SEMICONDUCTOR

DATA SHEET

MMBT3904W-MMBT3906W

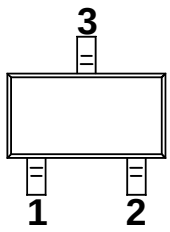
General Purpose Transistors

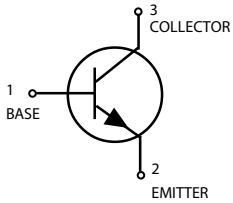
NPN and PNP Silicon

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.

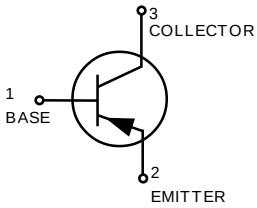
● Pb-Free Package is available.

SOT–323





MMBT3904W



MMBT3906W

DEVICE MARKING AND ORDERING INFORMATION

Device	Marking	Package	Shipping
MMBT3904W	AM	SOT-323/SC-70	3000/Tape&Reel
MMBT3906W	2A	SOT-323/SC-70	3000/Tape&Reel

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector–Emitter Voltage	MMBT3904W	V_{CEO}	40	Vdc
	MMBT3906W		– 40	
Collector–Base Voltage	MMBT3904W	V_{CBO}	60	Vdc
	MMBT3906W		– 40	
Emitter–Base Voltage	MMMBT3904W	V_{EBO}	6.0	Vdc
	MMBT3906W		– 5.0	
Collector Current — Continuous	MMBT3904W	I_C	200	mAdc
	MMBT3906W		– 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

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)	MMBT3904W	$V_{(BR)CEO}$	40	—	Vdc
(I_C = –1.0 mAdc, I_B = 0)	MMBT3906W		– 40	—	
Collector–Base Breakdown Voltage					
(I_C = 10 μAdc, I_E = 0)	MMBT3904W	$V_{(BR)CBO}$	60	—	Vdc
(I_C = –10 μAdc, I_E = 0)	MMBT3906W		– 40	—	
Emitter–Base Breakdown Voltage					
(I_E= 10 μAdc, I_C = 0)	MMBT3904W	$V_{(BR)EBO}$	6.0	—	Vdc
(I_E = –10 μAdc, I_C = 0)	MMBT3906W		– 5.0	—	
Base Cutoff Current					
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904W	I_{BL}	—	50	nAdc
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906W		—	-50	
Collector Cutoff Current					
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MMBT3904W	I_{CEX}	—	50	nAdc
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MMBT3906W		—	– 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%.

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)	MMBT3904W		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)	MMBT3906W		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)	MMBT3904W		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.3	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906W		—	– 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)	MMBT3904W		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.95	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906W		– 0.65	– 0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			—	– 0.95	

SMALL–SIGNAL CHARACTERISTICS

		Symbol	Min	Max	Unit
Current–Gain — Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT3904W		300	—	
(I_C = –10 mAdc, V_{CE}= –20 Vdc, f = 100 MHz)	MMBT3906W		250	—	
Output Capacitance		C_{obo}			pF
(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3904W		—	4.0	
(V_{CB}= –5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3906W		—	4.5	
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3904W		—	8.0	
(V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3906W		—	10.0	
Input Impedance		h_{ie}			kΩ
(V_{CE}= 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904W		1.0	10	
(V_{CE}= –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906W		2.0	12	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(V_{CE}= 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904W		0.5	8.0	
(V_{CE}= –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906W		0.1	10	
Small–Signal Current Gain		h_{fe}			—
(V_{CE}= 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904W		100	400	
(V_{CE}= –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906W		100	400	
Output Admittance		h_{oe}			μmhos
(V_{CE}= 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904W		1.0	40	
(V_{CE}= –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906W		3.0	60	
Noise Figure		NF			dB
(V_{CE}= 5.0Vdc, I_C = 100μAdc, R_S=1.0 kΩ, f =1.0kHz)	MMBT3904W		—	5.0	
(V_{CE}= –5.0Vdc, I_C = –100 μAdc, R_S=1.0 kΩ, f =1.0kHz)	MMBT3906W		—	4.0	

