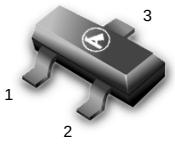
General Purpose Transistors

NPN and PNP Silicon

NPN
MMBT3904WT1
PNP
MMBT3906WT1

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.

GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT



CASE 419–02, STYLE 3
SOT– 323 / SC–70

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	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation (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

DEVICE MARKING

MMBT3904WT1 = AM; MMBT3906WT1 = 2A

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (2)					
(I_C = 1.0 mAdc, I_B = 0)	MMBT3904WT1	$V_{(BR)CEO}$	40	—	Vdc
(I_C = –1.0 mAdc, I_B = 0)	MMBT3906WT1		– 40	—	
Collector–Base Breakdown Voltage					
(I_C = 10 μAdc, I_E = 0)	MMBT3904WT1	$V_{(BR)CBO}$	60	—	Vdc
(I_C = –10 μAdc, I_E = 0)	MMBT3906WT1		– 40	—	
Emitter–Base Breakdown Voltage					
(I_E= 10 μAdc, I_C = 0)	MMBT3904WT1	$V_{(BR)EBO}$	6.0	—	Vdc
(I_E = –10 μAdc, I_C = 0)	MMBT3906WT1		– 5.0	—	
Base Cutoff Current					
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904WT1	I_{BL}	—	50	nAdc
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906WT1		—	-50	
Collector Cutoff Current					
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904WT1	I_{CEX}	—	50	nAdc
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906WT1		—	– 50	

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤300 μs; Duty Cycle ≤2.0%.

NPN MMBT3904WT1 PNP MMBT3906WT1

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

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS (2)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MMBT3904WT1		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		—	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		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	

SMALL–SIGNAL CHARACTERISTICS

Current–Gain — Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT3904WT1		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		—	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		—	8.0	
(V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3906WT1		—	10.0	
Input Impedance		h_{ie}			kΩ
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1		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		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		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		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} = 5.0Vdc, I_C = 100µAdc, R_S=1.0 kΩ, f =1.0kHz)	MMBT3904WT1		—	5.0	
(V_{CE} = –5.0Vdc, I_C = –100 µAdc, R_S=1.0 kΩ, f =1.0kHz)	MMBT3906WT1		—	4.0	

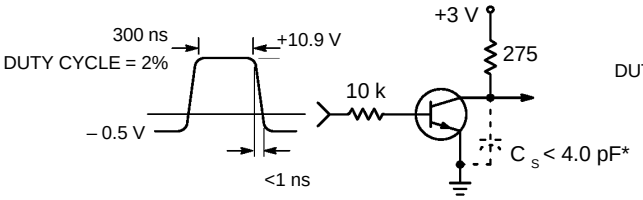
NPN MMBT3904WT1 PNP MMBT3906WT1

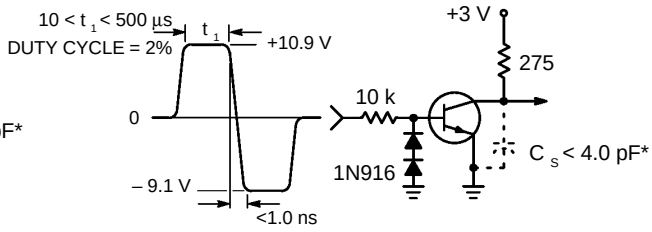
SWITCHING CHARACTERISTICS

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

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

MMBT3904WT1



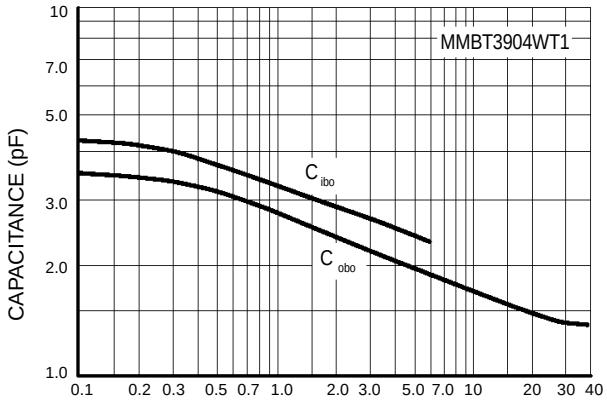


*Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

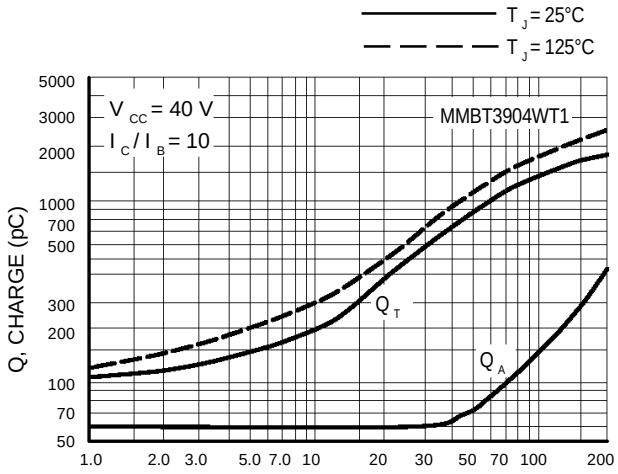
Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS



