

MMBT3904WT1, 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

- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

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	$^\circ\text{C/W}$
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	$^\circ\text{C}$

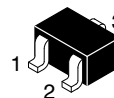
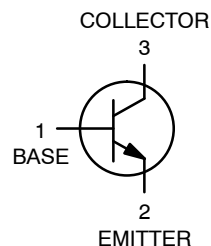
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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



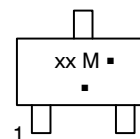
ON Semiconductor®

<http://onsemi.com>



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†
MMBT3904WT1G	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.

MMBT3904WT1, NPN MMBT3906WT1, 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, I _B = 0) (I _C = -1.0 mA, I _B = 0)	MMBT3904WT1 MMBT3906WT1	V _{(BR)CEO}	40 -40	- -	Vdc
Collector – Base Breakdown Voltage (I _C = 10 µA, I _E = 0) (I _C = -10 µA, I _E = 0)	MMBT3904WT1 MMBT3906WT1	V _{(BR)CBO}	60 -40	- -	Vdc
Emitter – Base Breakdown Voltage (I _E = 10 µA, I _C = 0) (I _E = -10 µA, I _C = 0)	MMBT3904WT1 MMBT3906WT1	V _{(BR)EBO}	6.0 -5.0	- -	Vdc
Base Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc) (V _{CE} = -30 Vdc, V _{EB} = -3.0 Vdc)	MMBT3904WT1 MMBT3906WT1	I _{BL}	- -	50 -50	nAdc
Collector Cutoff Current (V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc) (V _{CE} = -30 Vdc, V _{EB} = -3.0 Vdc)	MMBT3904WT1 MMBT3906WT1	I _{CEX}	- -	50 -50	nAdc
ON CHARACTERISTICS (Note 2)					
DC Current Gain (I _C = 0.1 mA, V _{CE} = 1.0 Vdc) (I _C = 1.0 mA, V _{CE} = 1.0 Vdc) (I _C = 10 mA, V _{CE} = 1.0 Vdc) (I _C = 50 mA, V _{CE} = 1.0 Vdc) (I _C = 100 mA, V _{CE} = 1.0 Vdc) (I _C = -0.1 mA, V _{CE} = -1.0 Vdc) (I _C = -1.0 mA, V _{CE} = -1.0 Vdc) (I _C = -10 mA, V _{CE} = -1.0 Vdc) (I _C = -50 mA, V _{CE} = -1.0 Vdc) (I _C = -100 mA, V _{CE} = -1.0 Vdc)	MMBT3904WT1 MMBT3906WT1 	h _{FE}	40 70 100 60 30 60 80 100 60 30	- - 300 - - - - 300 - -	-
Collector – Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 50 mA, I _B = 5.0 mA) (I _C = -10 mA, I _B = -1.0 mA) (I _C = -50 mA, I _B = -5.0 mA)	MMBT3904WT1 MMBT3906WT1	V _{CE(sat)}	- - - -	0.2 0.3 -0.25 -0.4	Vdc
Base – Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 50 mA, I _B = 5.0 mA) (I _C = -10 mA, I _B = -1.0 mA) (I _C = -50 mA, I _B = -5.0 mA)	MMBT3904WT1 MMBT3906WT1	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%.