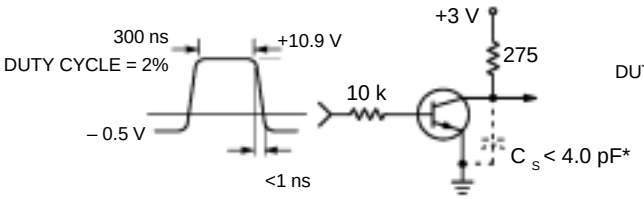
DEVICE CHARACTERISTICS

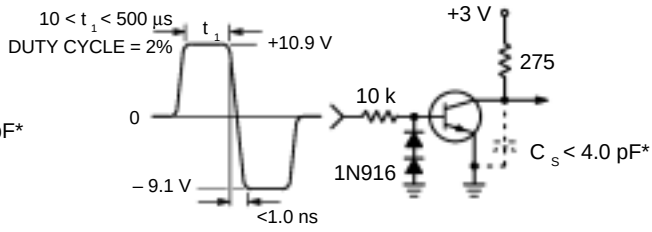
MMBT3904W-MMBT3906W

SWITCHING CHARACTERISTICS		Symbol	Min	Max	Unit
Delay Time (V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	MMBT3904W	t_d	—	3 5	
(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	MMBT3906W		—	35	ns
Rise Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	MMBT3904W	t_r	—	3 5	
(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	MMBT3906W		—	35	ns
Storage Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	MMBT3904W	t_s	—	200	
(V_{CC} = –3.0 Vdc, I C = –10 mAdc)	MMBT3906W		—	225	ns
Fall Time (I_{B1} = I_{B2} = 1.0 mAdc)	MMBT3904W	t_f	—	5 0	
(I_{B1} = I_{B2} = –1.0 mAdc)	MMBT3906W		—	75	ns

