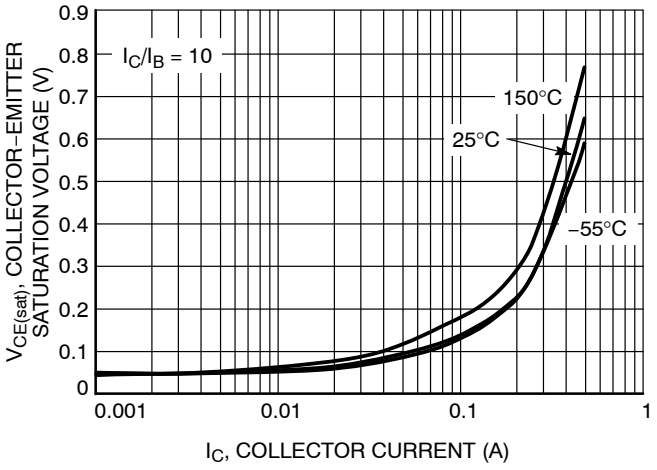


Figure 15. Collector Emitter Saturation Voltage vs. Collector Current

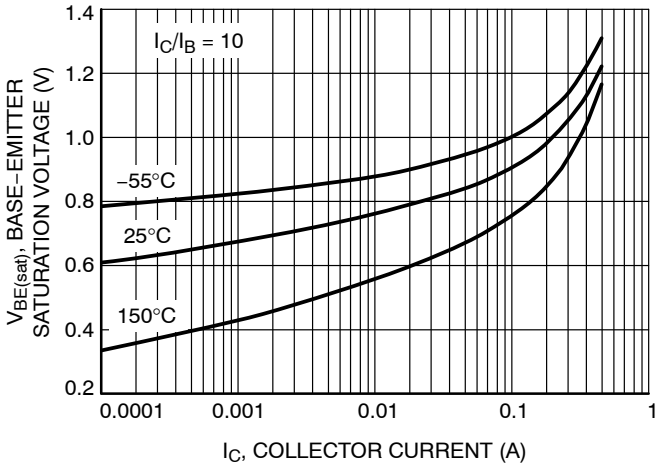


Figure 16. Base Emitter Saturation Voltage vs. Collector Current

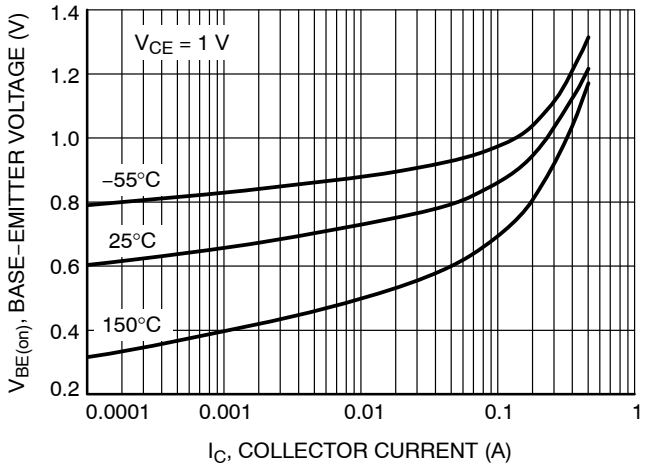


Figure 17. Base Emitter Voltage vs. Collector Current