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

SWITCHING CHARACTERISTICS

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

MMBT3904WT1

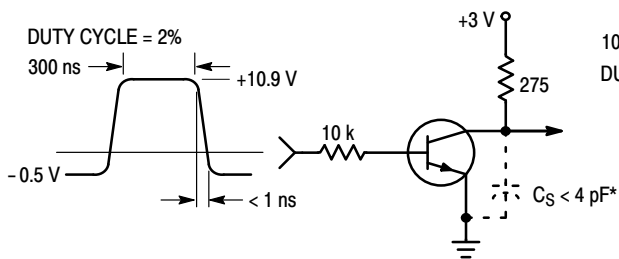


Figure 1. Delay and Rise Time
Equivalent Test Circuit

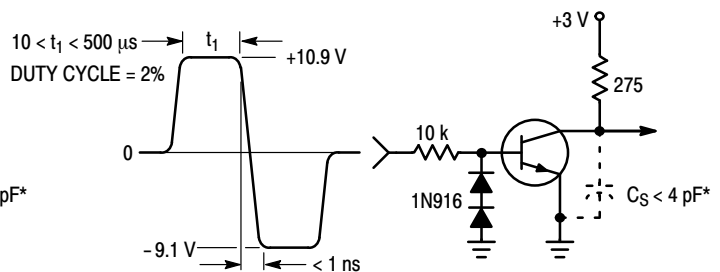


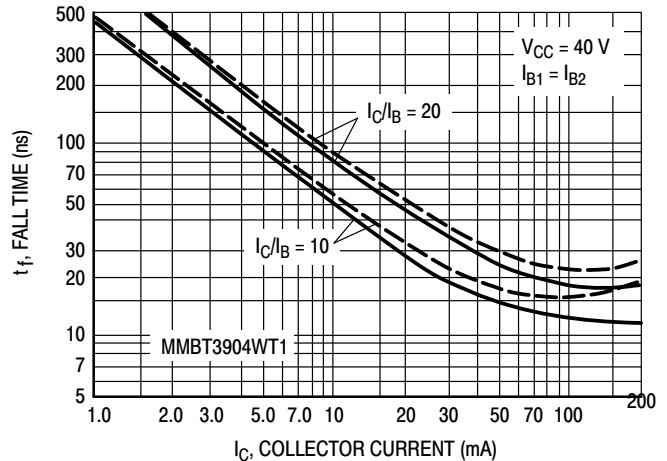
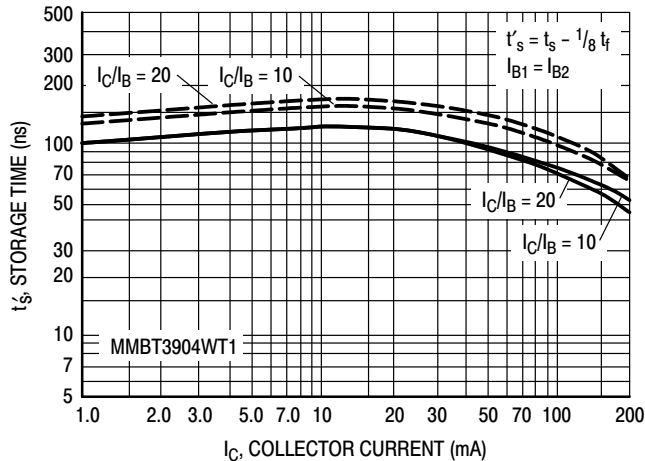
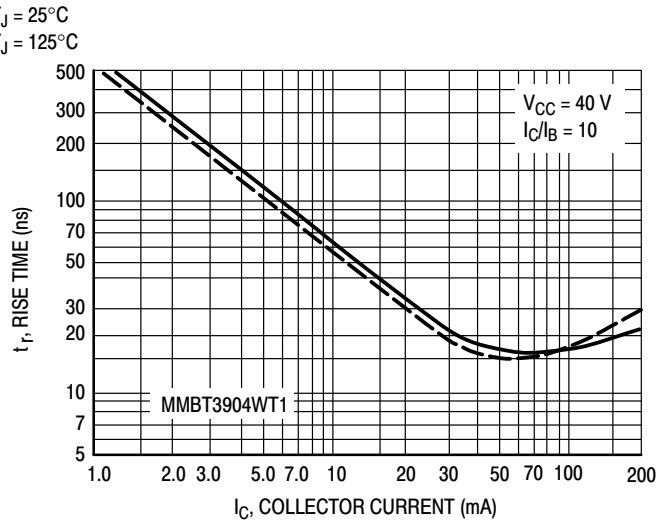
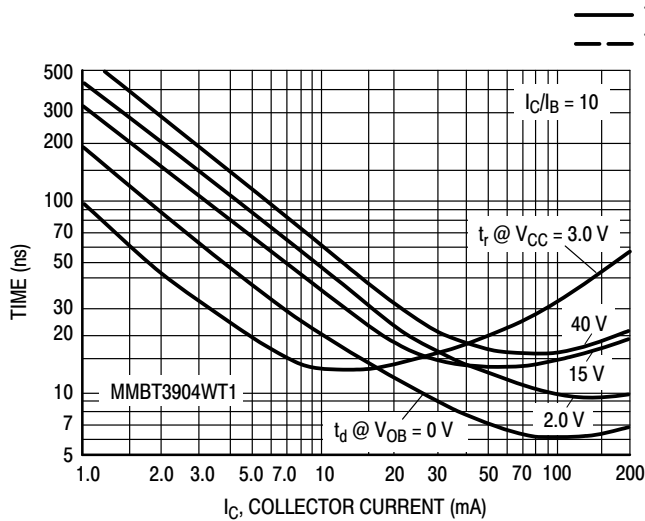
Figure 2. Storage and Fall Time
Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

MMBT3904WT1, NPN MMBT3906WT1, PNP

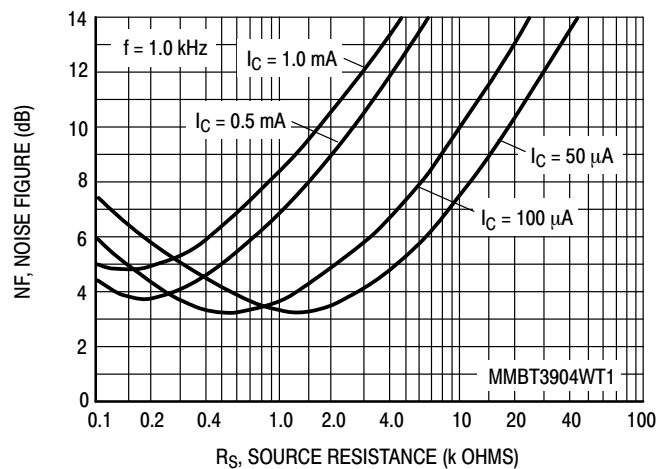
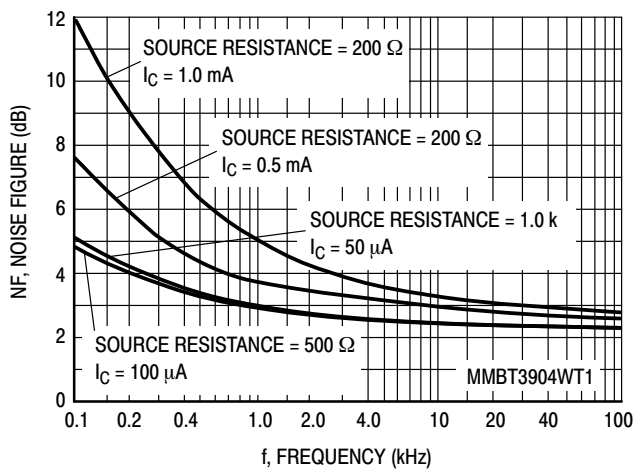
MMBT3904WT1