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

LMBT3904WT1





*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

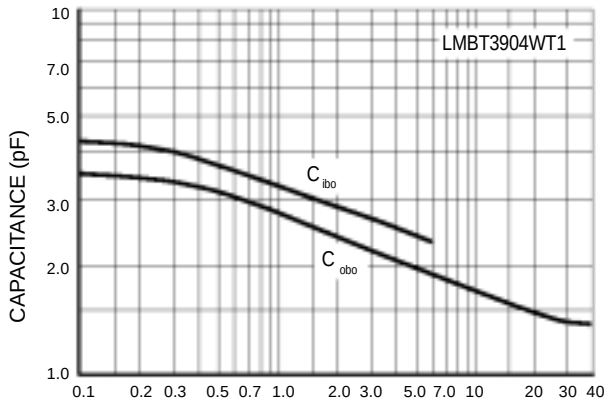


Figure 3. Capacitance

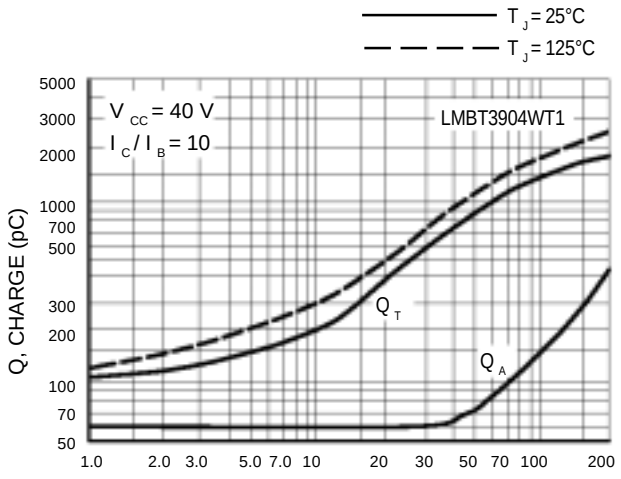


Figure 4. Charge Data

DEVICE CHARACTERISTICS

MMBT3904W-MMBT3906W

MMBT3904W

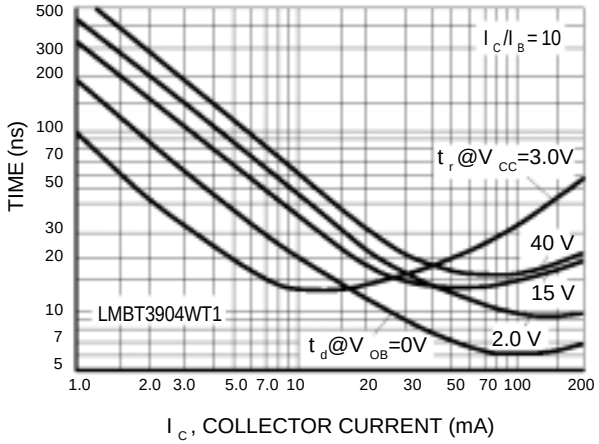


Figure 5. Turn–On Time