MMBT3904WT1, SMMBT3904WT1

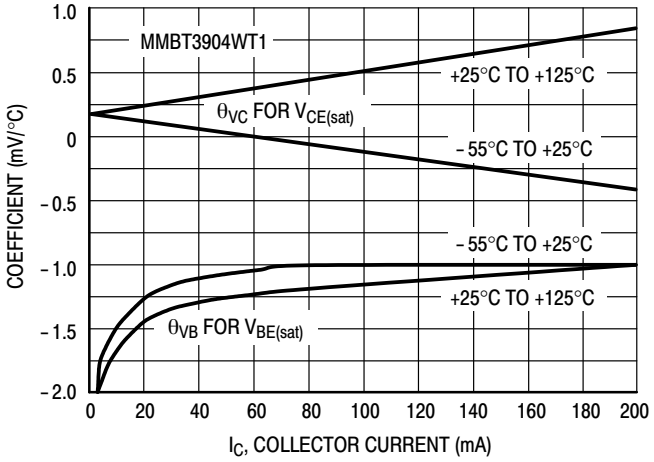


Figure 18. Temperature Coefficients

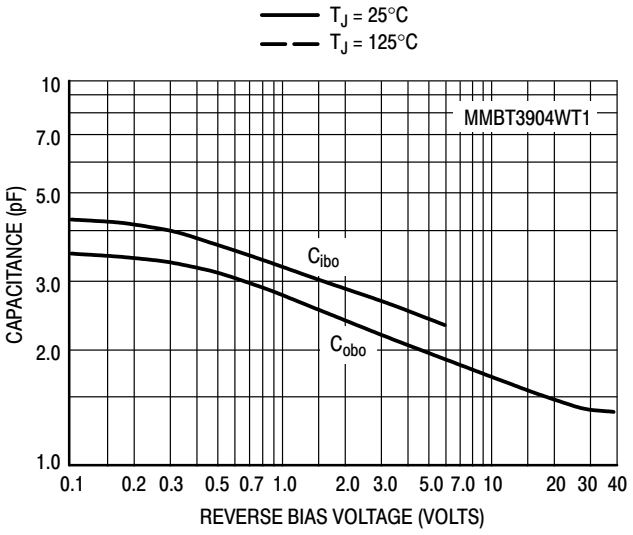


Figure 19. Capacitance

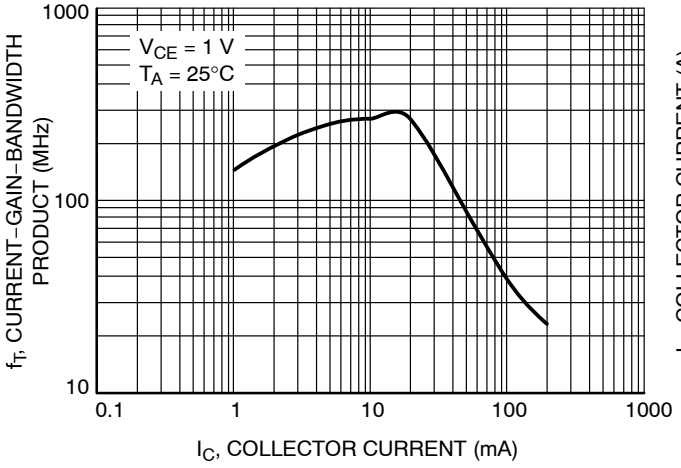


Figure 20. Current Gain Bandwidth Product vs. Collector Current