TYPICAL TRANSIENT CHARACTERISTICS



TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

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



MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3904WT1

h PARAMETERS

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

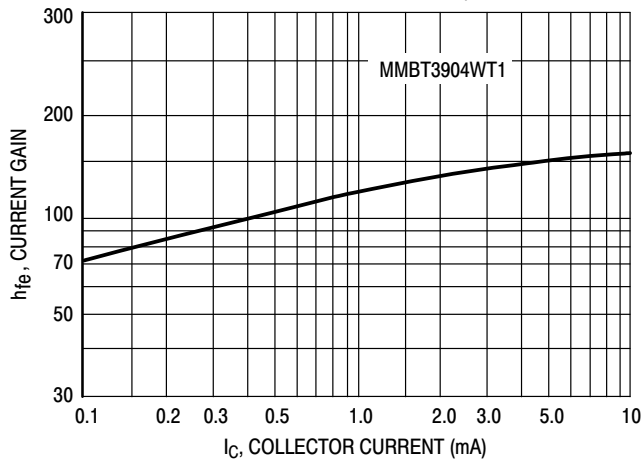


Figure 9. Current Gain

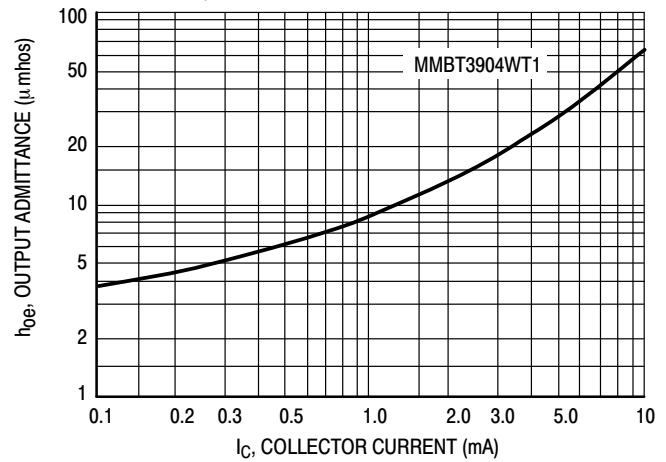


Figure 10. Output Admittance

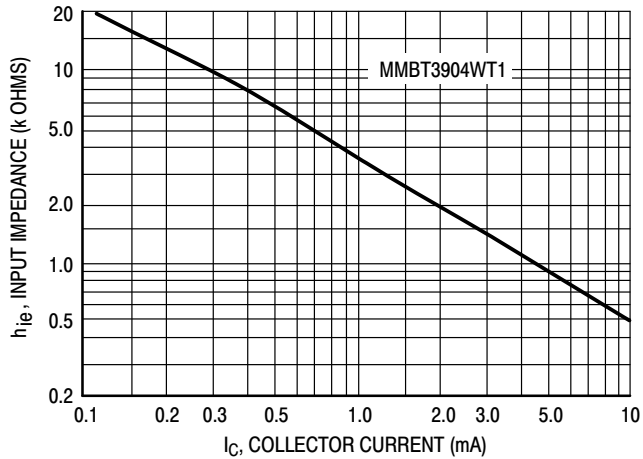


Figure 11. Input Impedance

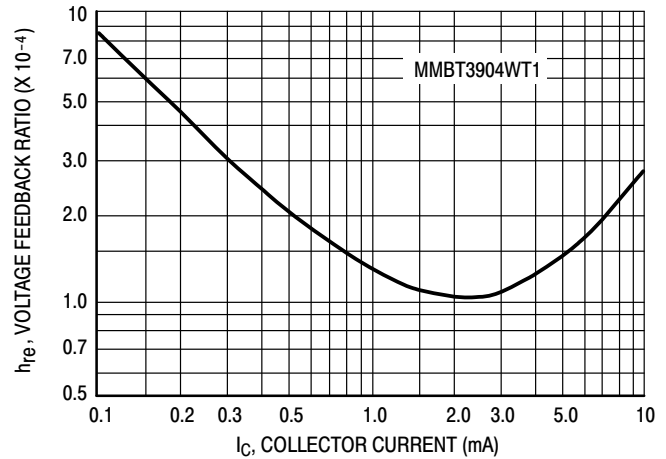


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

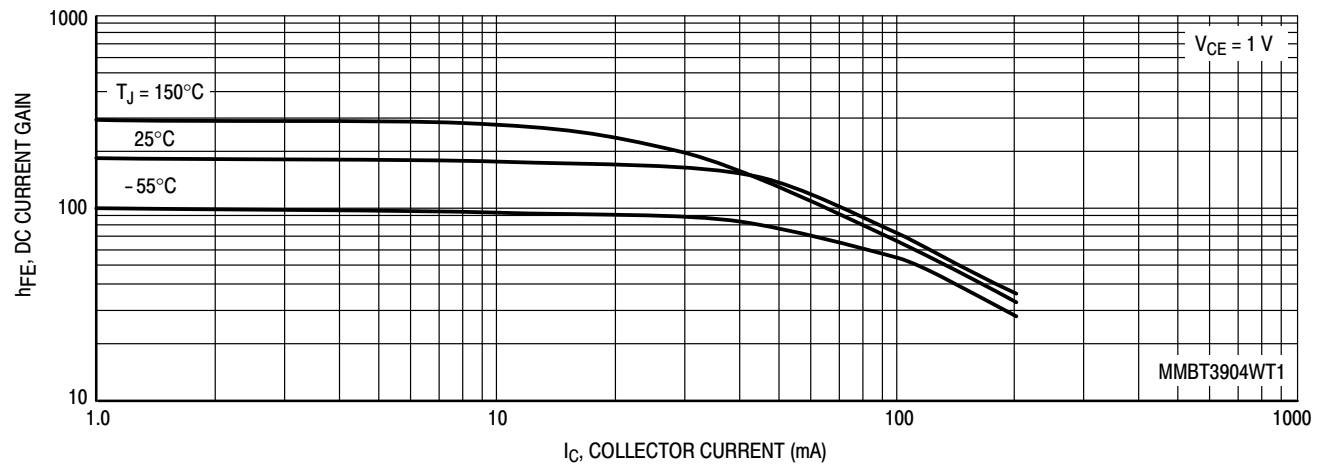


Figure 13. DC Current Gain

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3904WT1

