

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



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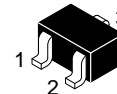
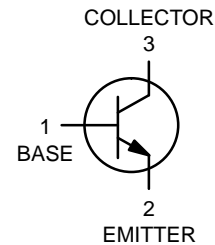
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General Purpose Transistors NPN and PNP Silicon

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

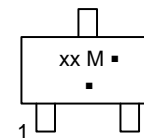
THERMAL CHARACTERISTICS

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_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 2) (I _C = 1.0 mA _{dc} , I _B = 0) (I _C = –1.0 mA _{dc} , I _B = 0)	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	V _{(BR)CEO}	40 –40	– – V _{dc}
Collector–Base Breakdown Voltage (I _C = 10 μA _{dc} , I _E = 0) (I _C = –10 μA _{dc} , I _E = 0)	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	V _{(BR)CBO}	60 –40	– – V _{dc}
Emitter–Base Breakdown Voltage (I _E = 10 μA _{dc} , I _C = 0) (I _E = –10 μA _{dc} , I _C = 0)	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	V _{(BR)EBO}	6.0 –5.0	– – V _{dc}
Base Cutoff Current (V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc}) (V _{CE} = –30 V _{dc} , V _{EB} = –3.0 V _{dc})	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	I _{BL}	– –	50 –50 nA _{dc}
Collector Cutoff Current (V _{CE} = 30 V _{dc} , V _{EB} = 3.0 V _{dc}) (V _{CE} = –30 V _{dc} , V _{EB} = –3.0 V _{dc})	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	I _{CEX}	– –	50 –50 nA _{dc}
ON CHARACTERISTICS (Note 2)				
DC Current Gain (I _C = 0.1 mA _{dc} , V _{CE} = 1.0 V _{dc}) (I _C = 1.0 mA _{dc} , V _{CE} = 1.0 V _{dc}) (I _C = 10 mA _{dc} , V _{CE} = 1.0 V _{dc}) (I _C = 50 mA _{dc} , V _{CE} = 1.0 V _{dc}) (I _C = 100 mA _{dc} , V _{CE} = 1.0 V _{dc}) (I _C = –0.1 mA _{dc} , V _{CE} = –1.0 V _{dc}) (I _C = –1.0 mA _{dc} , V _{CE} = –1.0 V _{dc}) (I _C = –10 mA _{dc} , V _{CE} = –1.0 V _{dc}) (I _C = –50 mA _{dc} , V _{CE} = –1.0 V _{dc}) (I _C = –100 mA _{dc} , V _{CE} = –1.0 V _{dc})	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	h _{FE}	40 70 100 60 30 60 80 100 60 30	– – 300 – – – – 300 – – –
Collector–Emitter Saturation Voltage (I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc}) (I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc}) (I _C = –10 mA _{dc} , I _B = –1.0 mA _{dc}) (I _C = –50 mA _{dc} , I _B = –5.0 mA _{dc})	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	V _{CE(sat)}	– – – –	0.2 0.3 –0.25 –0.4 V _{dc}
Base–Emitter Saturation Voltage (I _C = 10 mA _{dc} , I _B = 1.0 mA _{dc}) (I _C = 50 mA _{dc} , I _B = 5.0 mA _{dc}) (I _C = –10 mA _{dc} , I _B = –1.0 mA _{dc}) (I _C = –50 mA _{dc} , I _B = –5.0 mA _{dc})	MMBT3904WT1, SMMBT3904WT1 MMBT3906WT1, SMMBT3906WT1	V _{BE(sat)}	0.65 – –0.65 –	0.85 0.95 –0.85 –0.95 V _{dc}

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)

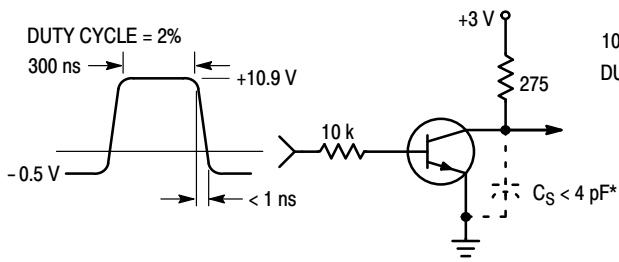
Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain – Bandwidth Product ($I_C = 10\text{ mAdc}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$) ($I_C = -10\text{ mAdc}$, $V_{CE} = -20\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	300 250	– –	MHz
Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) ($V_{CB} = -5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	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 Ω
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	μmhos
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

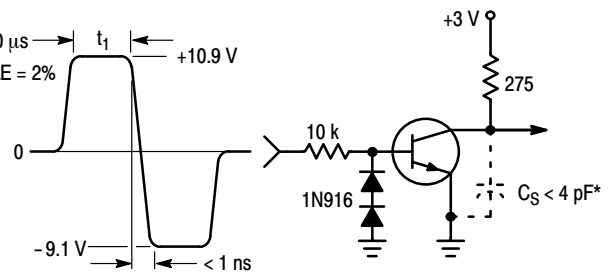
Characteristic	Condition	Symbol	Min	Max	Unit
Delay Time	($V_{CC} = 3.0\text{ Vdc}$, $V_{BE} = -0.5\text{ Vdc}$) MMBT3904WT1, SMMBT3904WT1 ($V_{CC} = -3.0\text{ Vdc}$, $V_{BE} = 0.5\text{ Vdc}$) MMBT3906WT1, SMMBT3906WT1	t_d	– –	35 35	ns
Rise Time	($I_C = 10\text{ mAdc}$, $I_{B1} = 1.0\text{ mAdc}$) MMBT3904WT1, 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