REVERSE BIAS VOLTAGE (VOLTS)

Figure 3. Capacitance

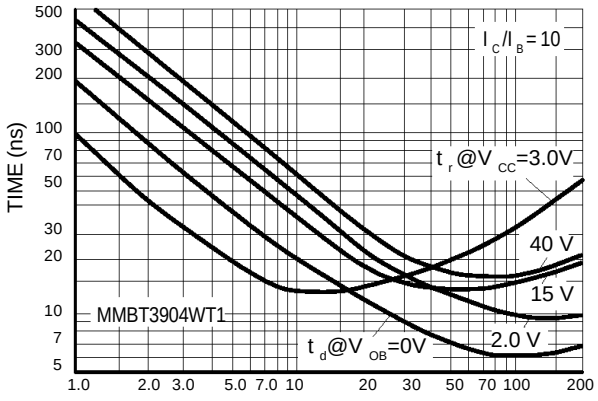


I C, COLLECTOR CURRENT (mA)

Figure 4. Charge Data

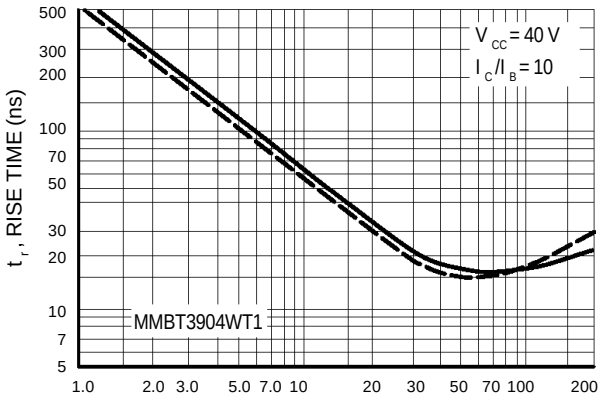
NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3904WT1



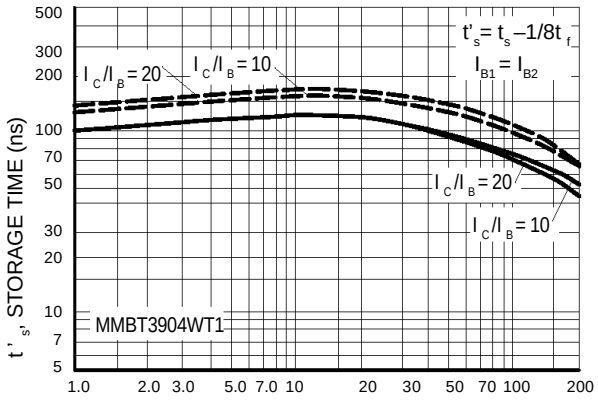
I C, COLLECTOR CURRENT (mA)

Figure 5. Turn–On Time



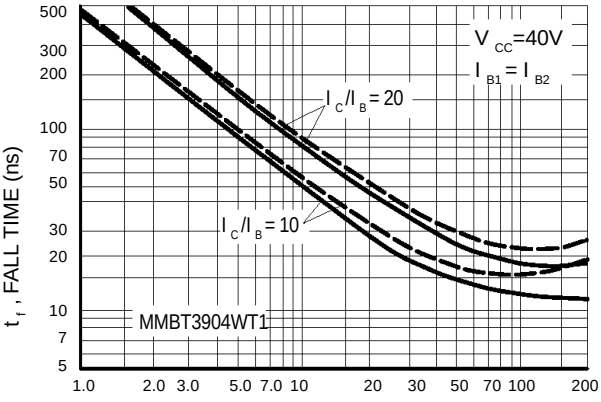
I C, COLLECTOR CURRENT (mA)

Figure 6. Rise Time



I C, COLLECTOR CURRENT (mA)

Figure 7. Storage Time



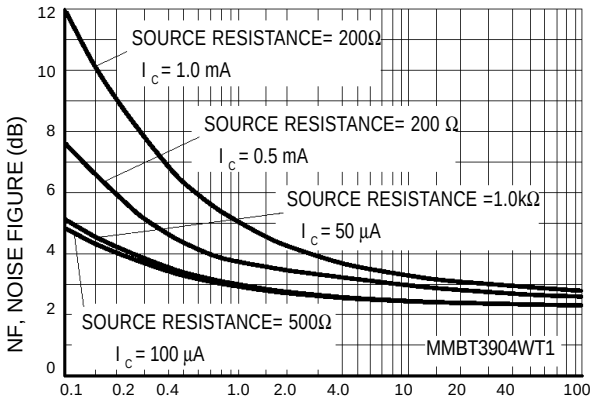
I C, COLLECTOR CURRENT (mA)

Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

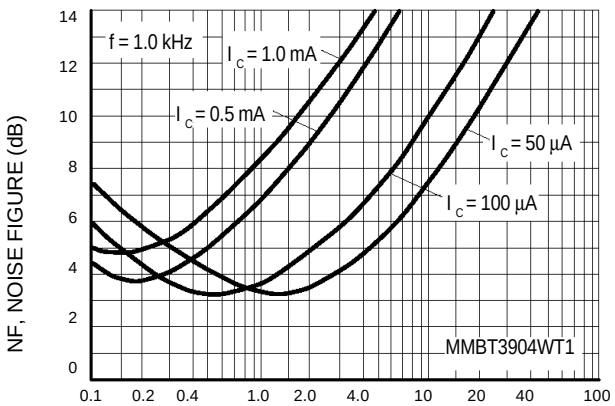
NOISE FIGURE VARIATIONS

(V CE = 5.0 Vdc, T A = 25°C, Bandwidth = 1.0 Hz)



f, FREQUENCY (kHz)

Figure 9. Noise Figure



R S, SOURCE RESISTANCE (kΩ)

Figure 10. Noise Figure

NPN MMBT3904WT1 PNP MMBT3906WT1

h PARAMETERS

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

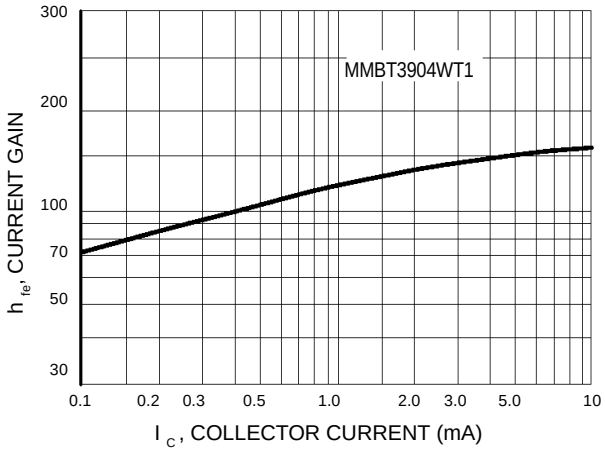


Figure 11. Current Gain

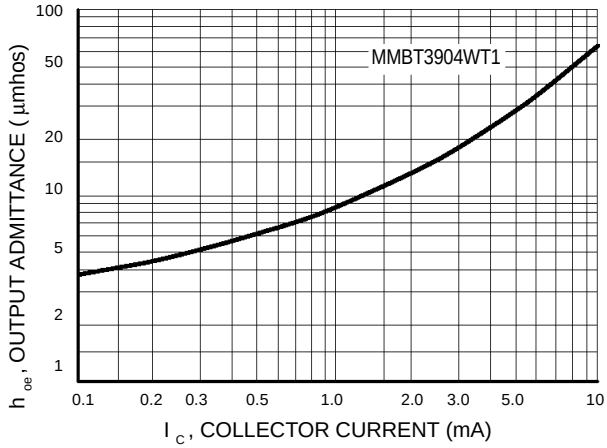


Figure 12. Output Admittance

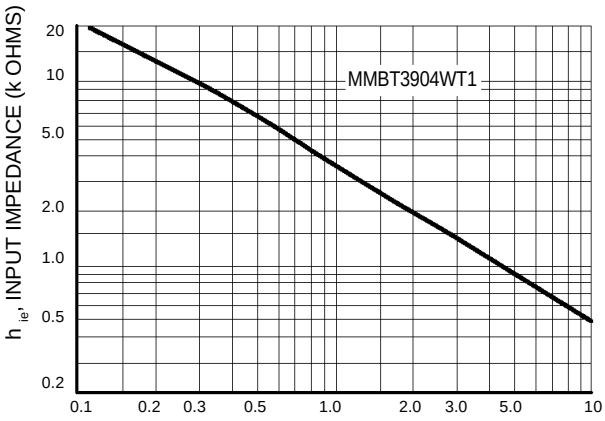


Figure 13. Input Impedance

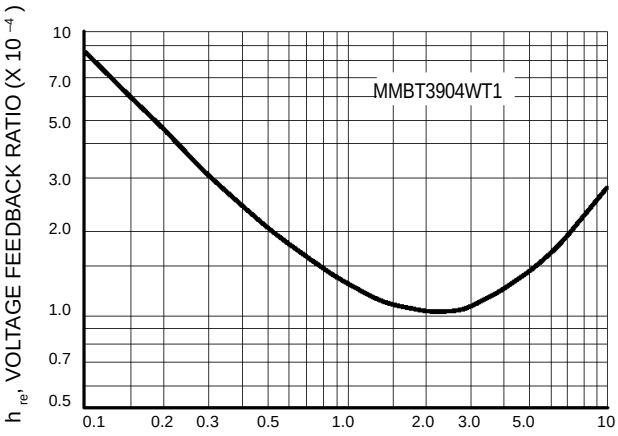


Figure 14. Voltage Feedback Ratio

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3904WT1
TYPICAL STATIC CHARACTERISTICS