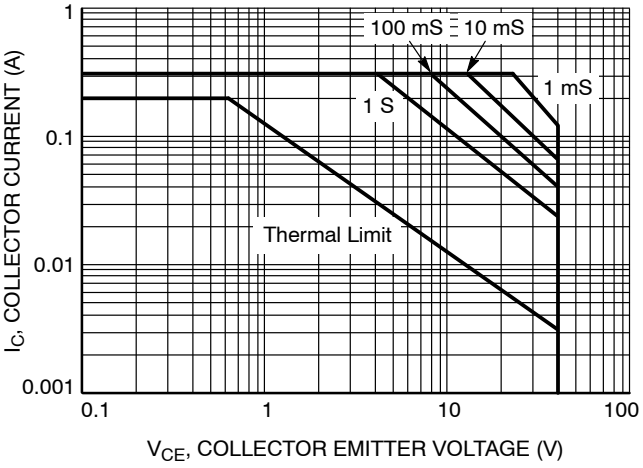
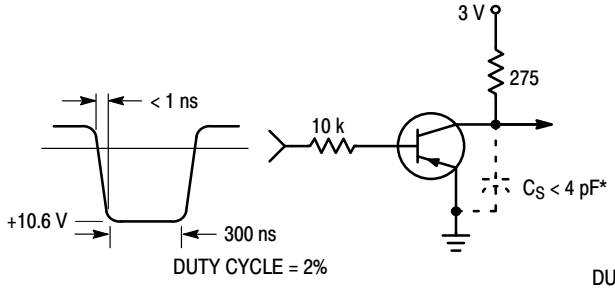
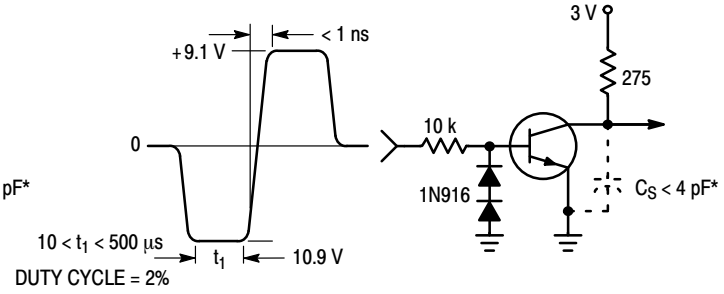


Figure 21. Safe Operating Area

MMBT3906WT1





* 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

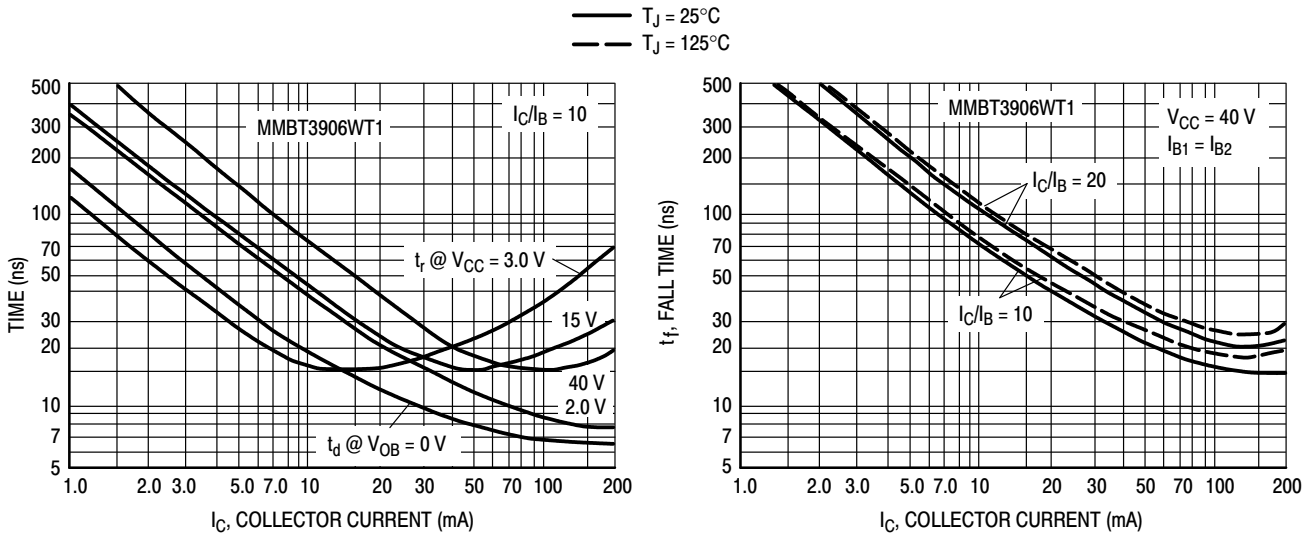
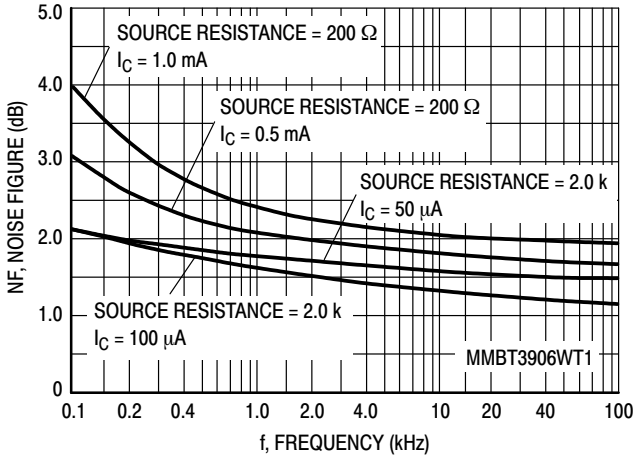