$10 < t_1 < 500 \mu\text{s}$
DUTY CYCLE = 2%



* 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

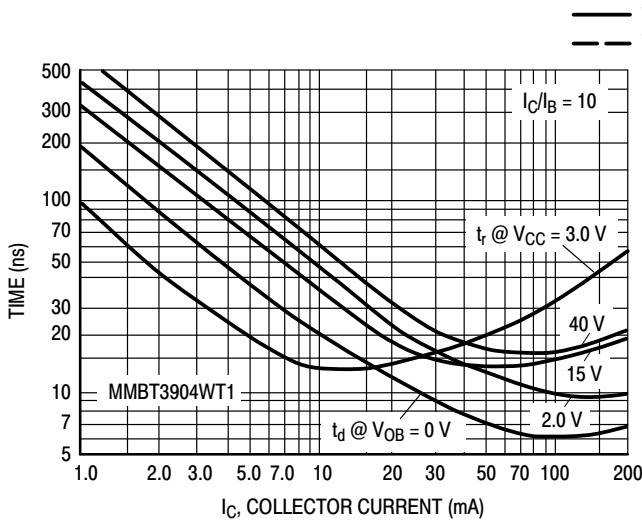


Figure 3. Turn-On Time

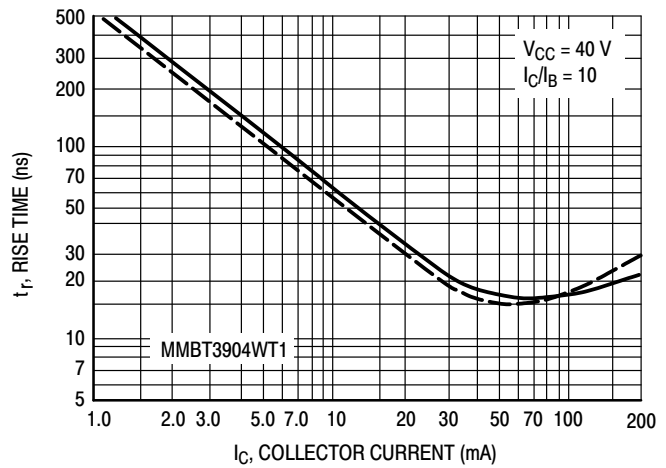


Figure 4. Rise Time

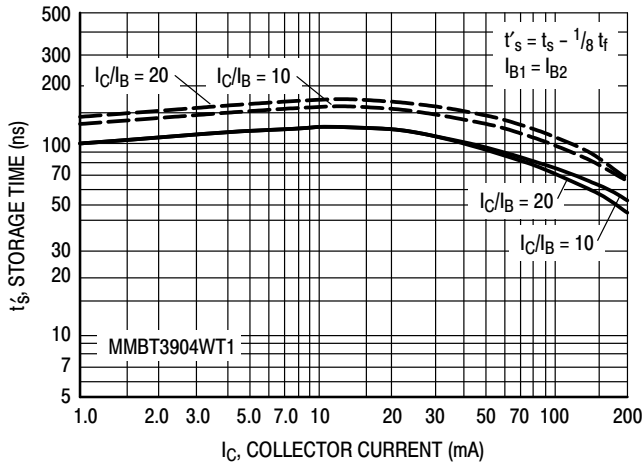


Figure 5. Storage Time

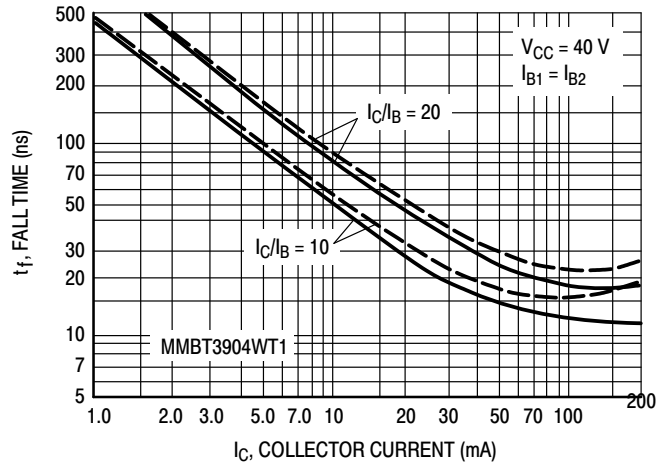


Figure 6. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

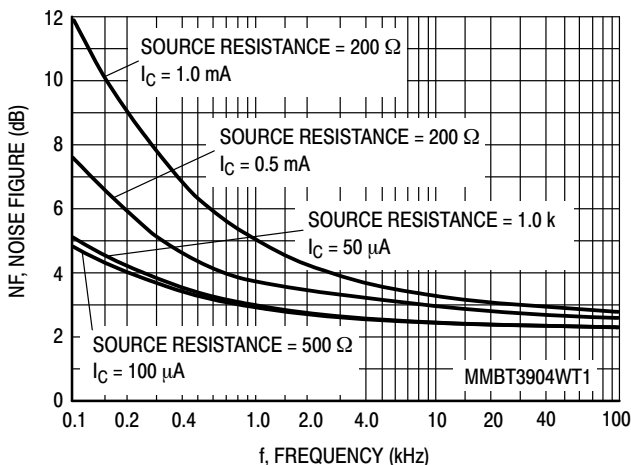


Figure 7. Noise Figure

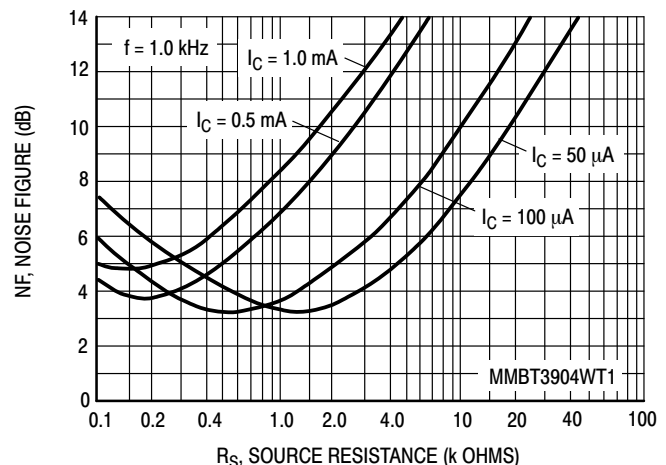


Figure 8. Noise Figure

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

MMBT3904WT1, SMMBT3904WT1

h PARAMETERS