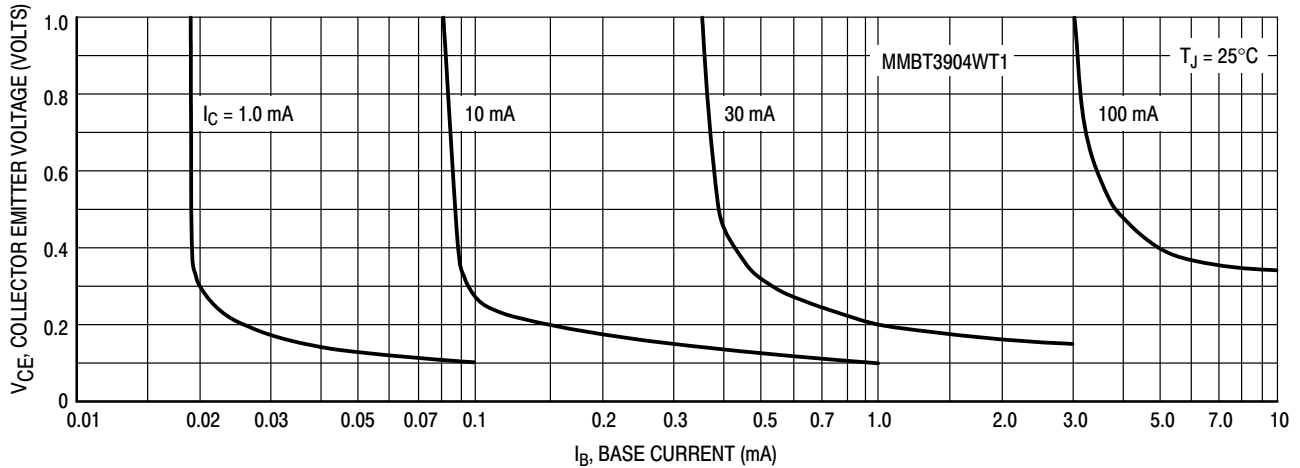


Figure 14. Collector Saturation Region

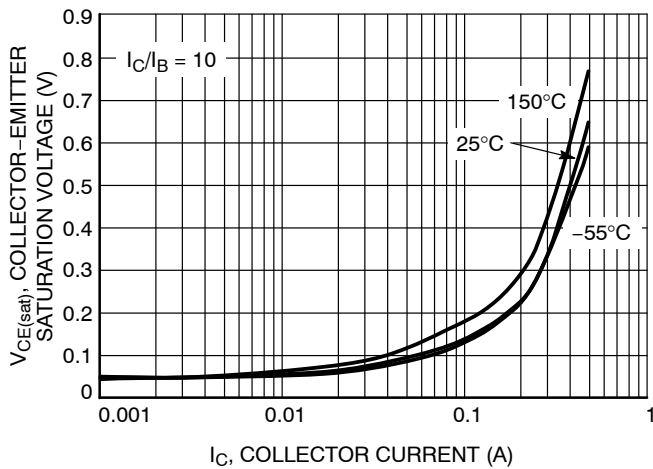


Figure 15. Collector Emitter Saturation Voltage vs. Collector Current

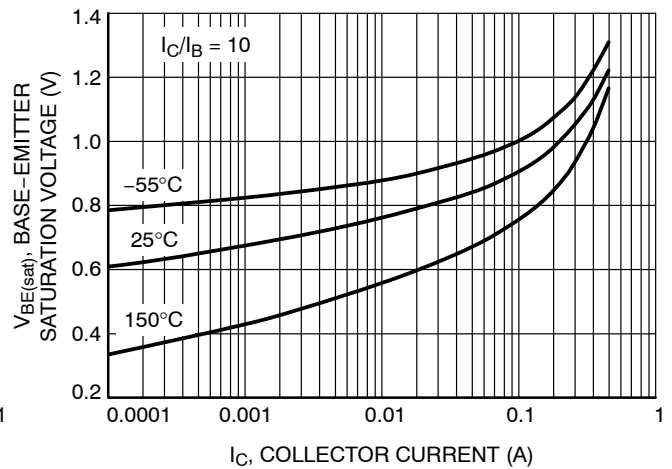


Figure 16. Base Emitter Saturation Voltage vs. Collector Current

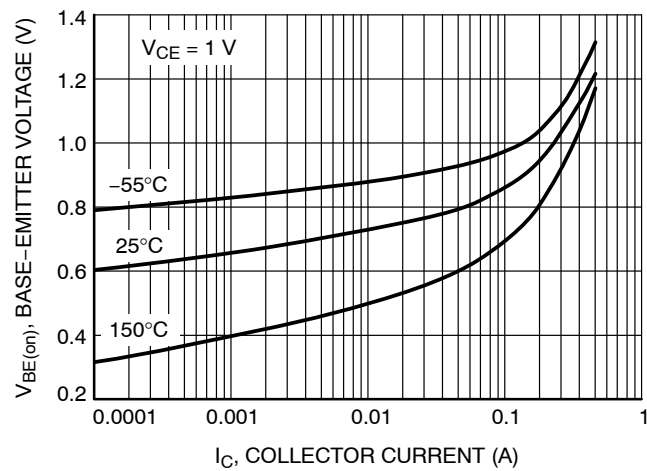


Figure 17. Base Emitter Voltage vs. Collector Current

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3904WT1

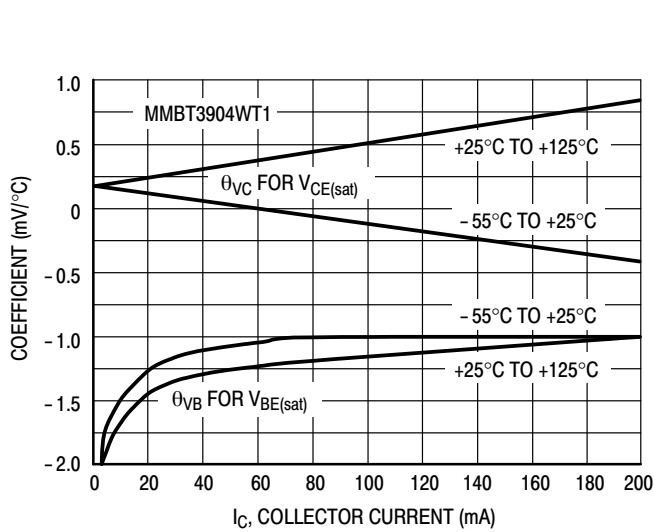


Figure 18. Temperature Coefficients

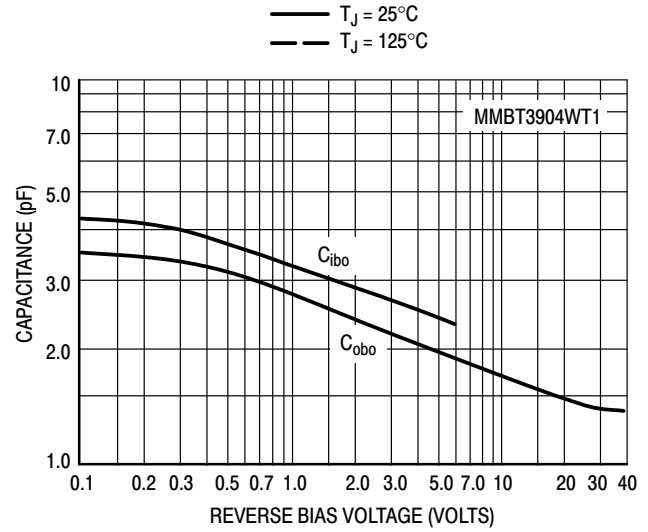


Figure 19. Capacitance

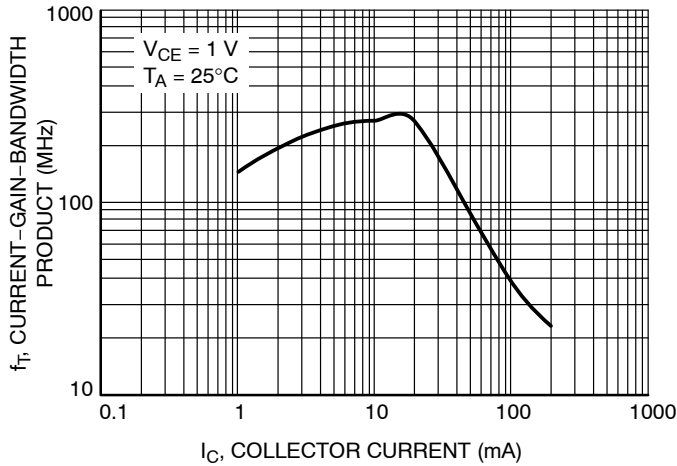