Figure 24. Turn – On Time

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)



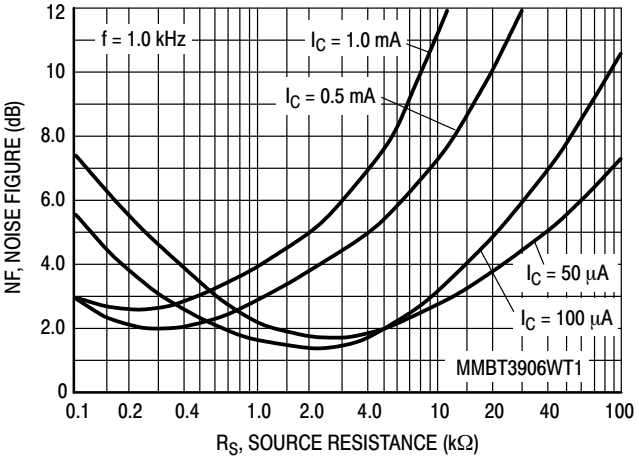


Figure 26.

Figure 27.

MMBT3906WT1

h PARAMETERS

(V_{CE} = −10 Vdc, f = 1.0 kHz, T_A = 25°C)

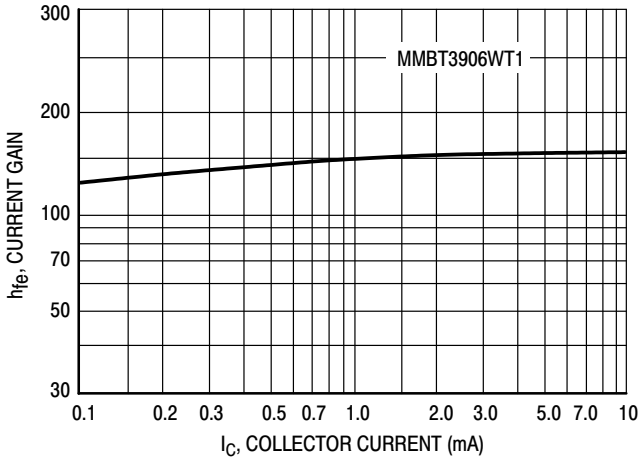


Figure 28. Current Gain

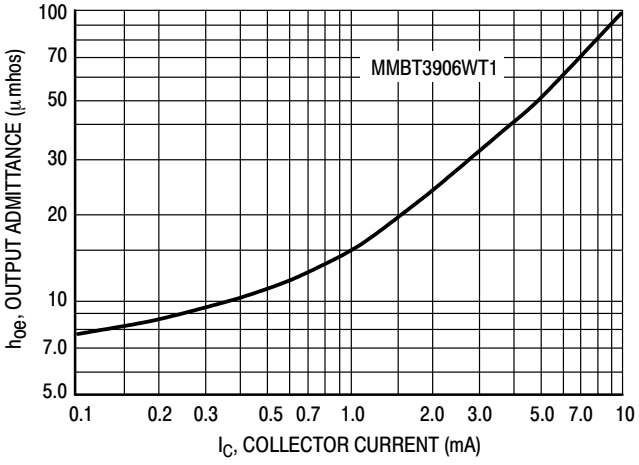


Figure 29. Output Admittance

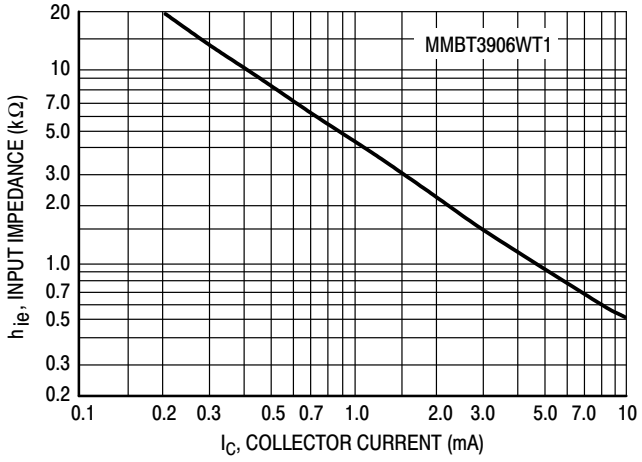


Figure 30. Input Impedance

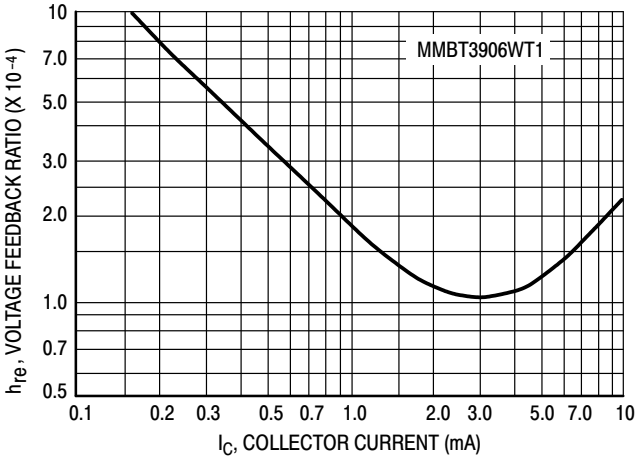