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

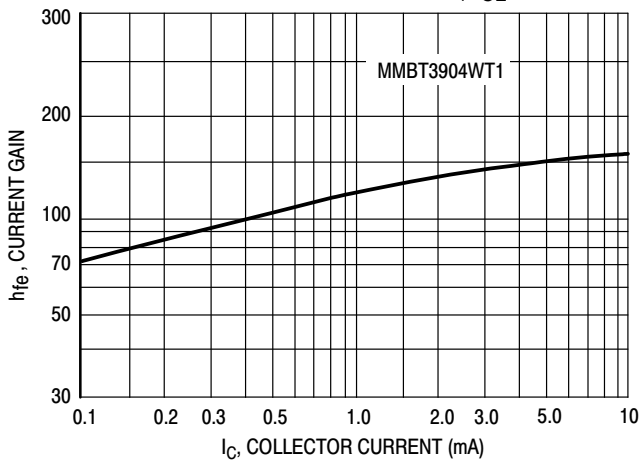


Figure 9. Current Gain

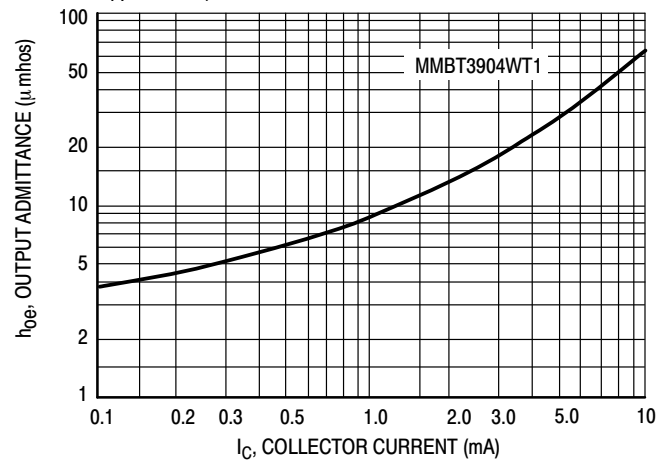


Figure 10. Output Admittance

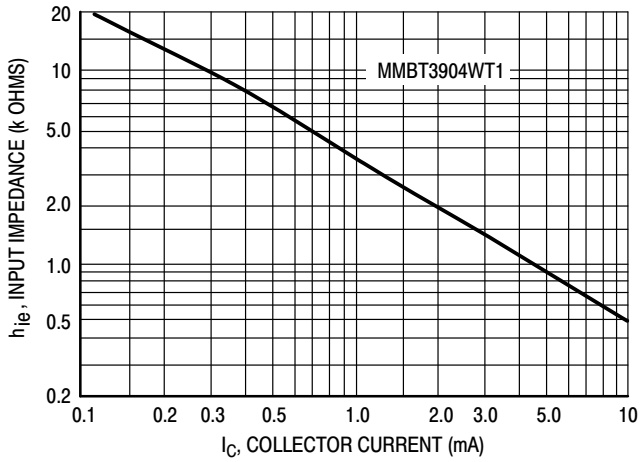


Figure 11. Input Impedance

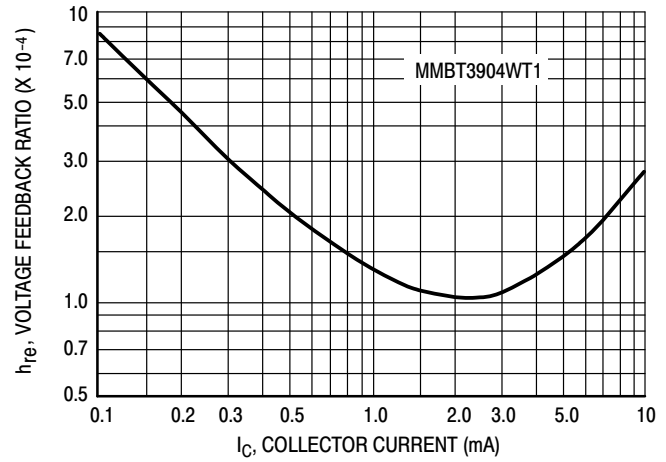


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

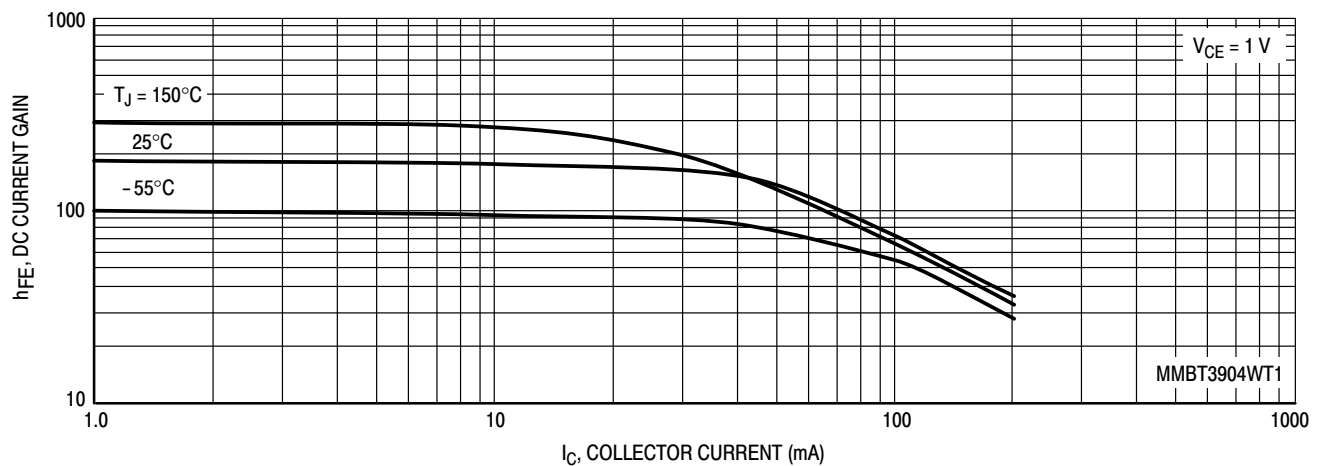


Figure 13. DC Current Gain

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

MMBT3904WT1, SMMBT3904WT1

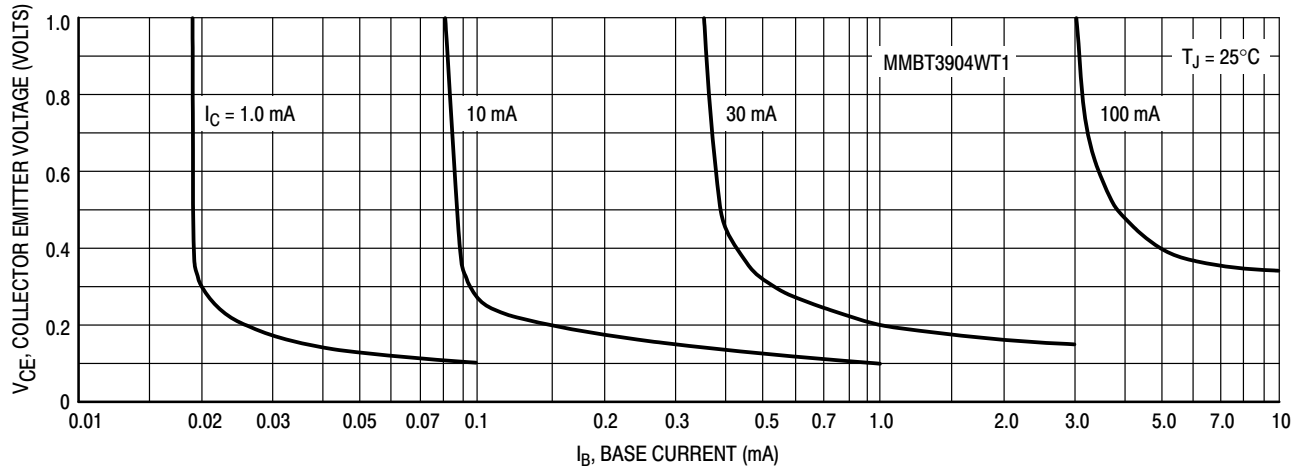


Figure 14. Collector Saturation Region

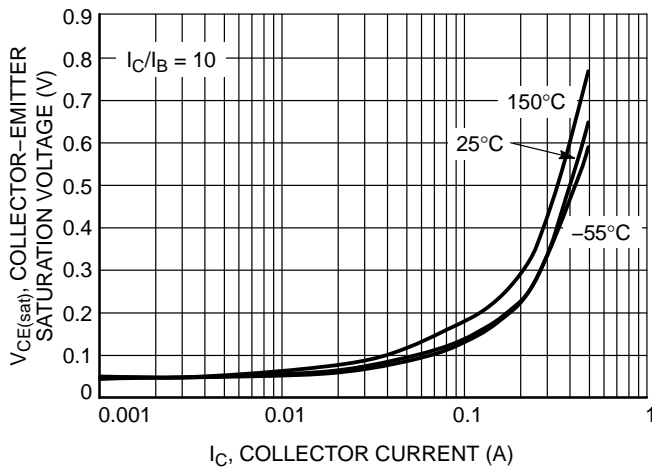