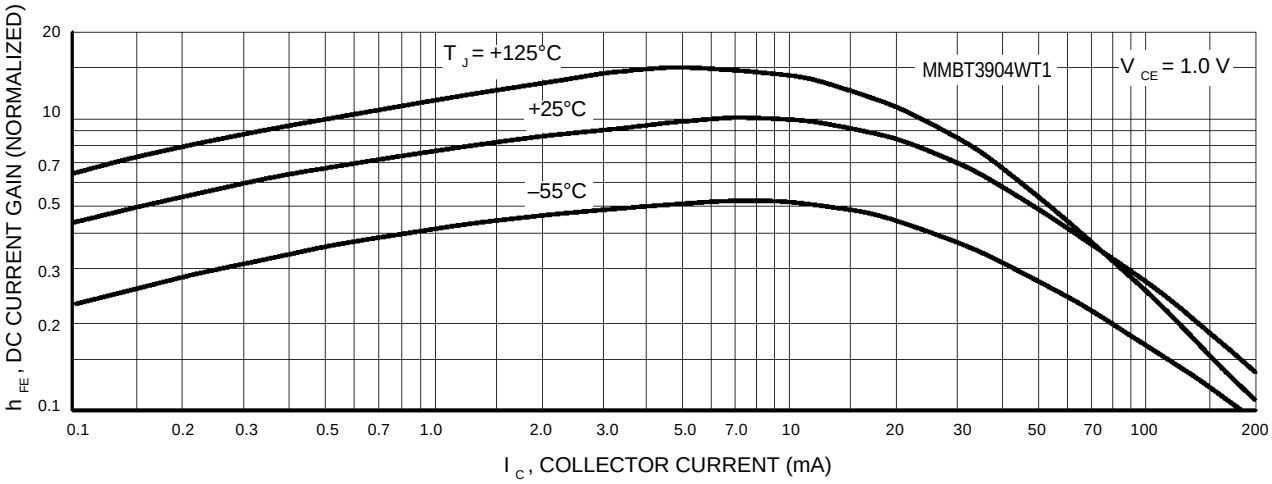


Figure 15. DC Current Gain

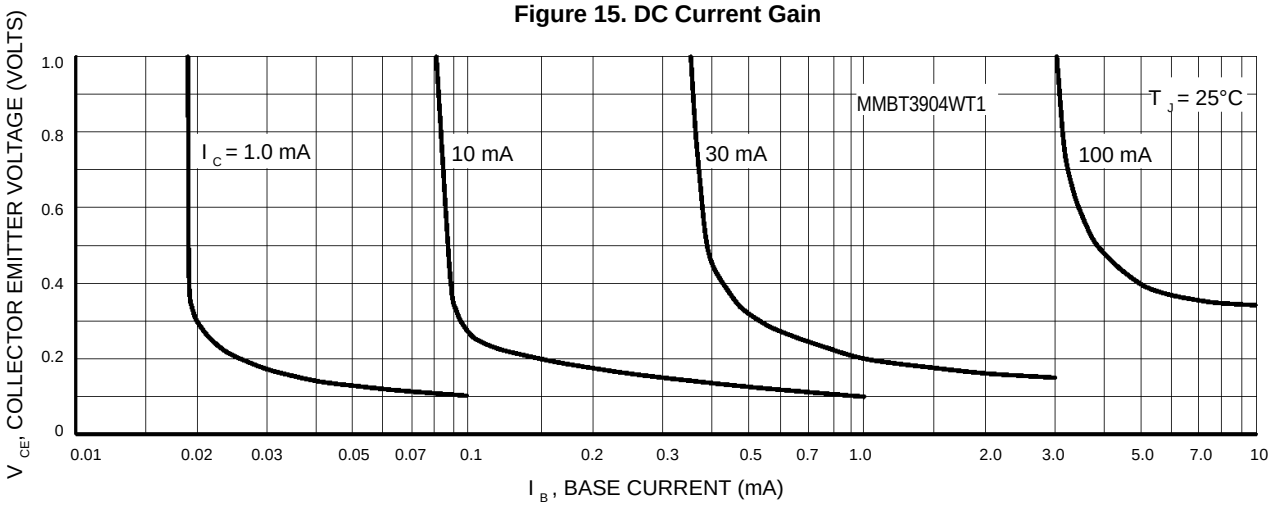


Figure 16. Collector Saturation Region