Figure 31. Voltage Feedback Ratio

STATIC CHARACTERISTICS

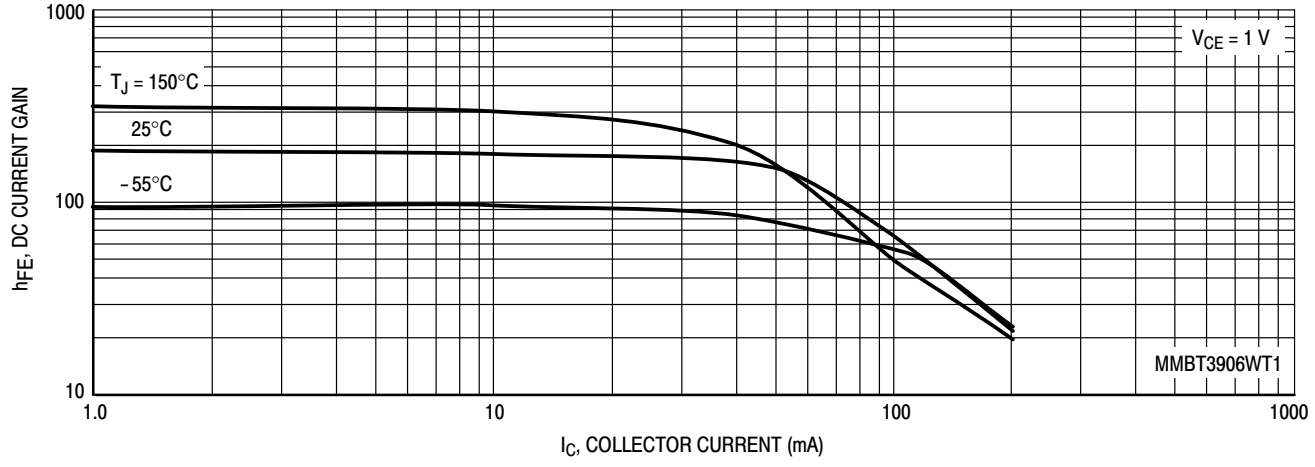


Figure 32. DC Current Gain

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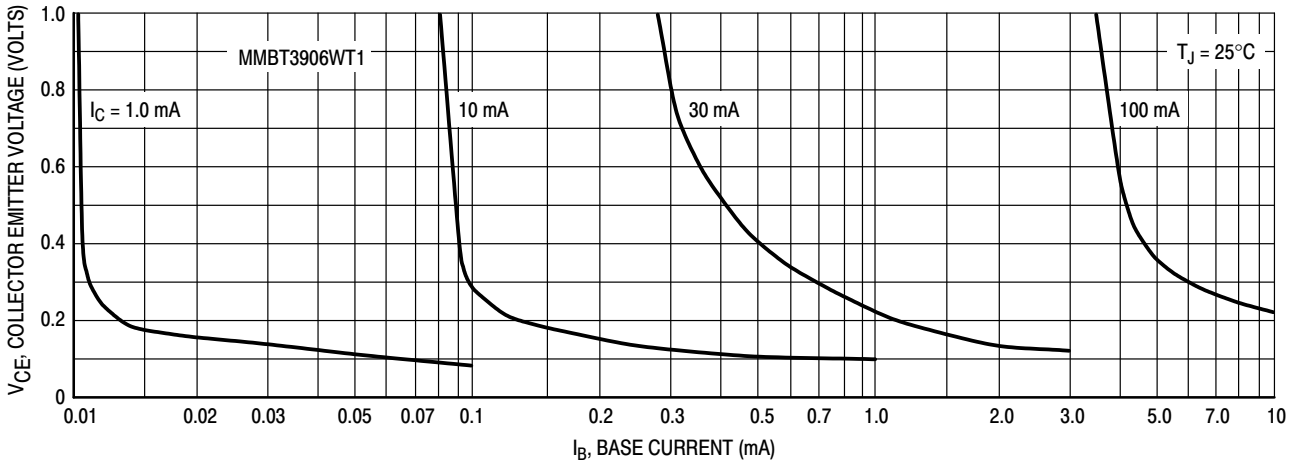