Figure 15. Collector-Emitter Saturation Voltage vs. Collector Current

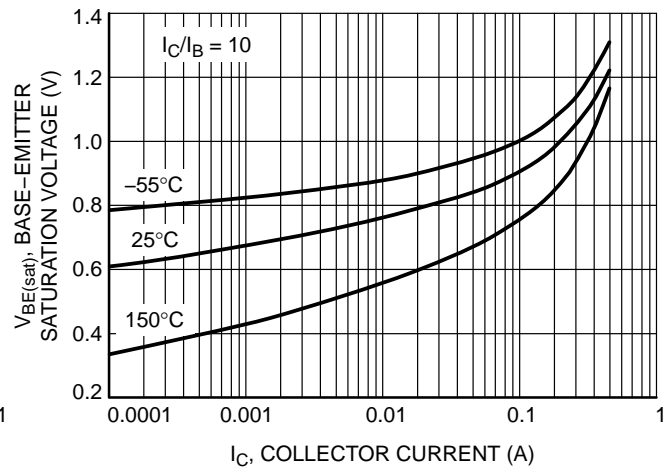


Figure 16. Base-Emitter Saturation Voltage vs. Collector Current

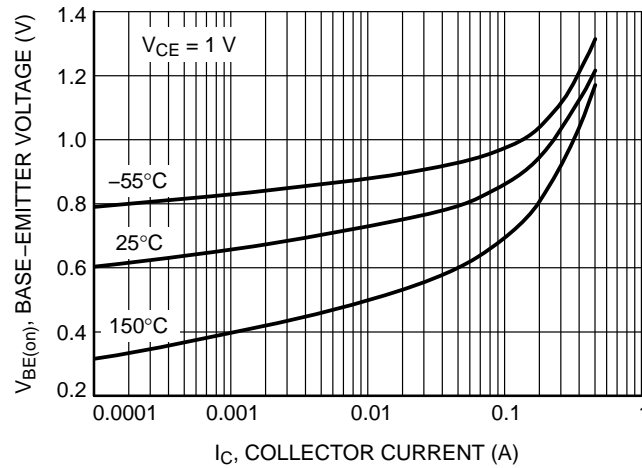


Figure 17. Base-Emitter Voltage vs. Collector Current

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

MMBT3904WT1, SMMBT3904WT1

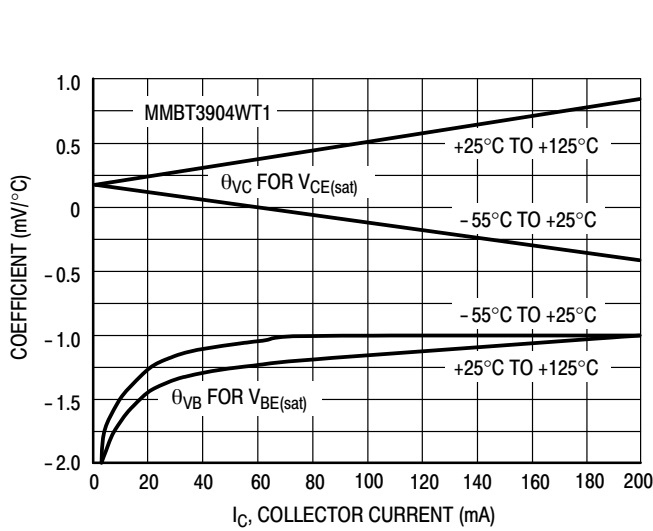


Figure 18. Temperature Coefficients

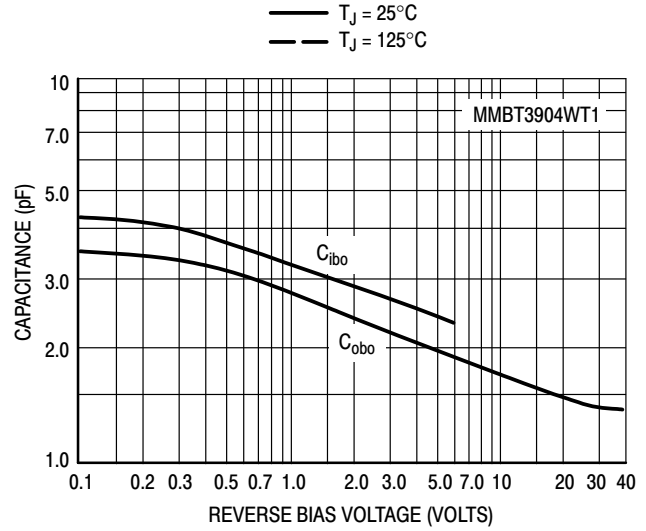


Figure 19. Capacitance

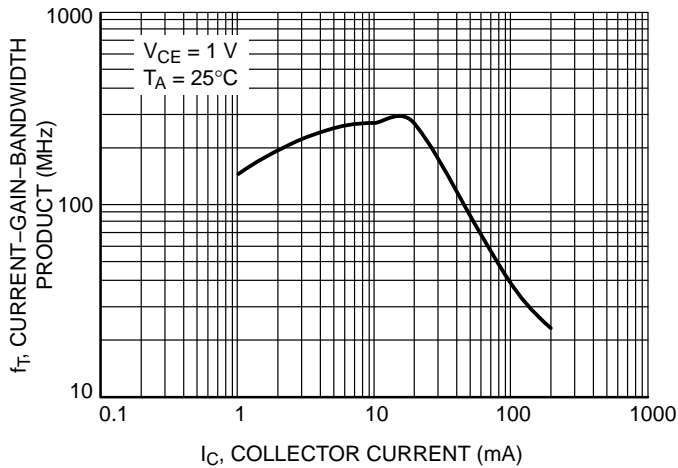


Figure 20. Current Gain Bandwidth Product vs. Collector Current