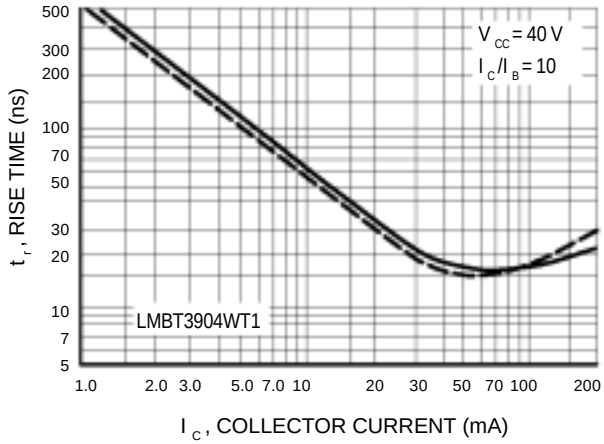


Figure 6. Rise Time

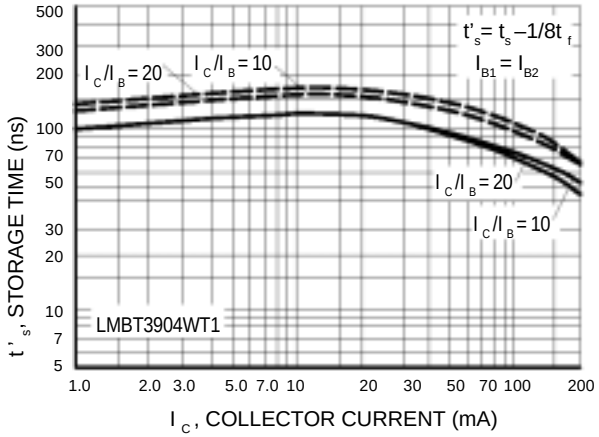


Figure 7. Storage Time

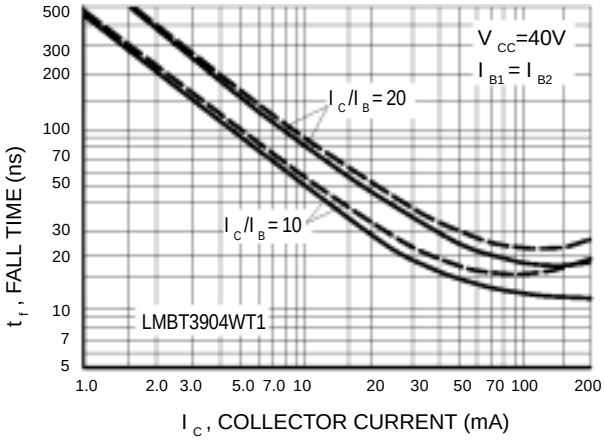


Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

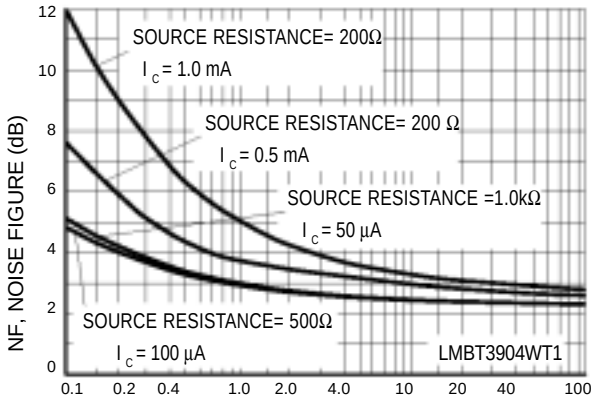


Figure 9. Noise Figure

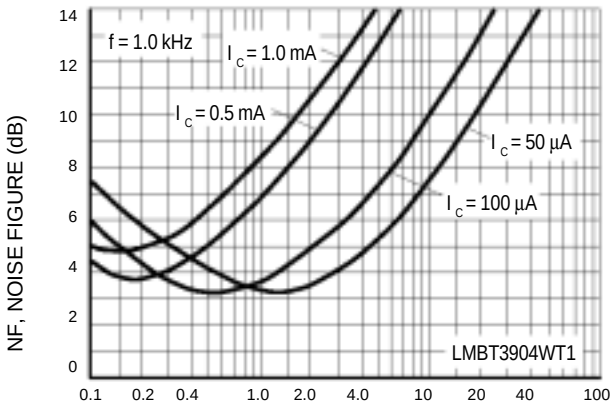


Figure 10. Noise Figure

DEVICE CHARACTERISTICS