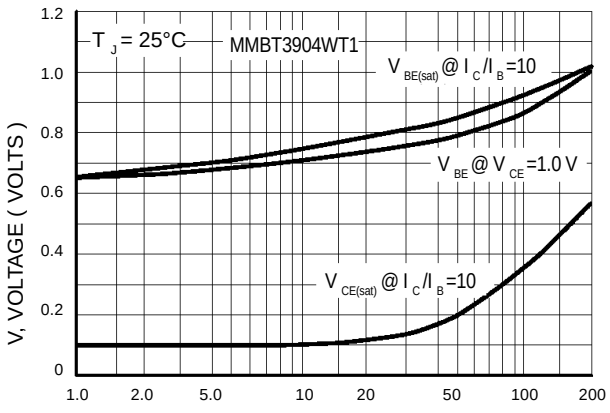


Figure 17. "ON" Voltages

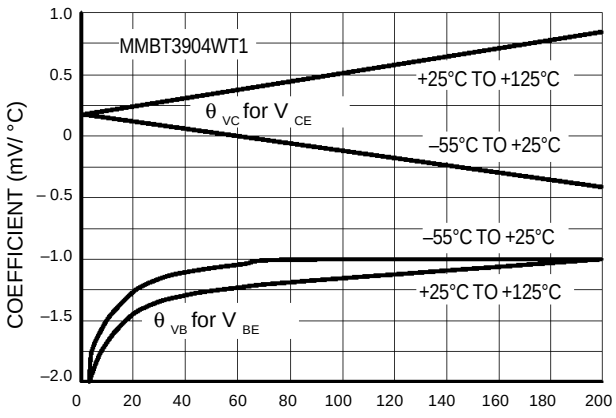
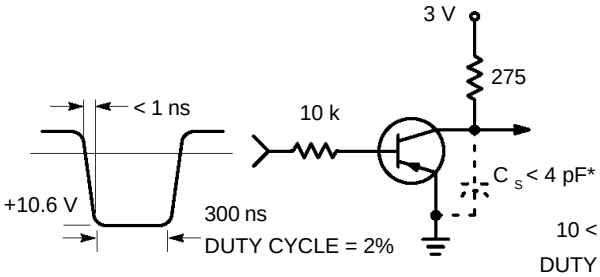
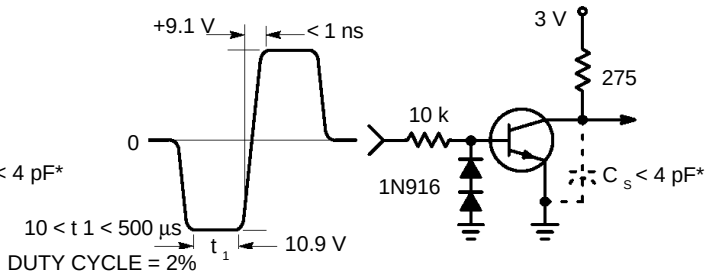