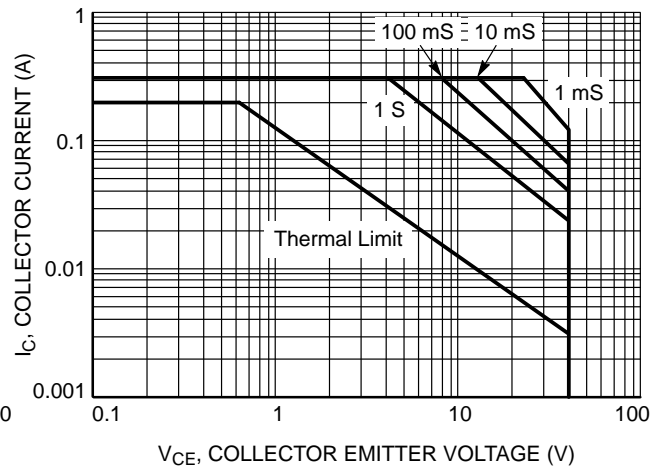


Figure 21. Safe Operating Area

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

MMBT3906WT1, SMMBT3906WT1

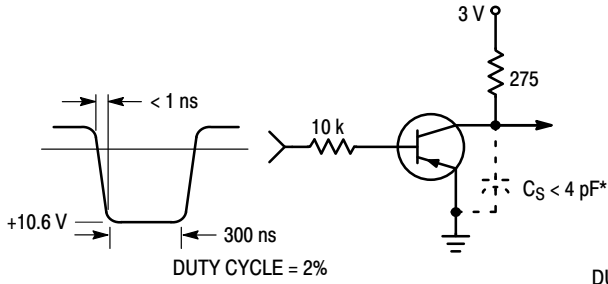


Figure 22. Delay and Rise Time Equivalent Test Circuit

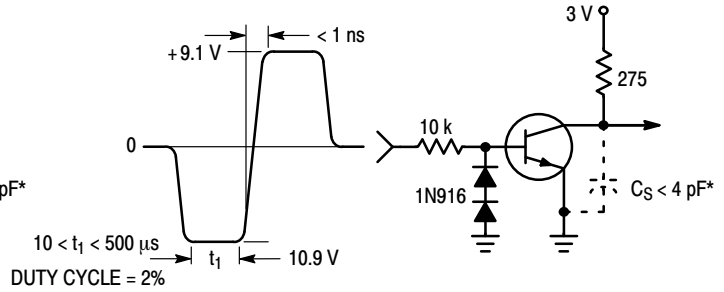


Figure 23. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

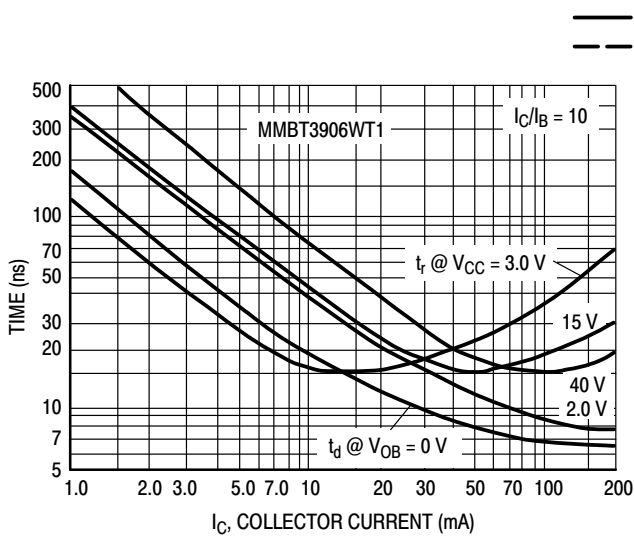


Figure 24. Turn-On Time

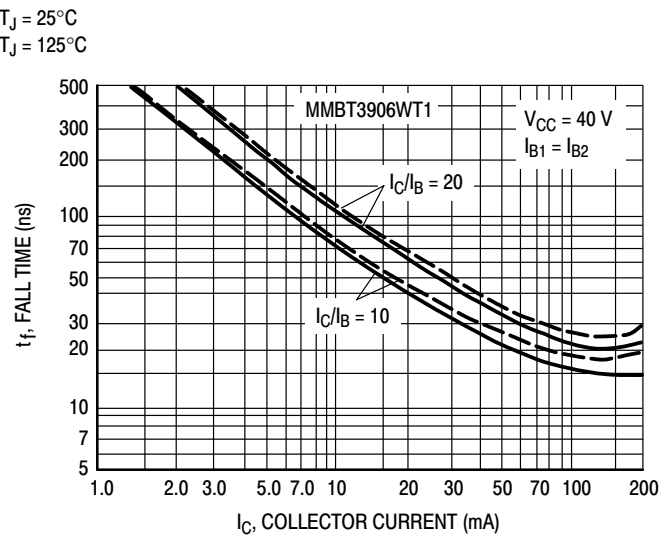


Figure 25. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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

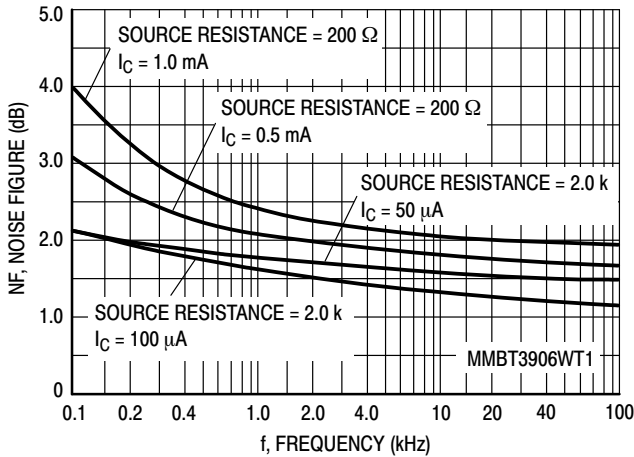


Figure 26.