Figure 20. Current Gain Bandwidth Product vs. Collector Current

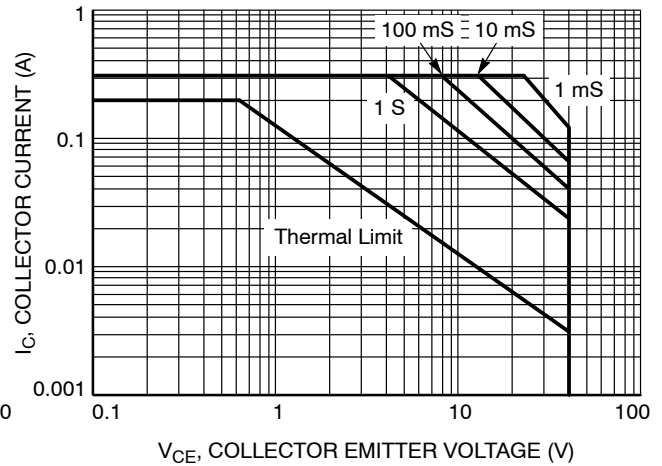


Figure 21. Safe Operating Area

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3906WT1

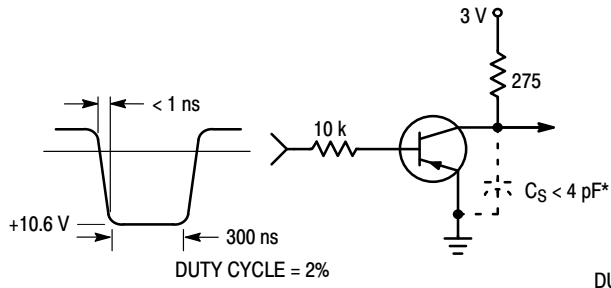


Figure 22. Delay and Rise Time
Equivalent Test Circuit

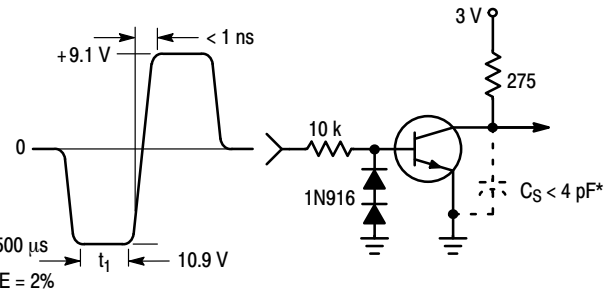


Figure 23. Storage and Fall Time
Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

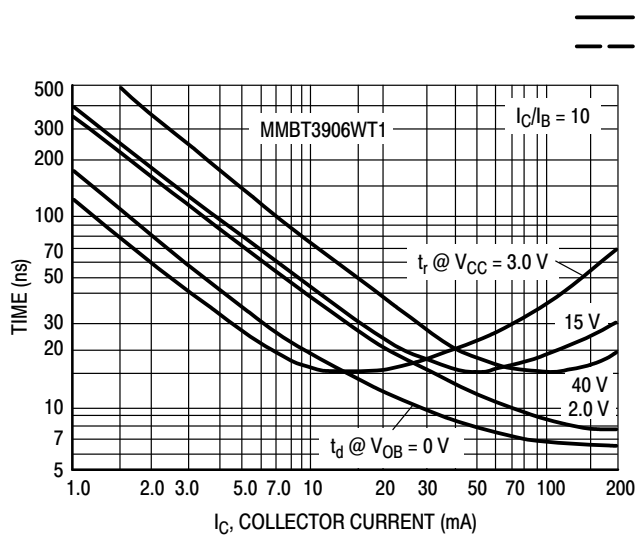


Figure 24. Turn-On Time

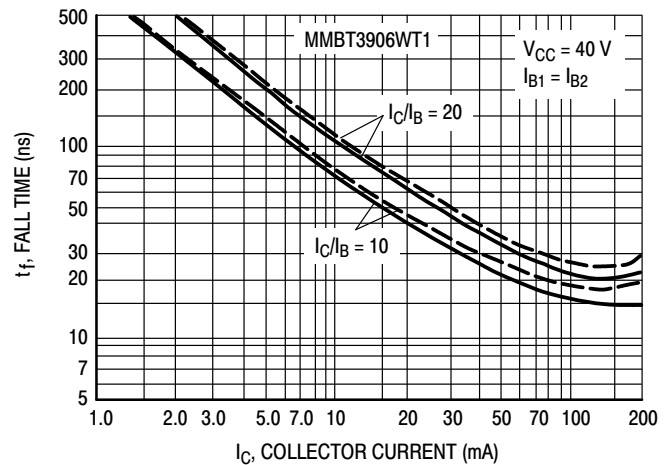


Figure 25. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

(VCE = -5.0 Vdc, TA = 25°C, Bandwidth = 1.0 Hz)

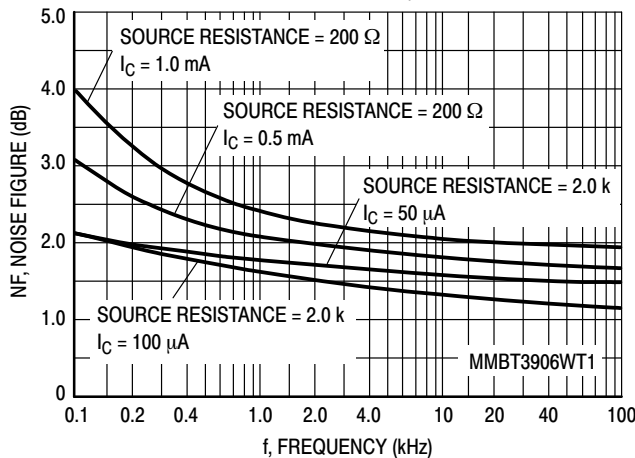


Figure 26.