Figure 18. Temperature Coefficients

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1





* Total shunt capacitance of test jig and connectors

Figure 19. Delay and Rise Time Equivalent Test Circuit

Figure 20. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

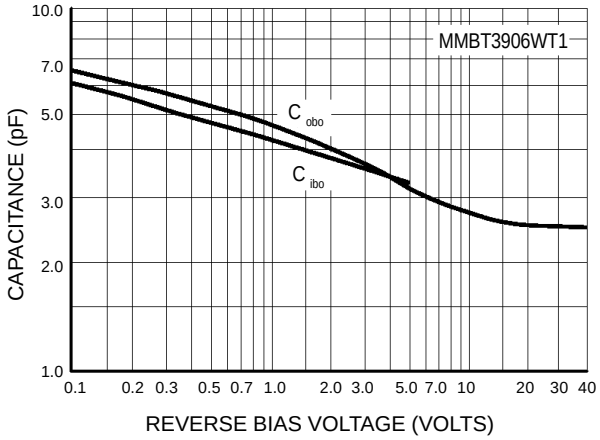


Figure 21. Capacitance

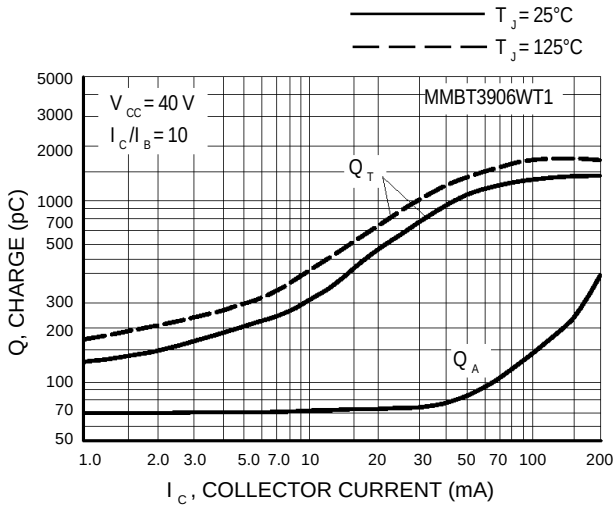


Figure 22. Charge Data

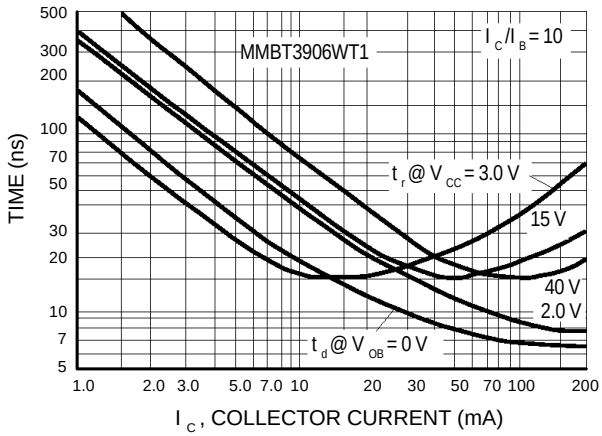


Figure 23. Turn–On Time