Figure 33. Collector Saturation Region

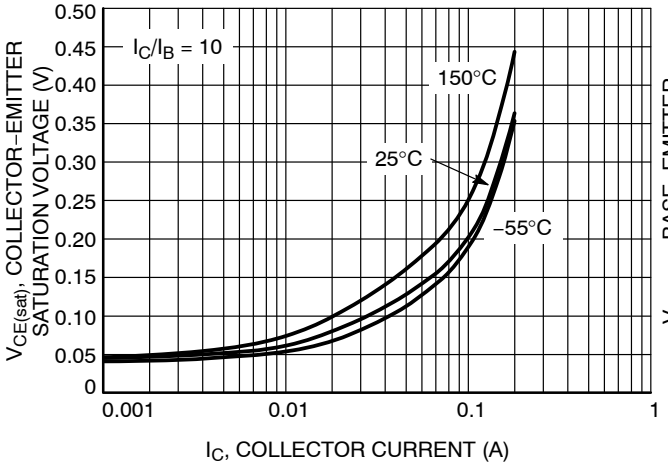

Figure 34. Collector Emitter Saturation Voltage vs. Collector Current

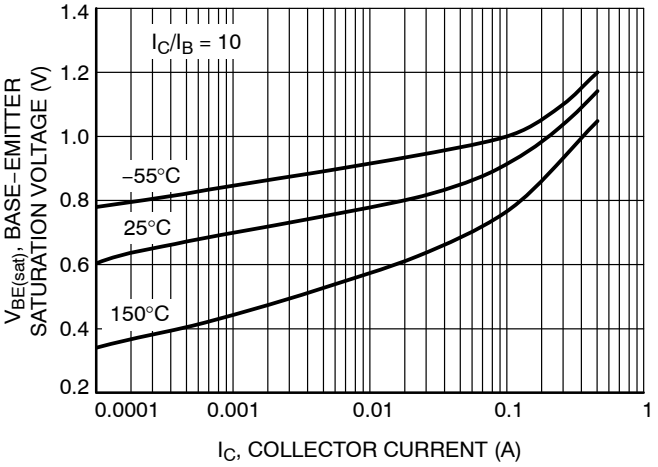

Figure 35. Base Emitter Saturation Voltage vs. Collector Current

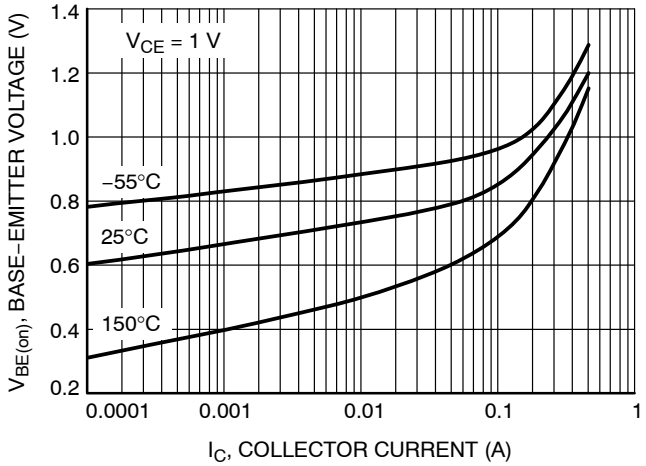

Figure 36. Base Emitter Voltage vs. Collector Current

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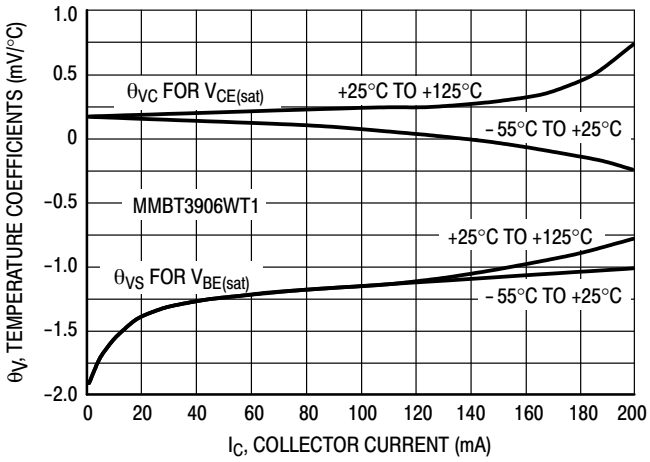