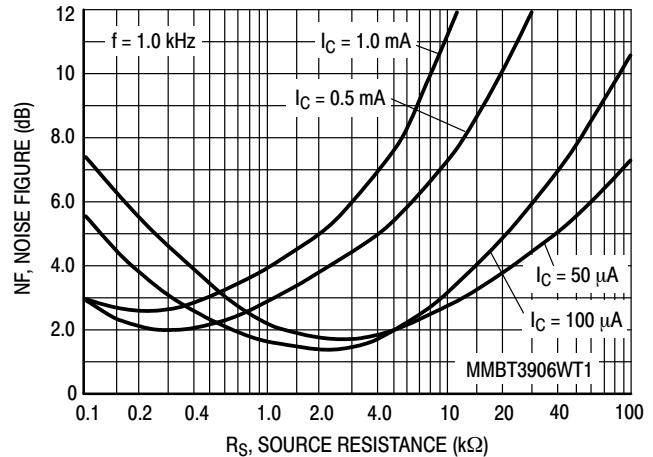


Figure 27.

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

MMBT3906WT1, SMMBT3906WT1

h PARAMETERS

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

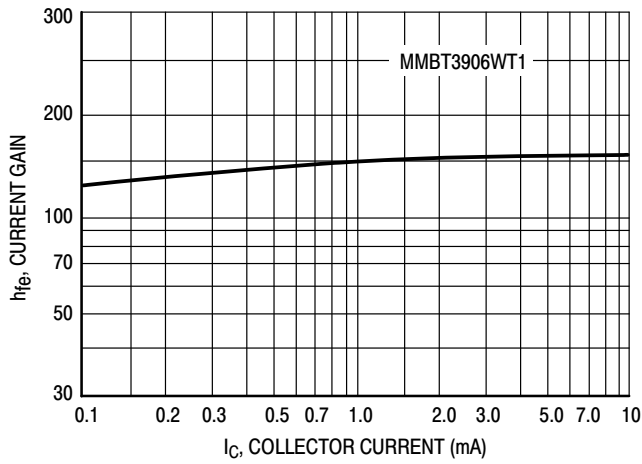


Figure 28. Current Gain

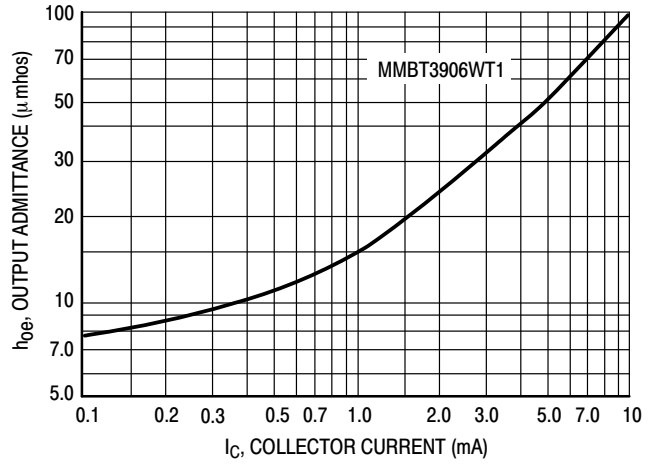


Figure 29. Output Admittance

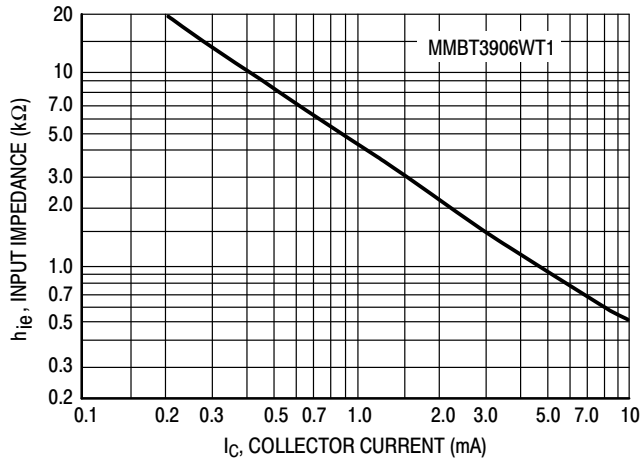


Figure 30. Input Impedance

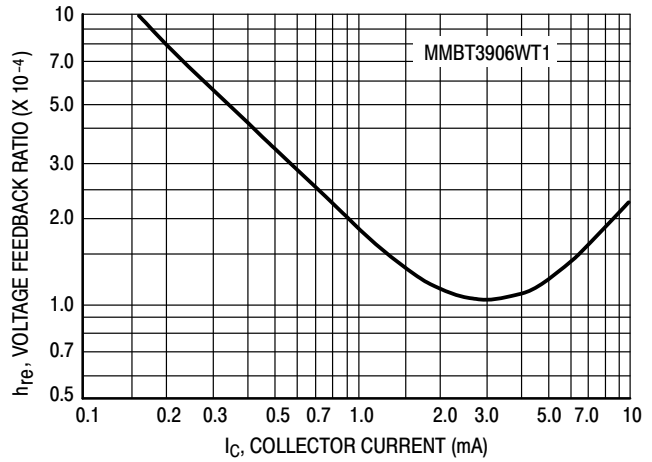


Figure 31. Voltage Feedback Ratio

STATIC CHARACTERISTICS

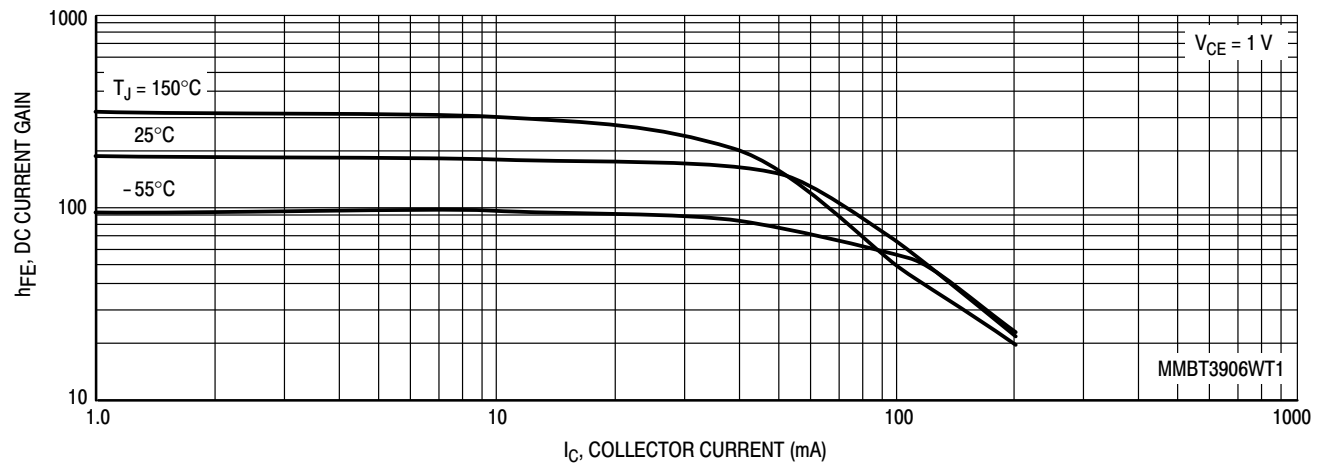


Figure 32. DC Current Gain

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