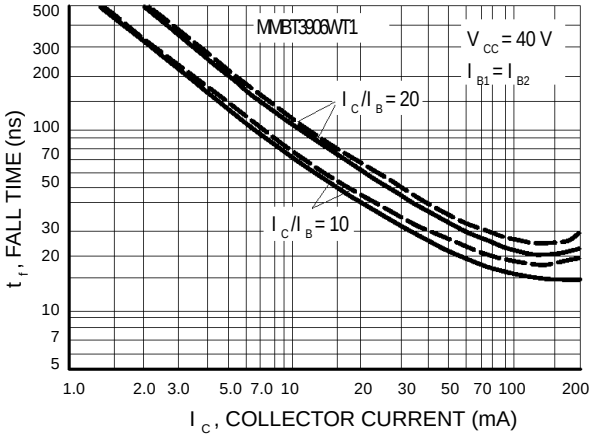


Figure 24. Fall Time

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

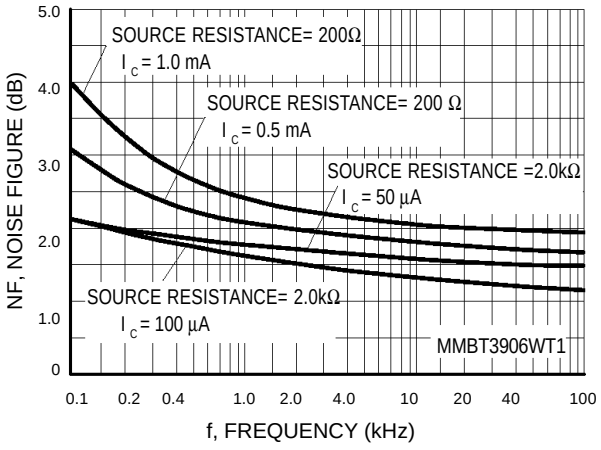


Figure 25

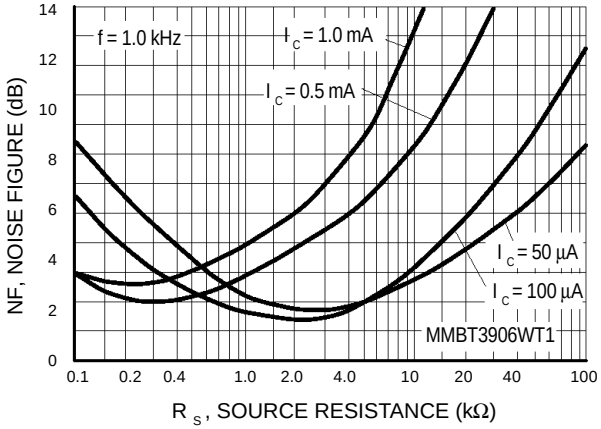


Figure 26

h PARAMETERS

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

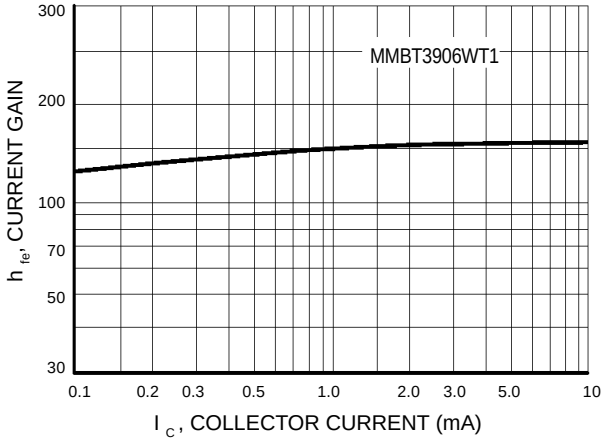


Figure 27. Current Gain

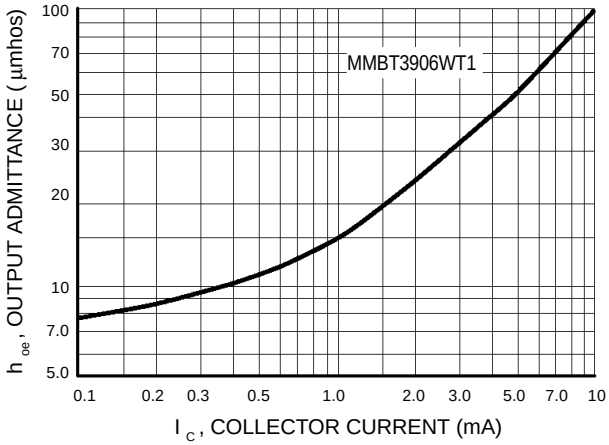


Figure 28. Output Admittance

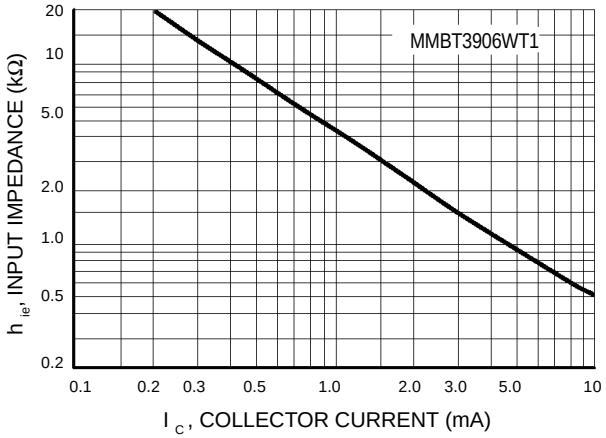