MMBT3904W-MMBT3906W

h PARAMETERS

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

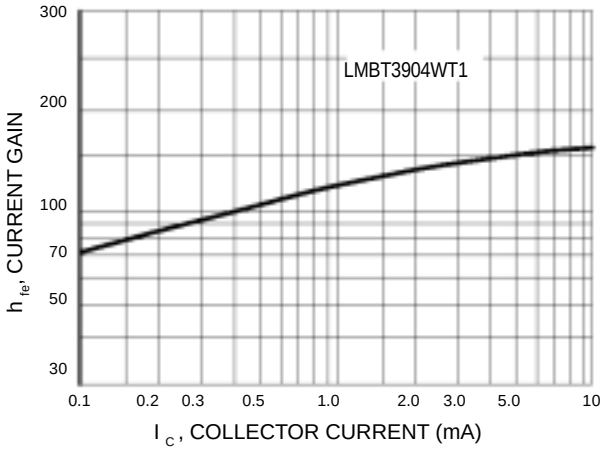


Figure 11. Current Gain

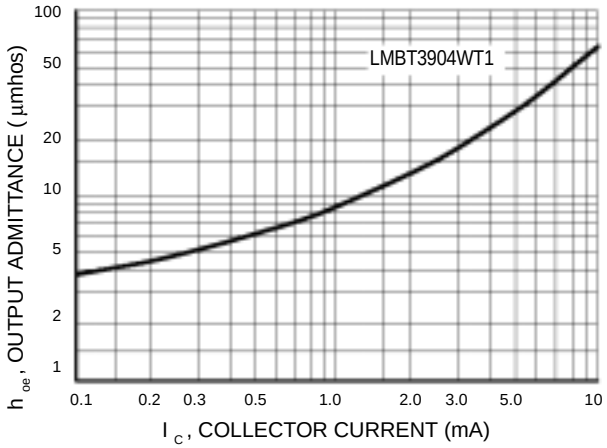


Figure 12. Output Admittance

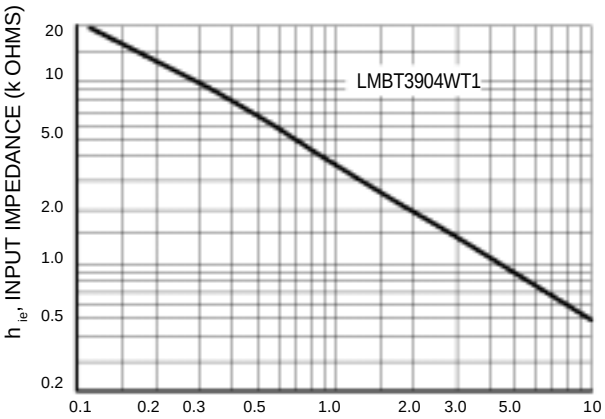


Figure 13. Input Impedance

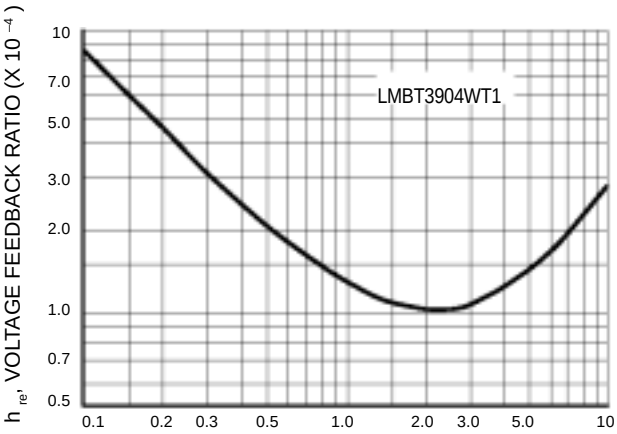


Figure 14. Voltage Feedback Ratio