MMBT3906WT1, SMMBT3906WT1

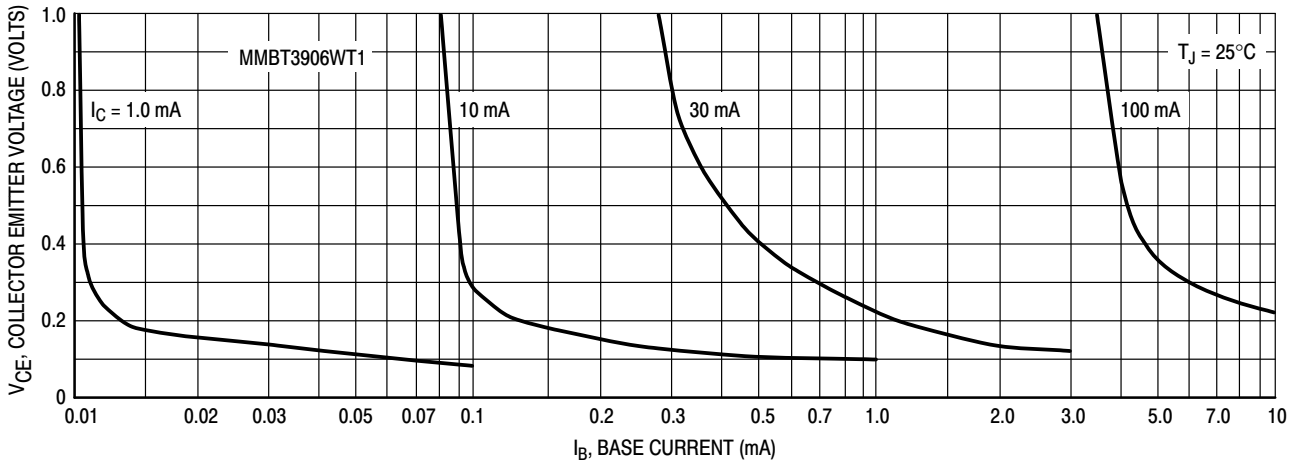


Figure 33. Collector Saturation Region

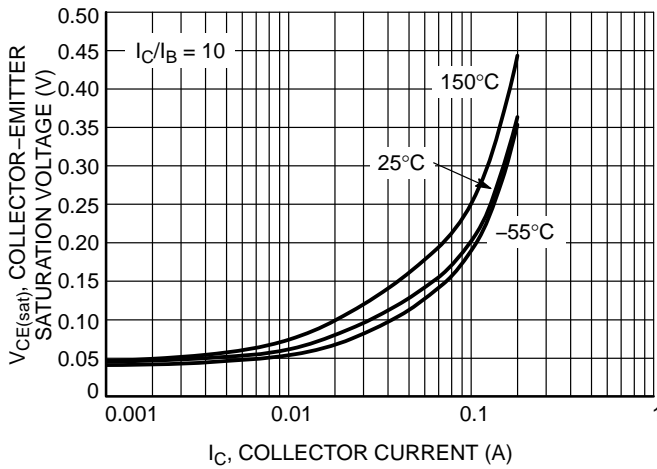


Figure 34. Collector Emitter Saturation Voltage vs. Collector Current

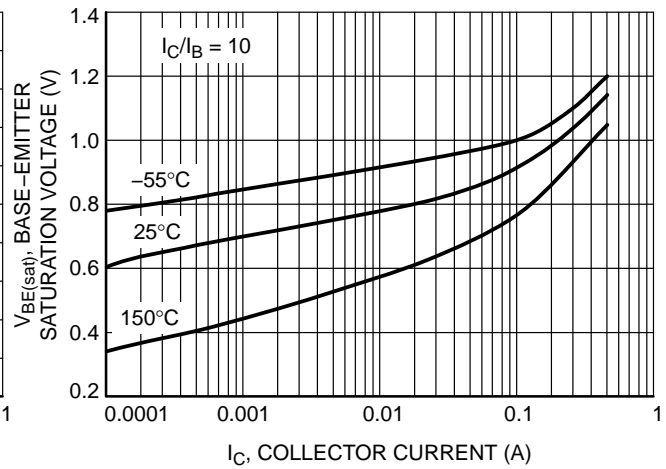


Figure 35. Base Emitter Saturation Voltage vs. Collector Current

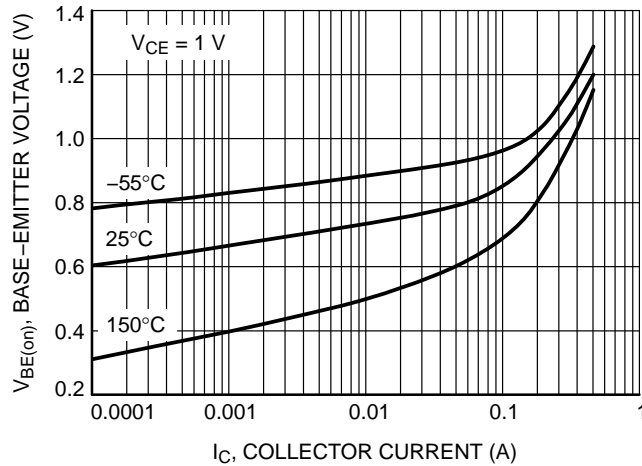


Figure 36. Base Emitter Voltage vs. Collector Current

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

MMBT3906WT1, SMMBT3906WT1

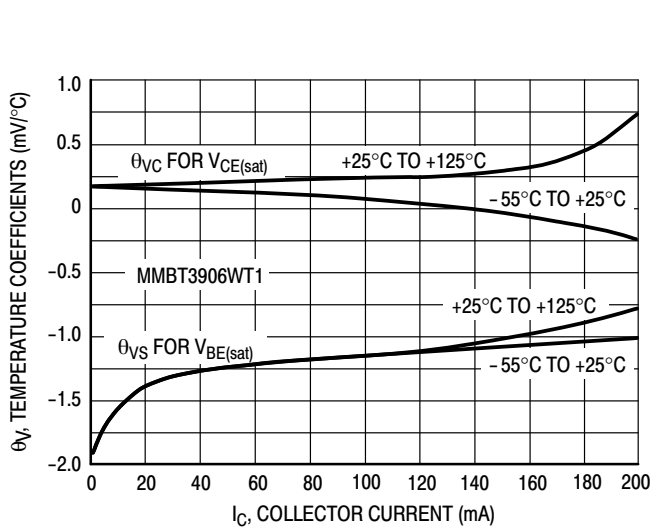


Figure 37. Temperature Coefficients

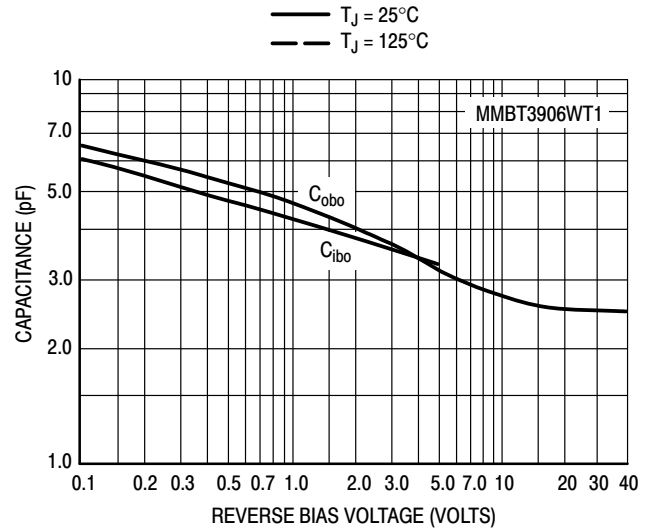