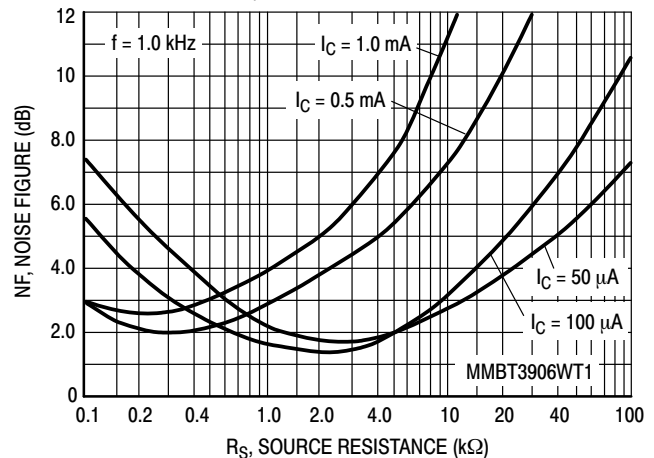


Figure 27.

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3906WT1

h PARAMETERS

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

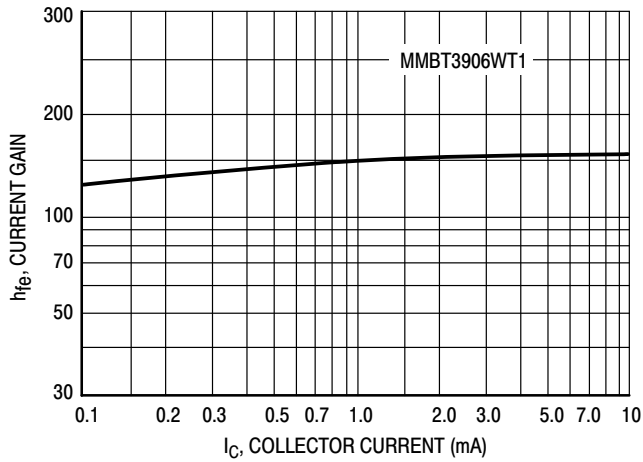


Figure 28. Current Gain

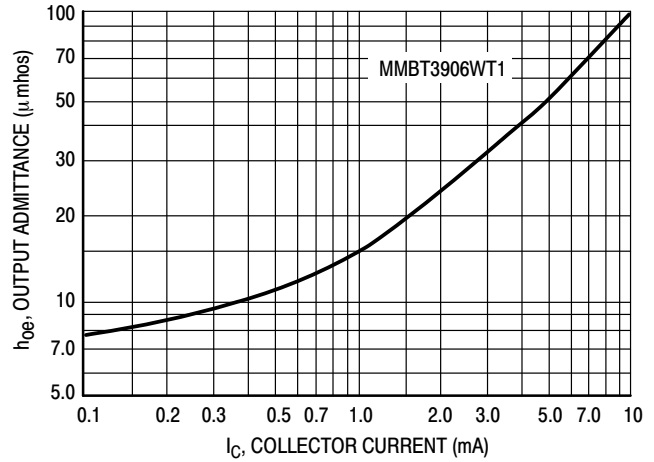


Figure 29. Output Admittance

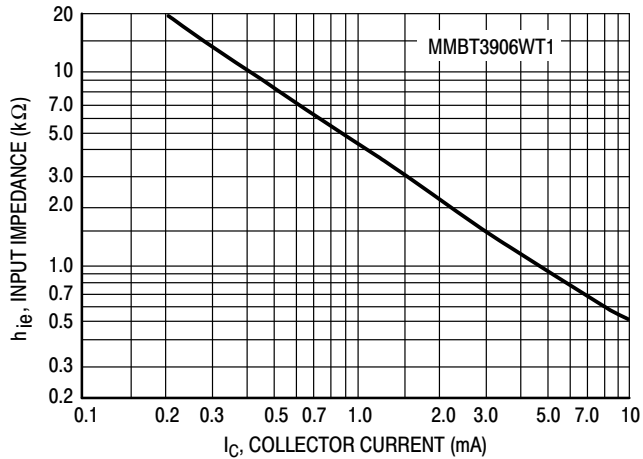


Figure 30. Input Impedance

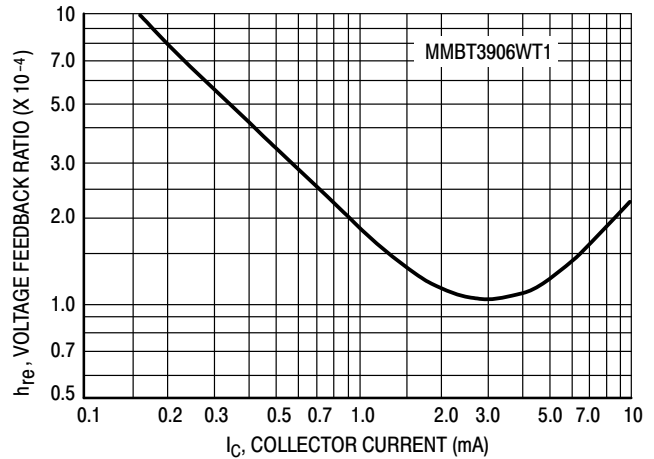


Figure 31. Voltage Feedback Ratio

STATIC CHARACTERISTICS

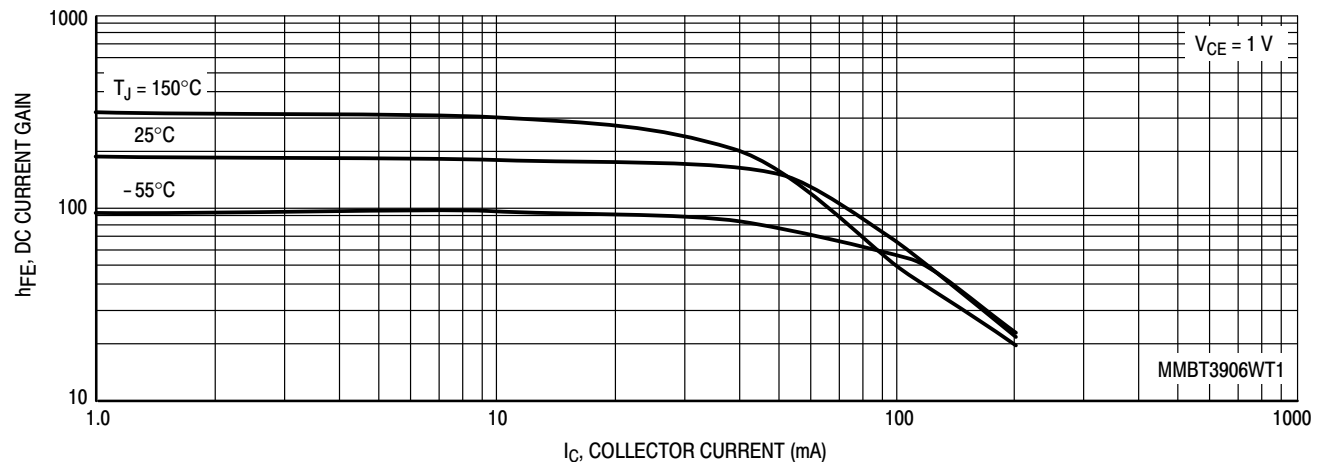


Figure 32. DC Current Gain

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3906WT1

