

General Purpose Transistors

NPN and PNP Silicon

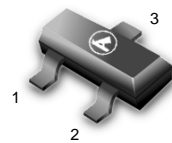
These transistors are designed for general purpose amplifier applications. They are housed in the SOT-323/SC-70 which is designed for low power surface mount applications.

NPN
MMBT3904WT1
PNP
MMBT3906WT1

MAXIMUM RATINGS

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

GENERAL PURPOSE
AMPLIFIER TRANSISTORS
SURFACE MOUNT



CASE 419-02, STYLE 3
SOT- 323 / SC-70

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation (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	$^\circ\text{C}$

DEVICE MARKING

MMBT3904WT1 = AM; MMBT3906WT1 = 2A

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
----------------	--------	-----	-----	------

OFF CHARACTERISTICS

Collector–Emitter Breakdown Voltage (2) ($I_C = 1.0\text{ mAdc}, I_B = 0$)	MMBT3904WT1	$V_{(BR)CEO}$	40	—	Vdc
($I_C = -1.0\text{ mAdc}, I_B = 0$)	MMBT3906WT1		– 40	—	
Collector–Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{Adc}, I_E = 0$)	MMBT3904WT1	$V_{(BR)CBO}$	60	—	Vdc
($I_C = -10\text{ }\mu\text{Adc}, I_E = 0$)	MMBT3906WT1		– 40	—	
Emitter–Base Breakdown Voltage ($I_E = 10\text{ }\mu\text{Adc}, I_C = 0$)	MMBT3904WT1	$V_{(BR)EBO}$	6.0	—	Vdc
($I_E = -10\text{ }\mu\text{Adc}, I_C = 0$)	MMBT3906WT1		– 5.0	—	
Base Cutoff Current ($V_{CE} = 30\text{ Vdc}, V_{EB} = 3.0\text{ Vdc}$)	MMBT3904WT1	I_{BL}	—	50	nAdc
($V_{CE} = -30\text{ Vdc}, V_{EB} = -3.0\text{ Vdc}$)	MMBT3906WT1		—	-50	
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}, V_{EB} = 3.0\text{ Vdc}$)	MMBT3904WT1	I_{CEX}	—	50	nAdc
($V_{CE} = -30\text{ Vdc}, V_{EB} = -3.0\text{ Vdc}$)	MMBT3906WT1		—	-50	

- Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.
- Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$; Duty Cycle $\leq 2.0\%$.

NPN MMBT3904WT1 PNP MMBT3906WT1
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS (2)				
DC Current Gain	h_{FE}			—
($I_C = 0.1\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)	MMBT3904WT1	40	—	
($I_C = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)		70	—	
($I_C = 10\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)		100	300	
($I_C = 50\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)		60	—	
($I_C = 100\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)		30	—	
($I_C = -0.1\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)	MMBT3906WT1	60	—	
($I_C = -1.0\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)		80	—	
($I_C = -10\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)		100	300	
($I_C = -50\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)		60	—	
($I_C = -100\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$)		30	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$)	MMBT3904WT1	—	0.2	
($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$)		—	0.3	
($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$)	MMBT3906WT1	—	-0.25	
($I_C = -50\text{ mA}$, $I_B = -5.0\text{ mA}$)		—	-0.4	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$)	MMBT3904WT1	0.65	0.85	
($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$)		—	0.95	
($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$)	MMBT3906WT1	-0.65	-0.85	
($I_C = -50\text{ mA}$, $I_B = -5.0\text{ mA}$)		—	-0.95	

SMALL-SIGNAL CHARACTERISTICS

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

NPN MMBT3904WT1 PNP MMBT3906WT1

SWITCHING CHARACTERISTICS

Delay Time ($V_{CC} = 3.0 \text{ Vdc}$, $V_{BE} = -0.5 \text{ Vdc}$) ($V_{CC} = -3.0 \text{ Vdc}$, $V_{BE} = 0.5 \text{ Vdc}$)	MMBT3904WT1	t_d	—	35
	MMBT3906WT1	—	—	35 ns
Rise Time ($I_C = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}$, $I_{B1} = -1.0 \text{ mAdc}$)	MMBT3904WT1	t_r	—	35
	MMBT3906WT1	—	—	35 ns
Storage Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_C = 10 \text{ mAdc}$) ($V_{CC} = -3.0 \text{ Vdc}$, $I_C = -10 \text{ mAdc}$)	MMBT3904WT1	t_s	—	200
	MMBT3906WT1	—	—	225 ns
Fall Time ($I_{B1} = I_{B2} = 1.0 \text{ mAdc}$) ($I_{B1} = I_{B2} = -1.0 \text{ mAdc}$)	MMBT3904WT1	t_f	—	50
	MMBT3906WT1	—	—	75 ns