Figure 38. Capacitance

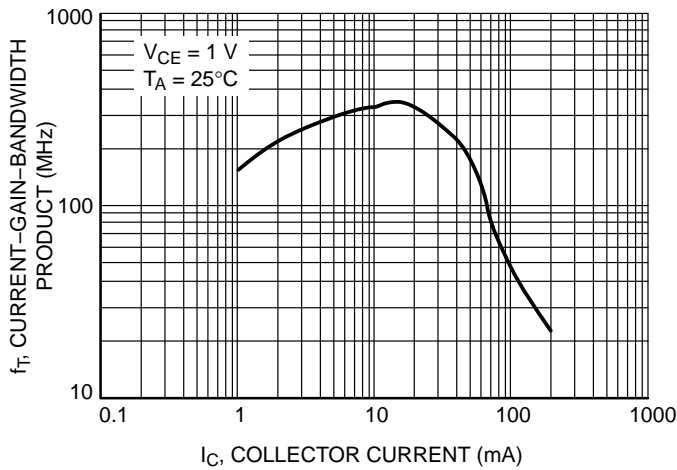


Figure 39. Current Gain Bandwidth Product vs. Collector Current

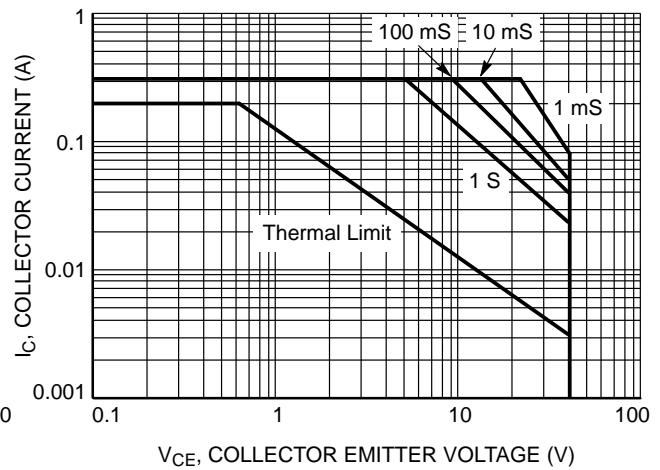
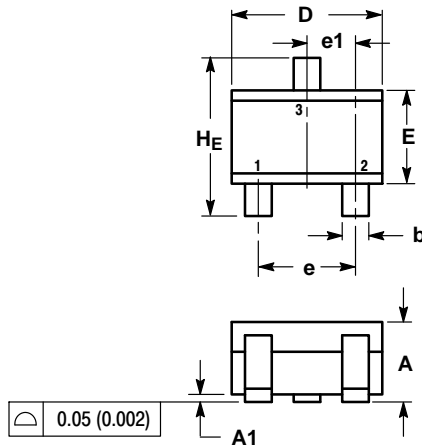


Figure 40. Safe Operating Area

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

PACKAGE DIMENSIONS

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



NOTES:

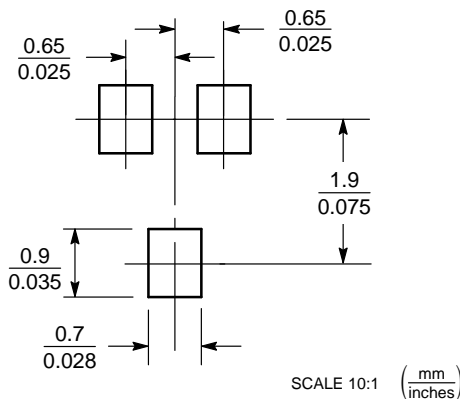
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

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

STYLE 3:

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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