DEVICE CHARACTERISTICS

MMBT3904W-MMBT3906W

MMBT3904W

TYPICAL STATIC CHARACTERISTICS

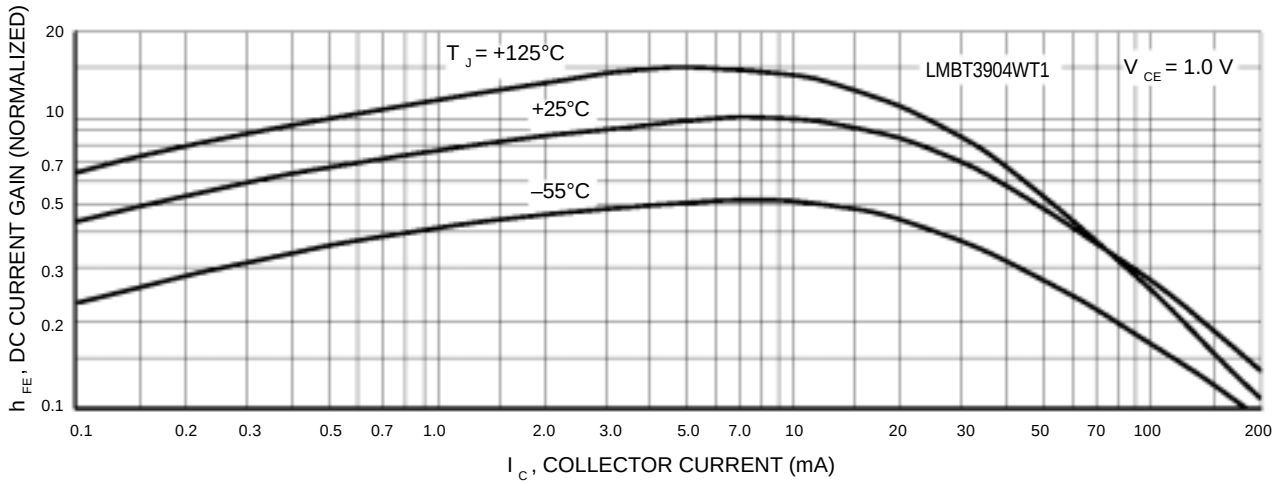


Figure 15. DC Current Gain

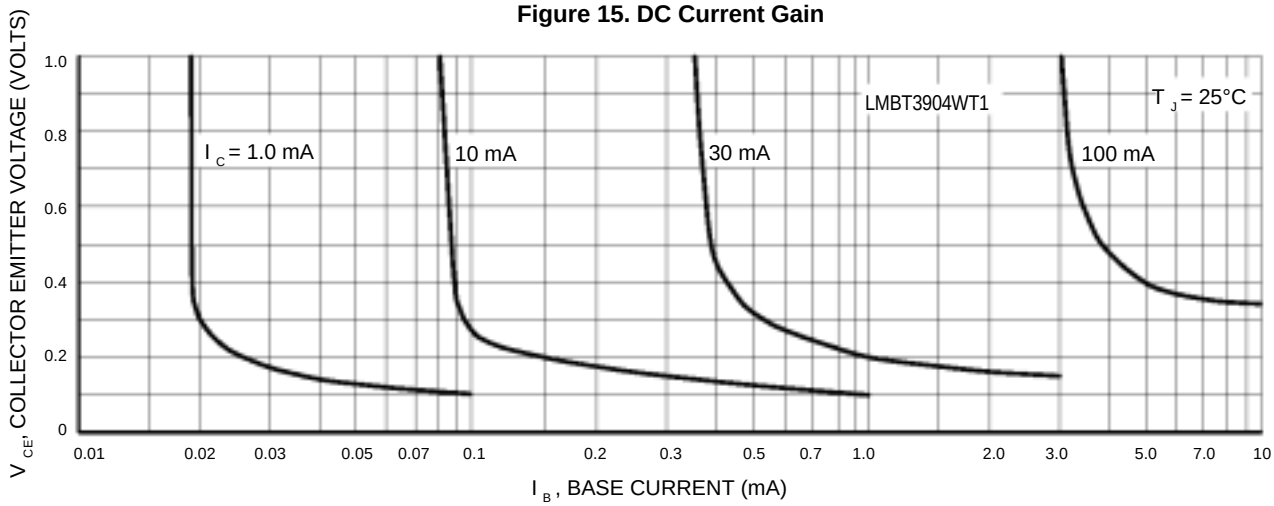


Figure 16. Collector Saturation Region

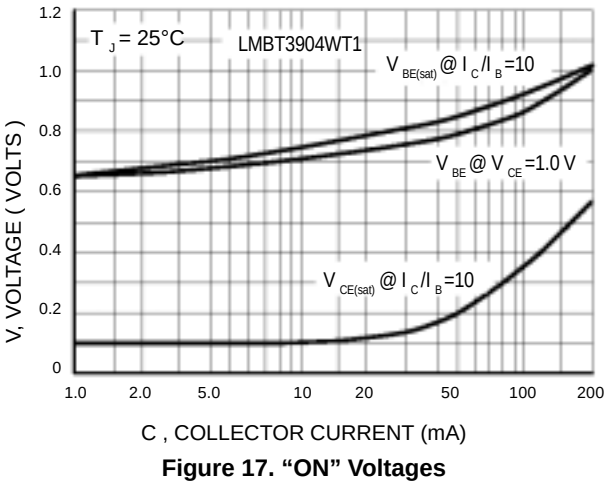


Figure 17. “ON” Voltages

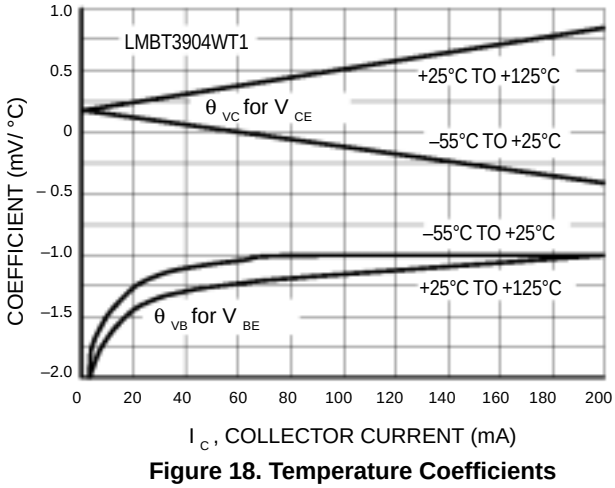
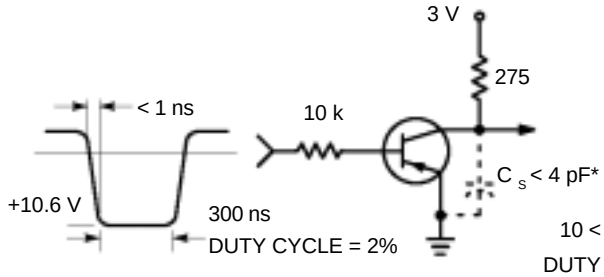