2. Pulse Test: Pulse Width $\leq 300 \mu\text{s}$; Duty Cycle $\leq 2.0\%$.

MMBT3904WT1

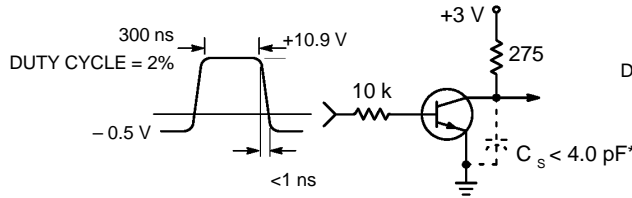


Figure 1. Delay and Rise Time Equivalent Test Circuit

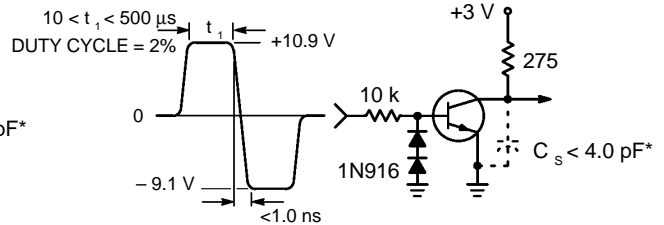


Figure 2. Storage and Fall Time Equivalent Test Circuit

*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

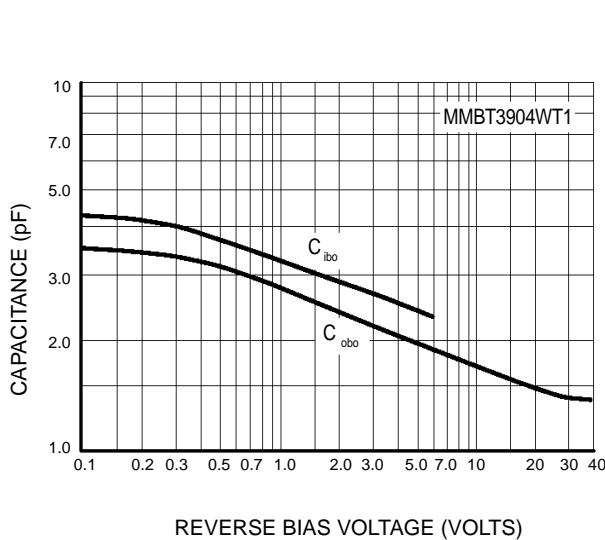


Figure 3. Capacitance

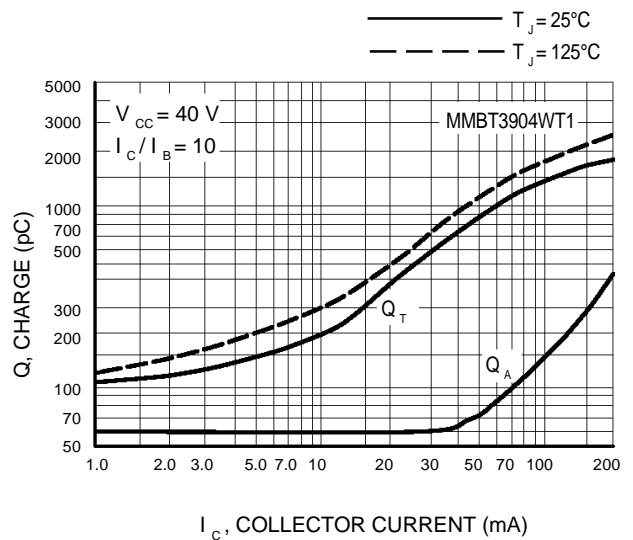


Figure 4. Charge Data