Figure 37. Temperature Coefficients

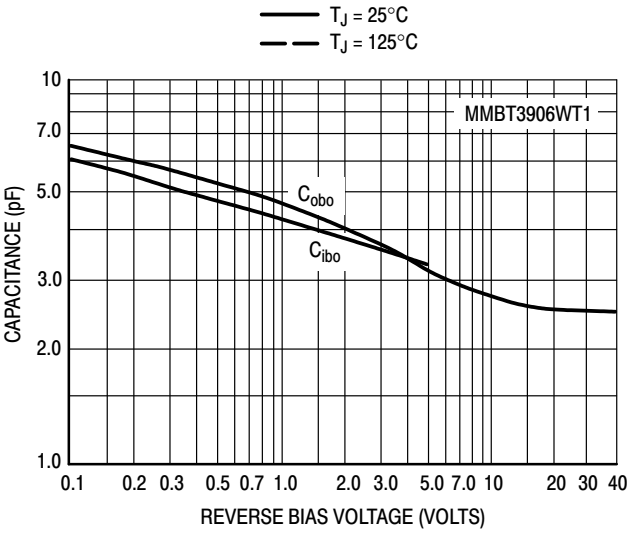


Figure 38. Capacitance

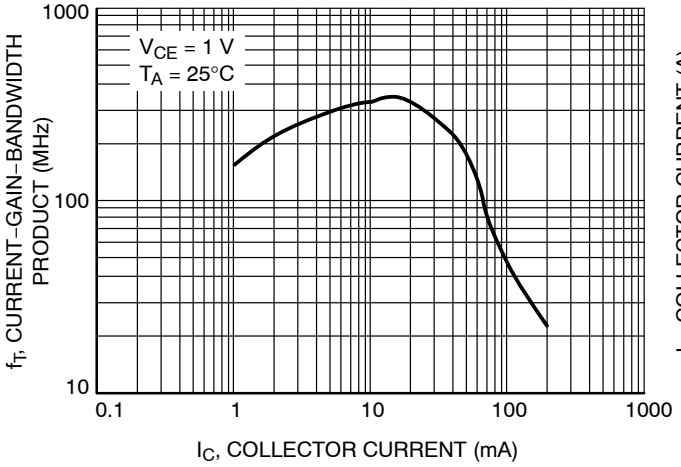


Figure 39. Current Gain Bandwidth Product vs. Collector Current

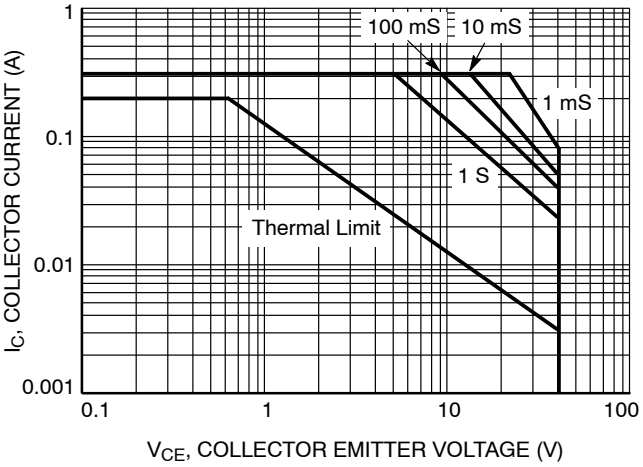
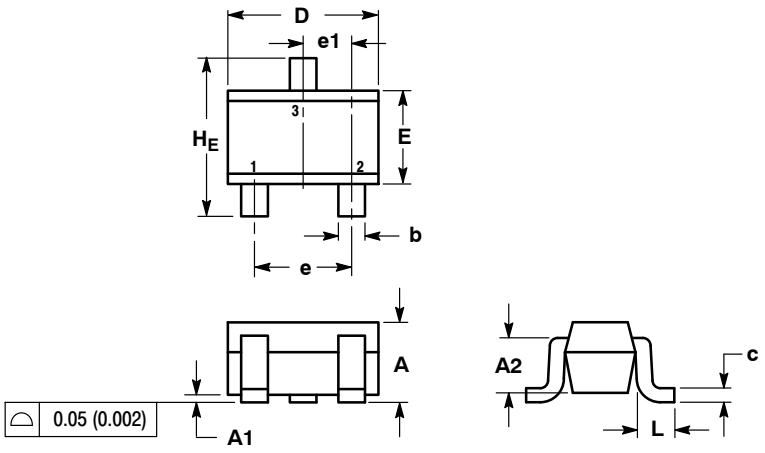


Figure 40. Safe Operating Area

PACKAGE DIMENSIONS

SC−70 (SOT−323)
CASE 419−04
ISSUE N

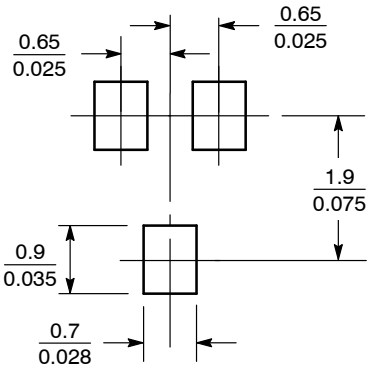


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	MILLIMETERS			INCHES		
DIM	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

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

SOLDERING FOOTPRINT*



SCALE 10:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

*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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