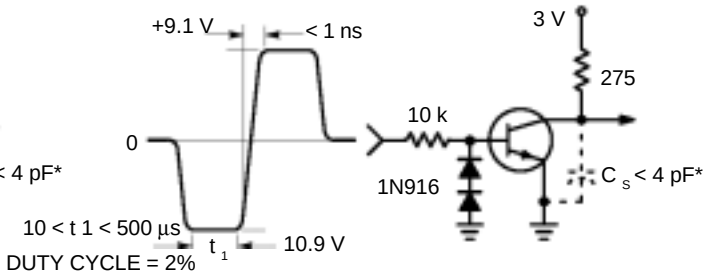
Figure 18. Temperature Coefficients

DEVICE CHARACTERISTICS

MMBT3904W-MMBT3906W

MMBT3906W





* 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

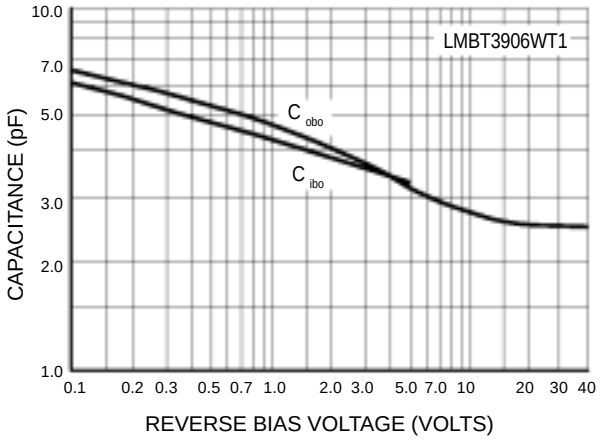


Figure 21. Capacitance

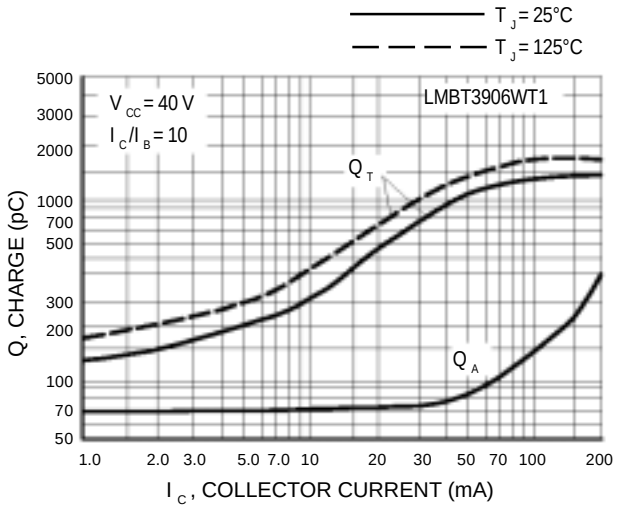


Figure 22. Charge Data

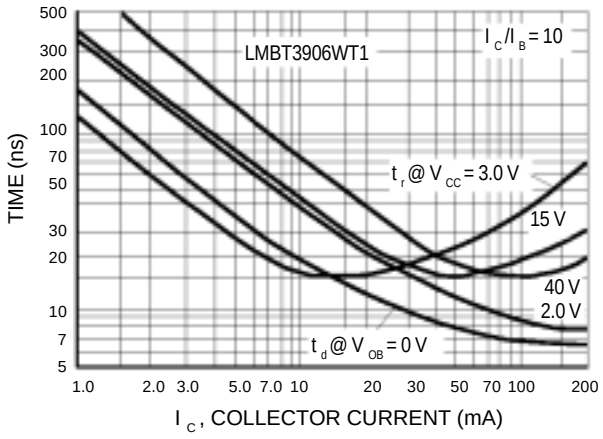


Figure 23. Turn–On Time

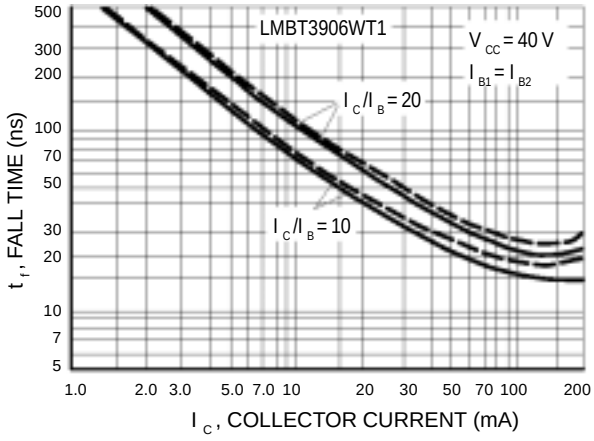


Figure 24. Fall Time

MMBT3906W

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