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3904WT1

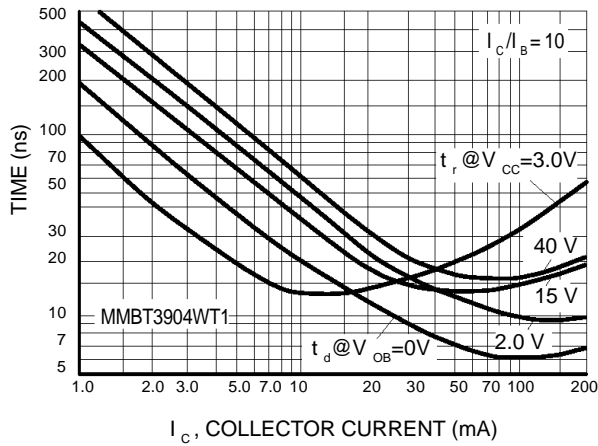


Figure 5. Turn-On Time

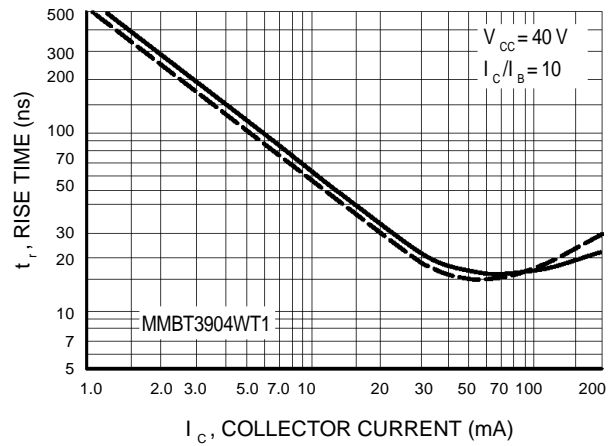


Figure 6. Rise Time

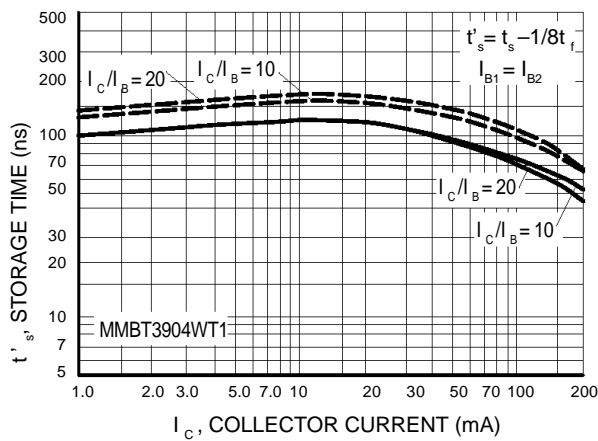


Figure 7. Storage Time

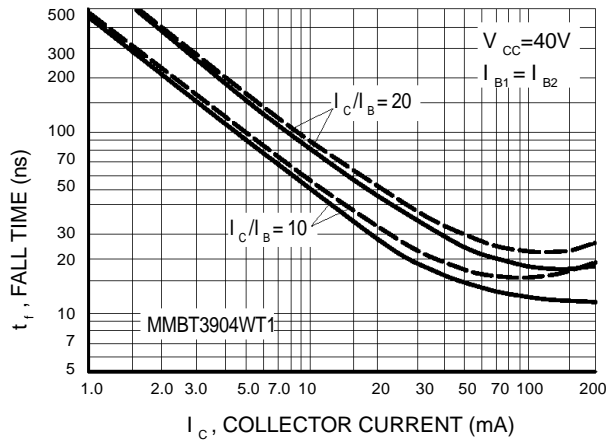


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

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

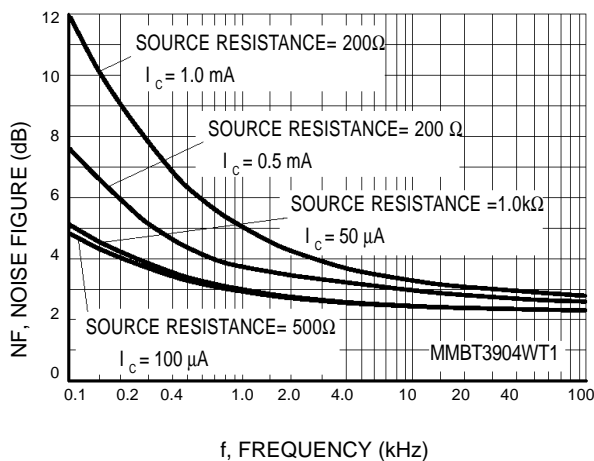


Figure 9. Noise Figure

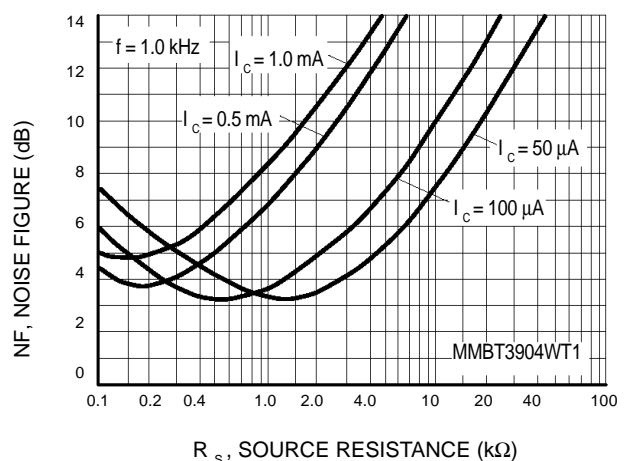