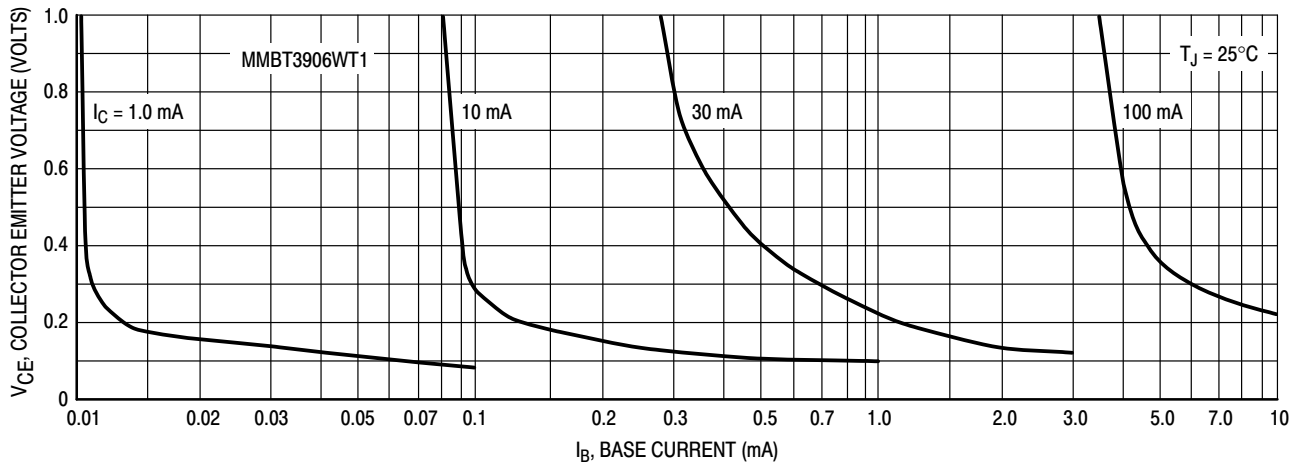


Figure 33. Collector Saturation Region

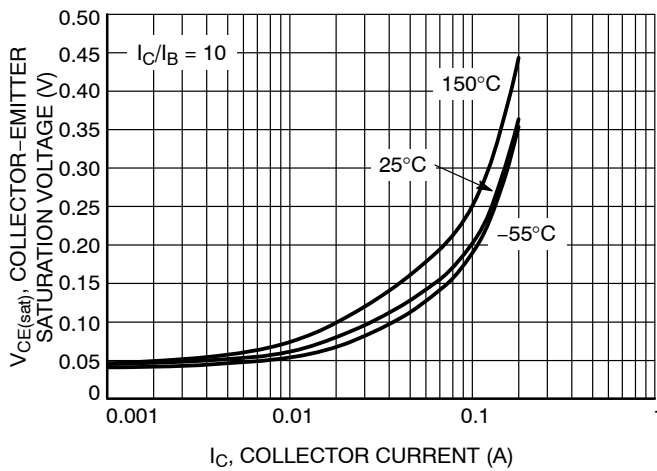


Figure 34. Collector Emitter Saturation Voltage vs. Collector Current

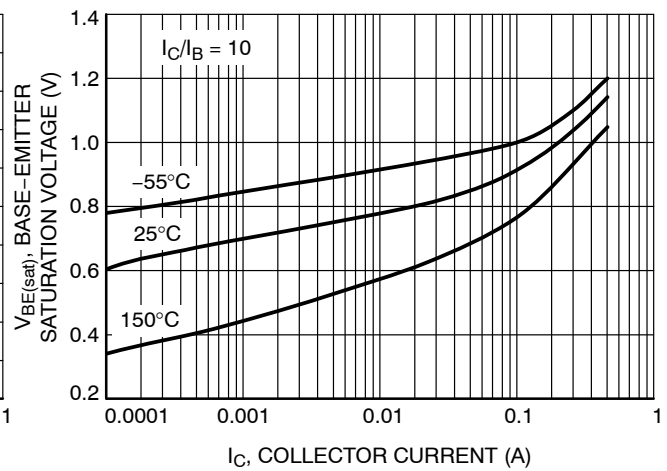


Figure 35. Base Emitter Saturation Voltage vs. Collector Current

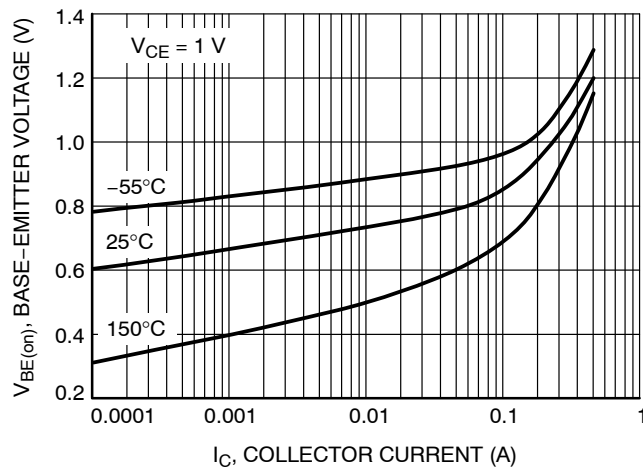


Figure 36. Base Emitter Voltage vs. Collector Current

MMBT3904WT1, NPN MMBT3906WT1, PNP

MMBT3906WT1

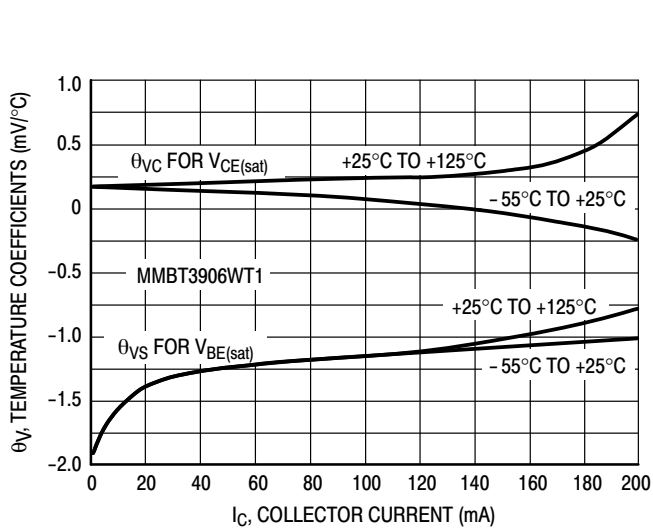


Figure 37. Temperature Coefficients

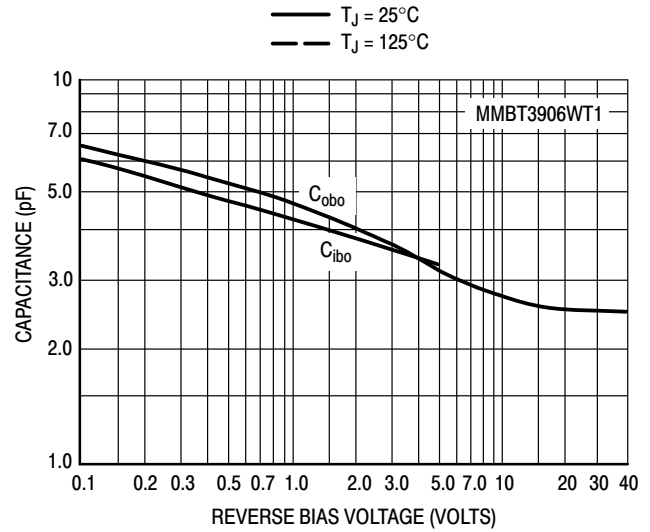


Figure 38. Capacitance

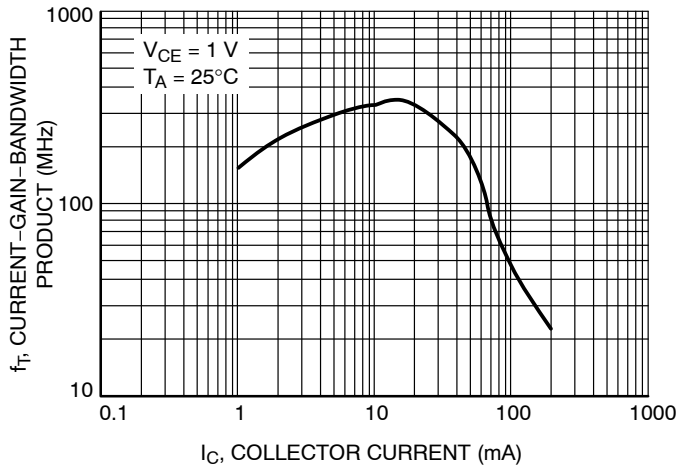