Figure 29. Input Impedance

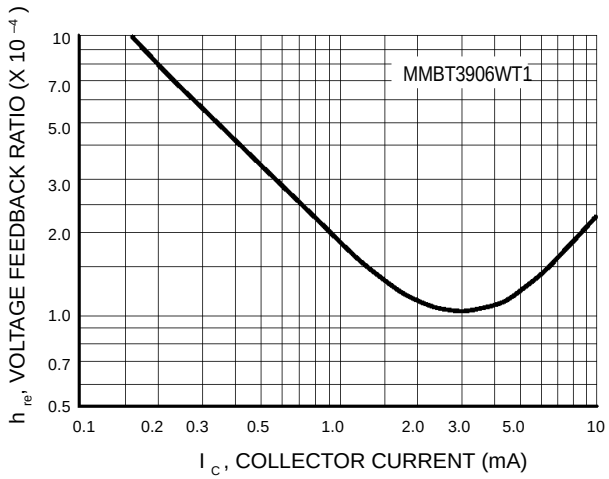


Figure 30. Voltage Feedback Ratio

NPN MMBT3904WT1 PNP MMBT3906WT1

MMBT3906WT1
STATIC CHARACTERISTICS

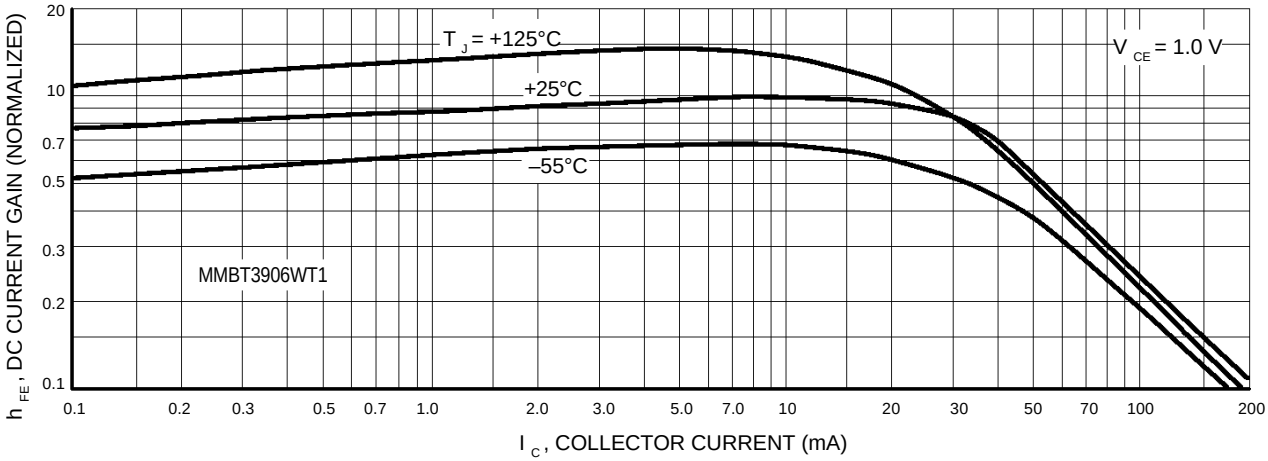


Figure 31. DC Current Gain

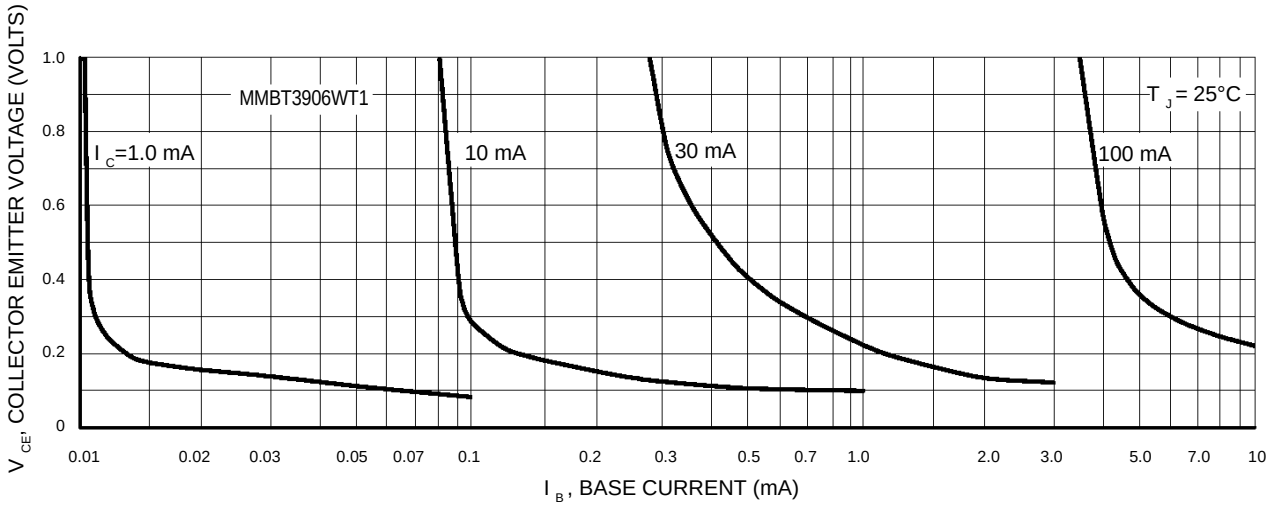


Figure 32. Collector Saturation Region

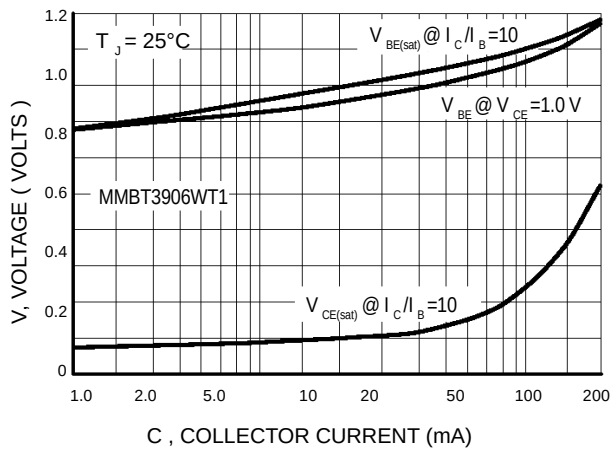


Figure 33. "ON" Voltages

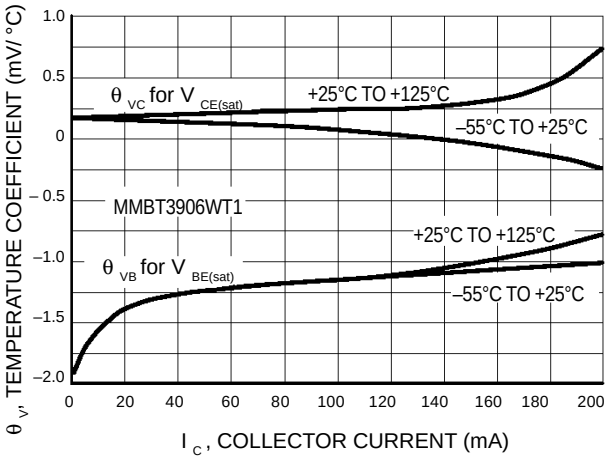


Figure 34. Temperature Coefficients