Figure 10. Noise Figure

NPN MMBT3904WT1 PNP MMBT3906WT1

h PARAMETERS

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

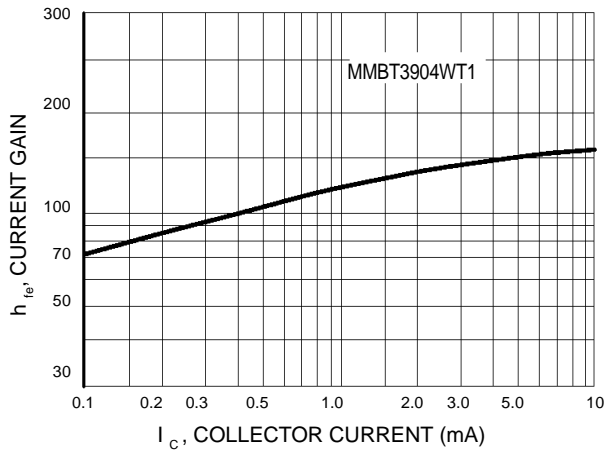


Figure 11. Current Gain

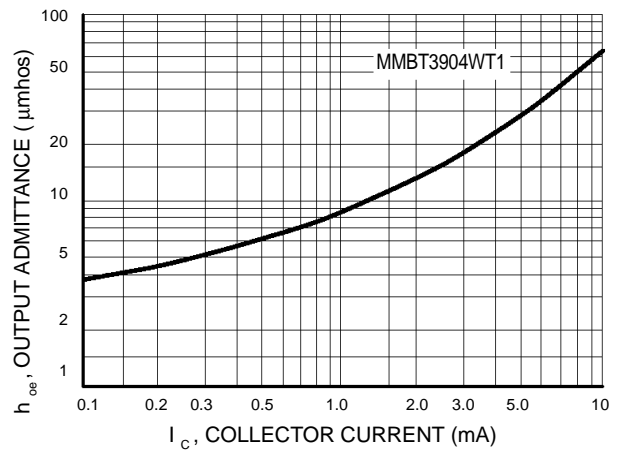


Figure 12. Output Admittance

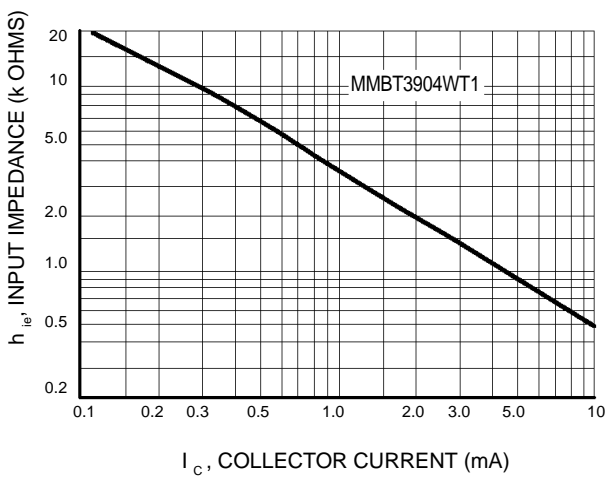


Figure 13. Input Impedance

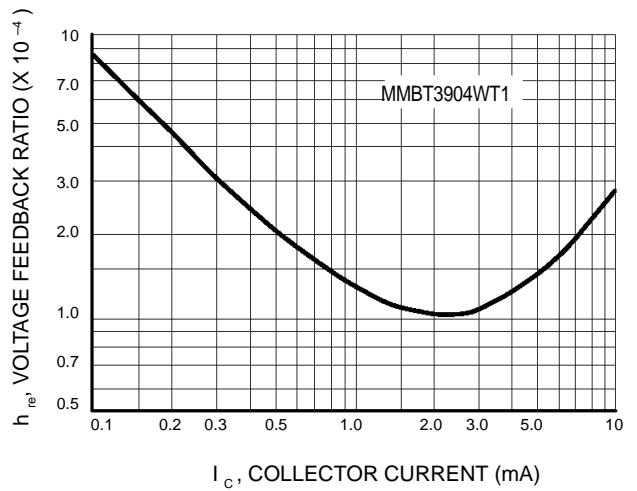


Figure 14. Voltage Feedback Ratio

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3904WT1
TYPICAL STATIC CHARACTERISTICS