Figure 39. Current Gain Bandwidth Product vs. Collector Current

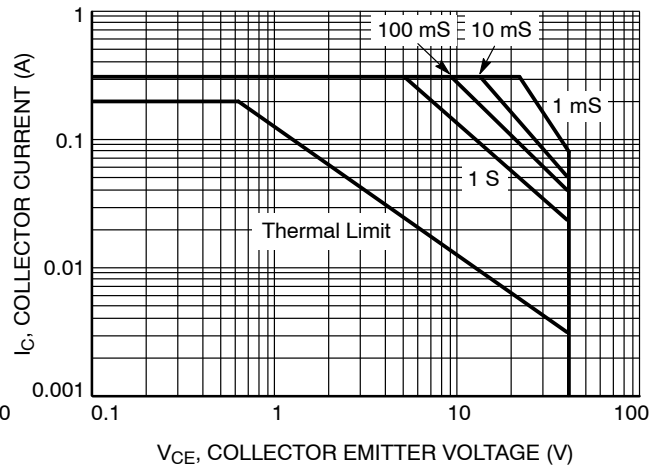
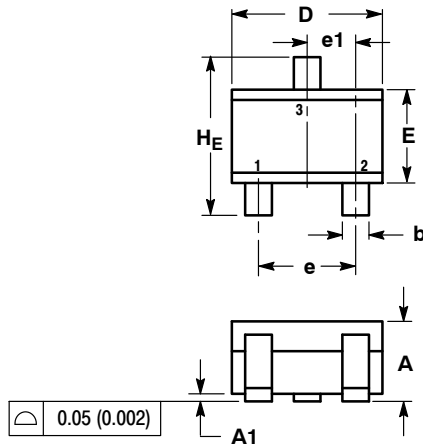


Figure 40. Safe Operating Area

MMBT3904WT1, NPN MMBT3906WT1, PNP

PACKAGE DIMENSIONS

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



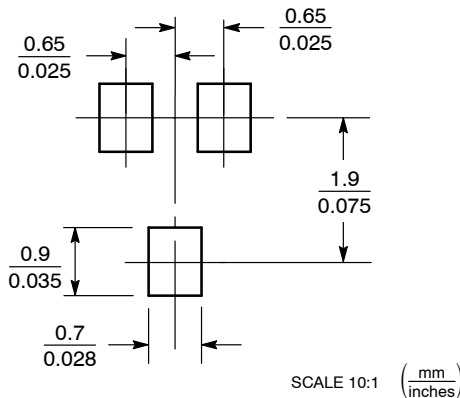
NOTES:

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
H	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.

ON Semiconductor and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5773-3850

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>
For additional information, please contact your local Sales Representative

MMBT3904WT1/D