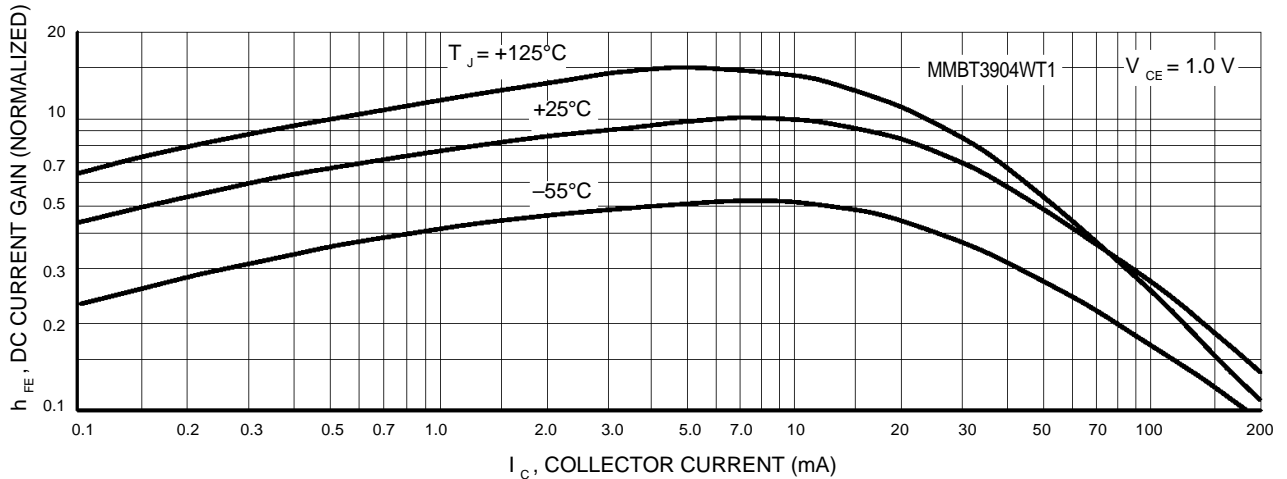


Figure 15. DC Current Gain

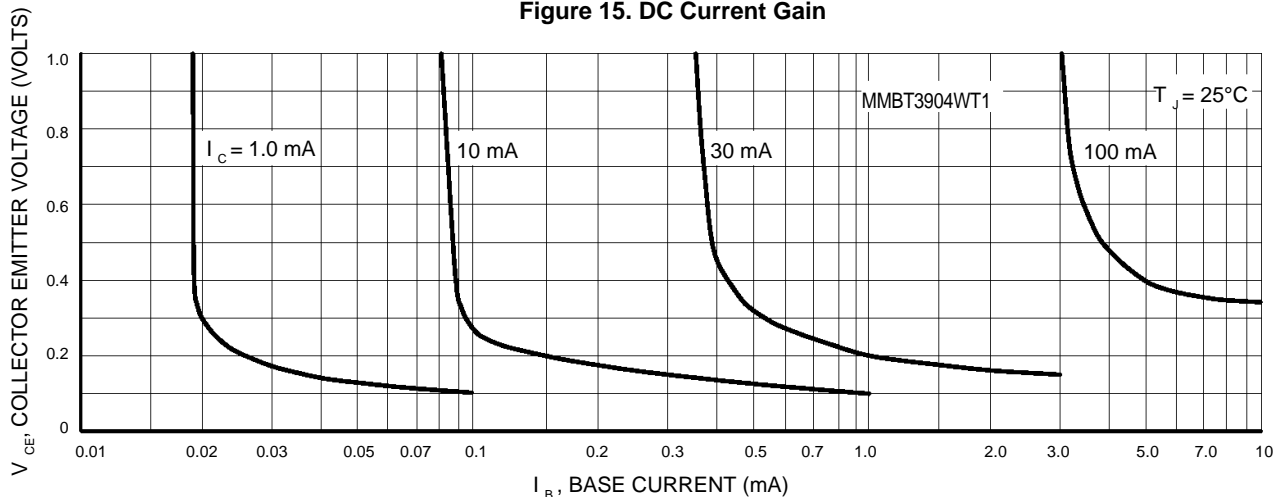


Figure 16. Collector Saturation Region

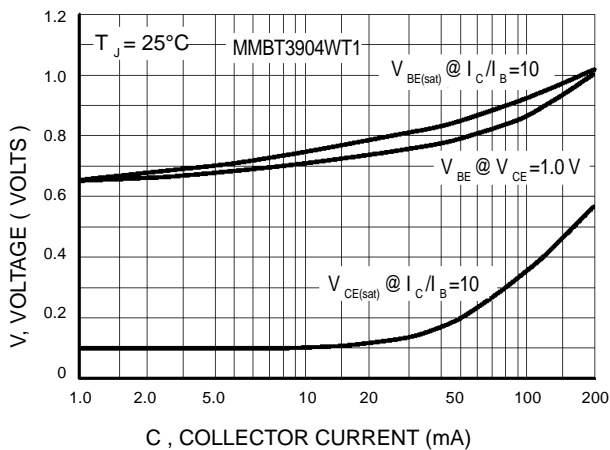


Figure 17. "ON" Voltages

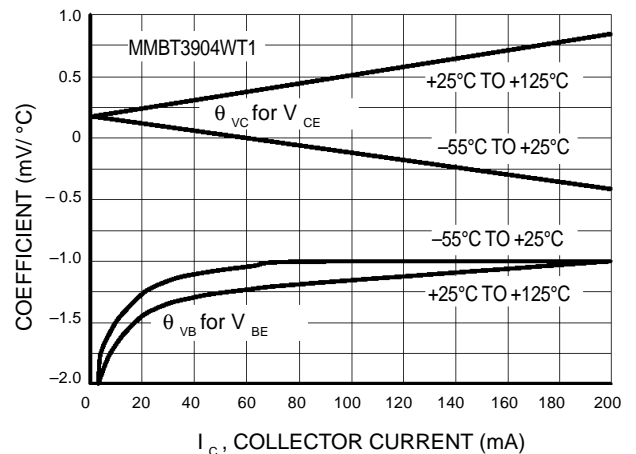


Figure 18. Temperature Coefficients

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1

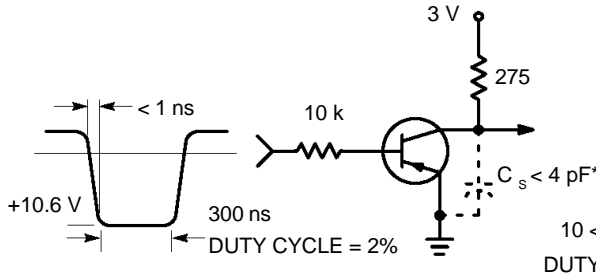


Figure 19. Delay and Rise Time Equivalent Test Circuit

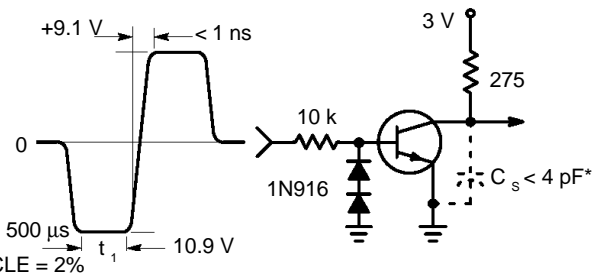


Figure 20. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

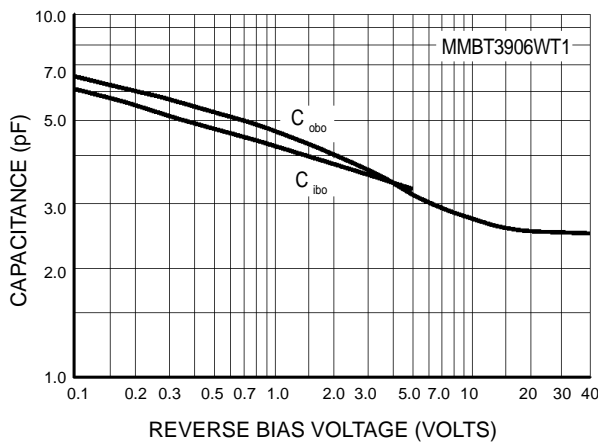


Figure 21. Capacitance

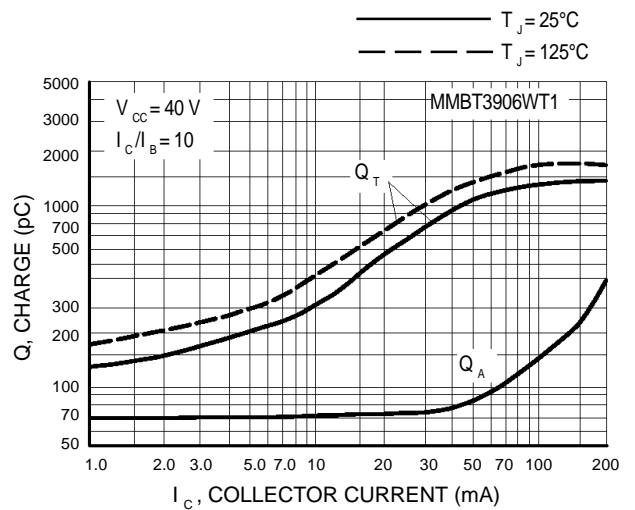


Figure 22. Charge Data

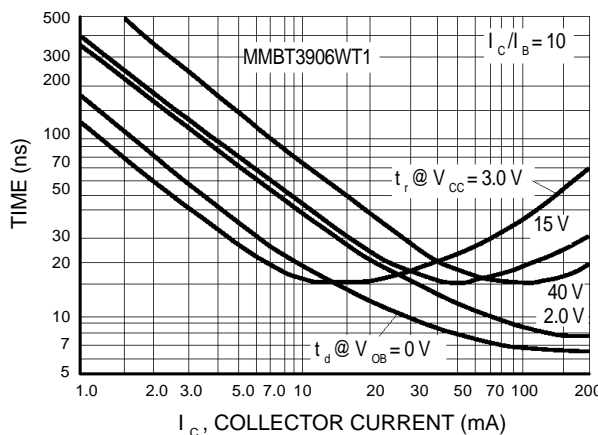


Figure 23. Turn-On Time

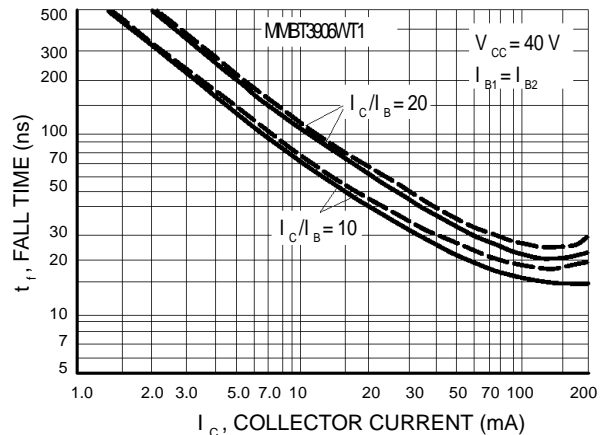


Figure 24. Fall Time

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

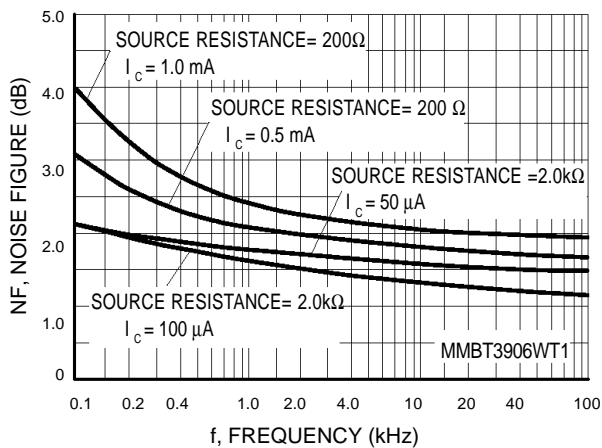


Figure 25

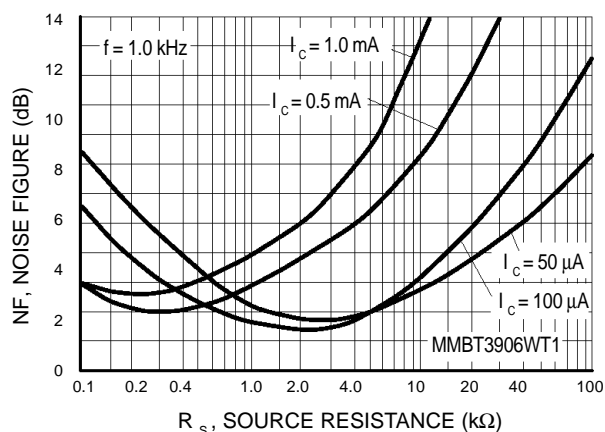


Figure 26

h PARAMETERS

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

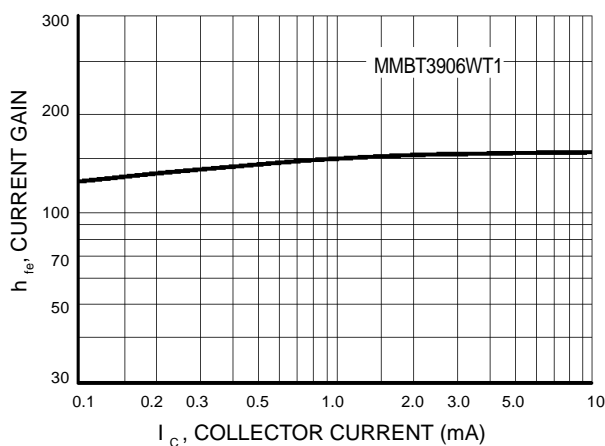


Figure 27. Current Gain

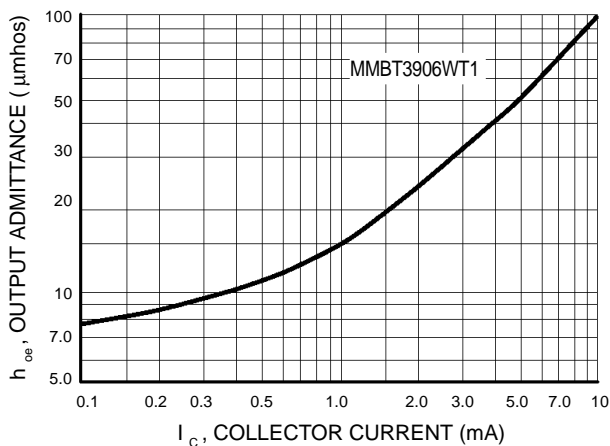


Figure 28. Output Admittance

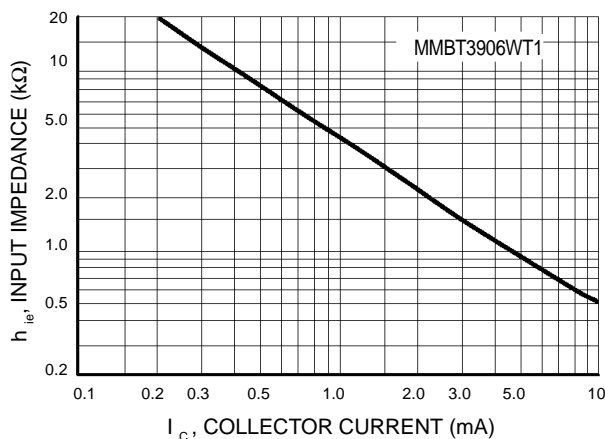


Figure 29. Input Impedance

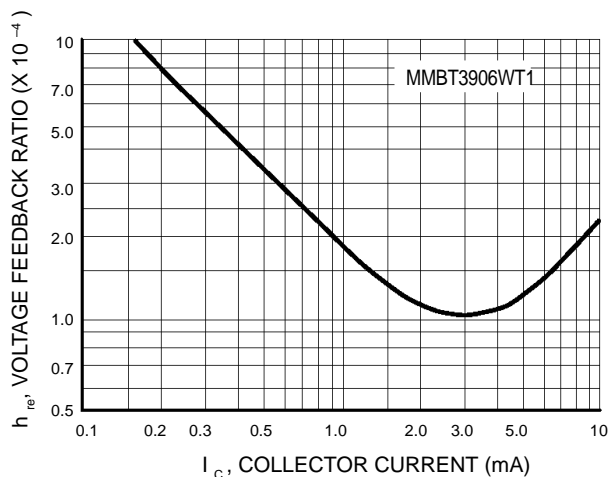


Figure 30. Voltage Feedback Ratio

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1
STATIC CHARACTERISTICS

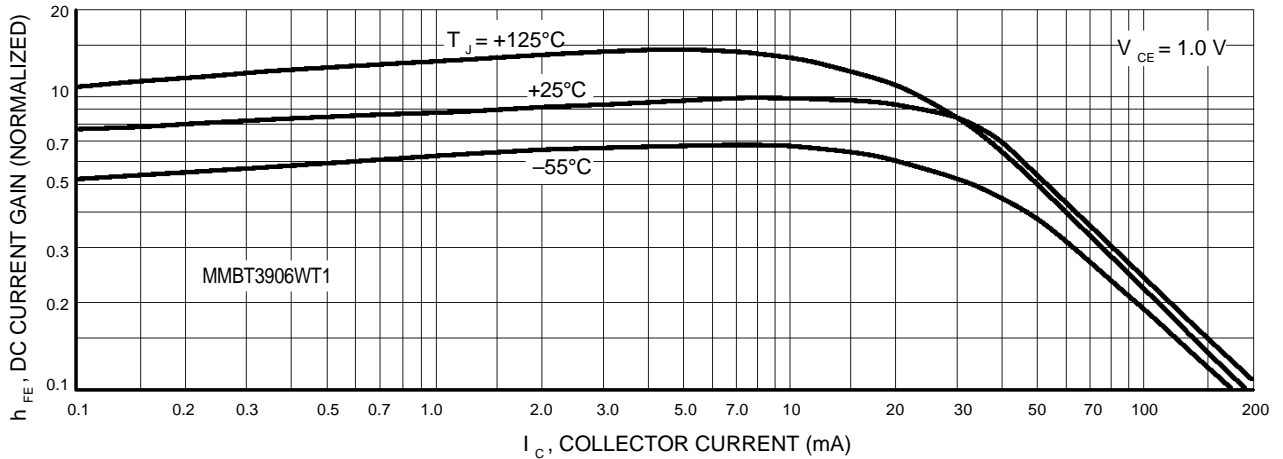


Figure 31. DC Current Gain

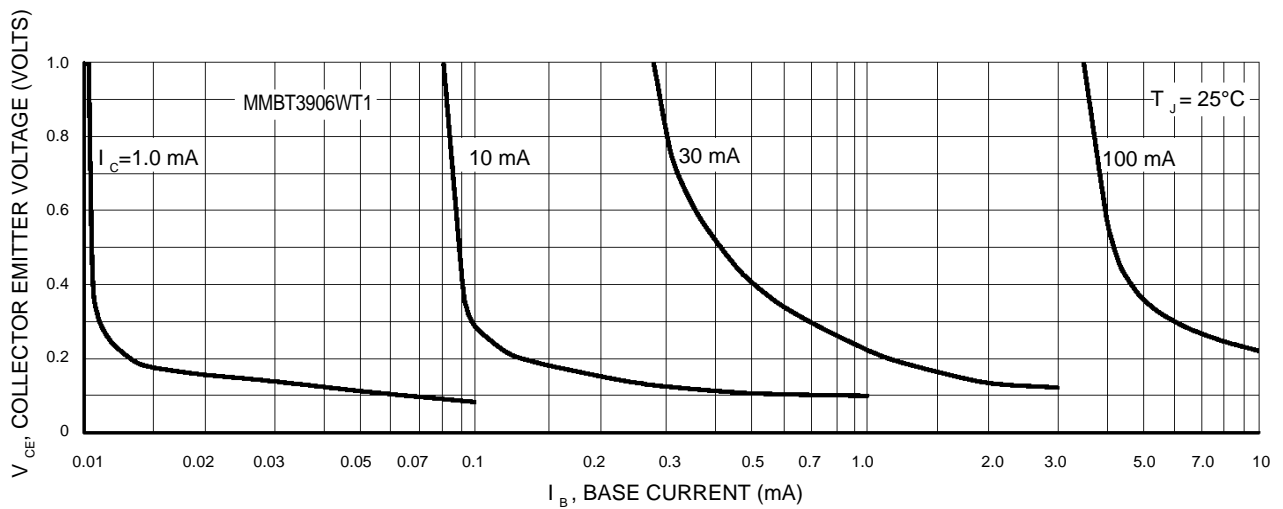


Figure 32. Collector Saturation Region

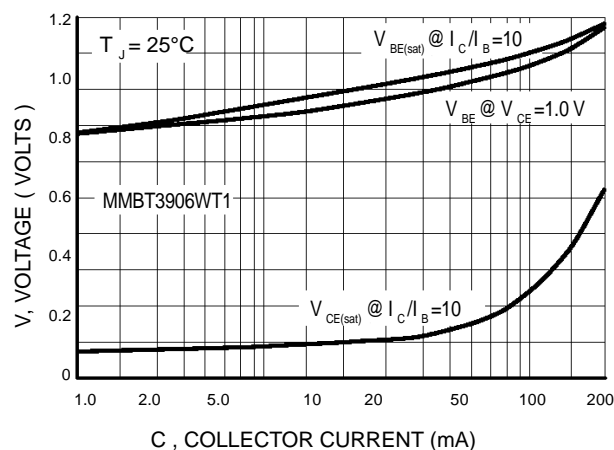


Figure 33. "ON" Voltages

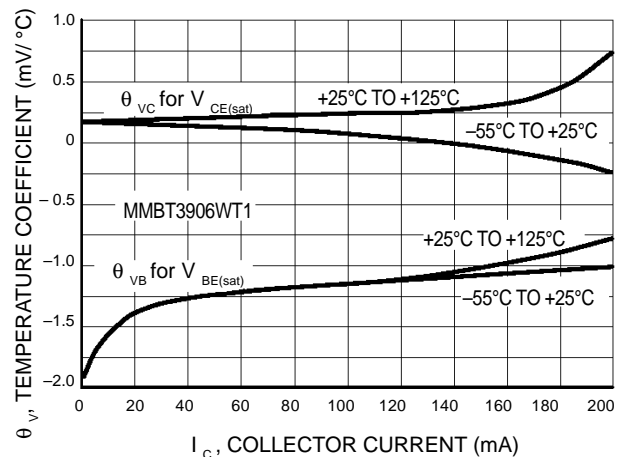


Figure 34. Temperature Coefficients