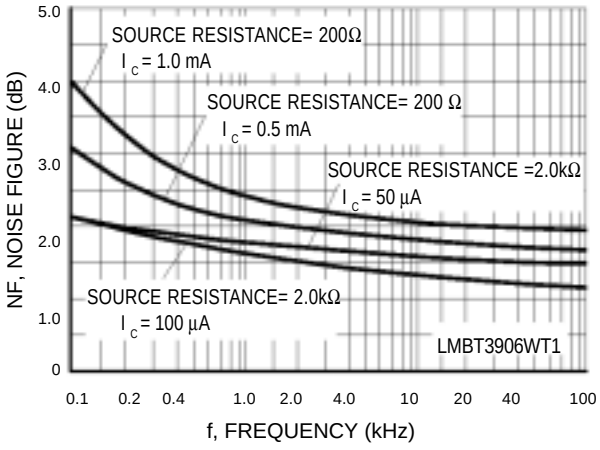


Figure 25

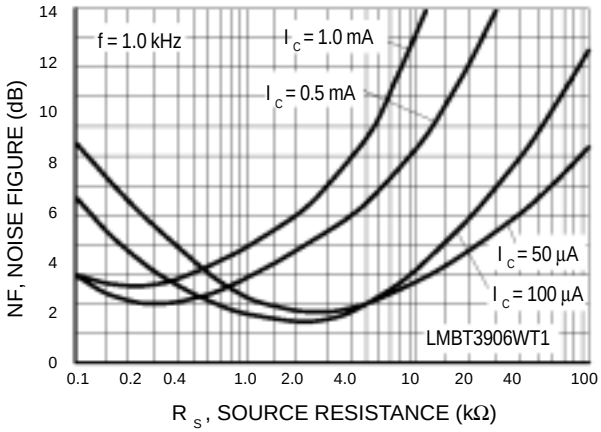


Figure 26

h PARAMETERS

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

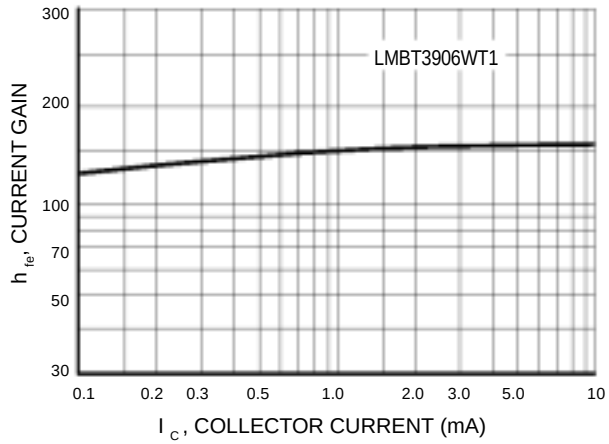


Figure 27. Current Gain

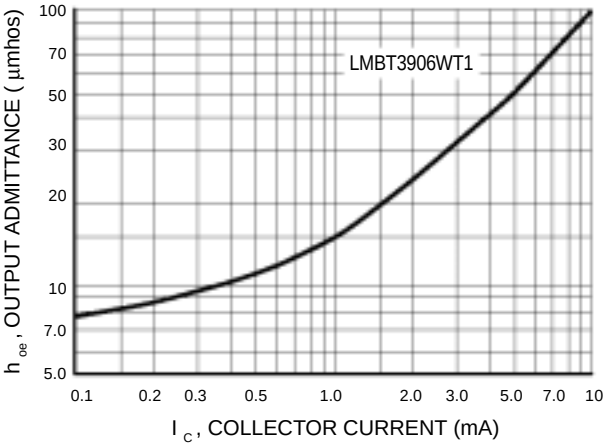


Figure 28. Output Admittance

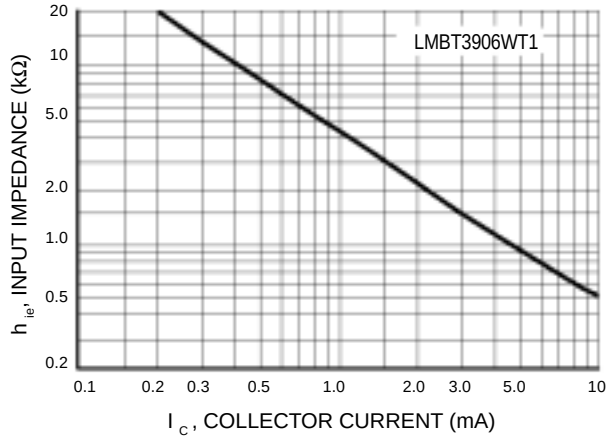


Figure 29. Input Impedance

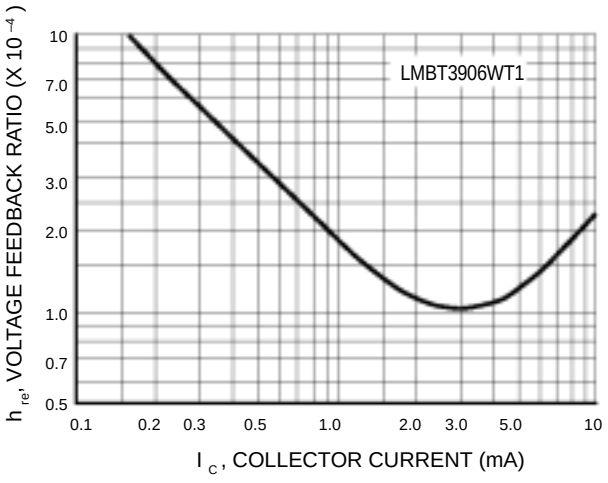


Figure 30. Voltage Feedback Ratio

DEVICE CHARACTERISTICS

MMBT3904W-MMBT3906W

MMBT3906W

STATIC CHARACTERISTICS

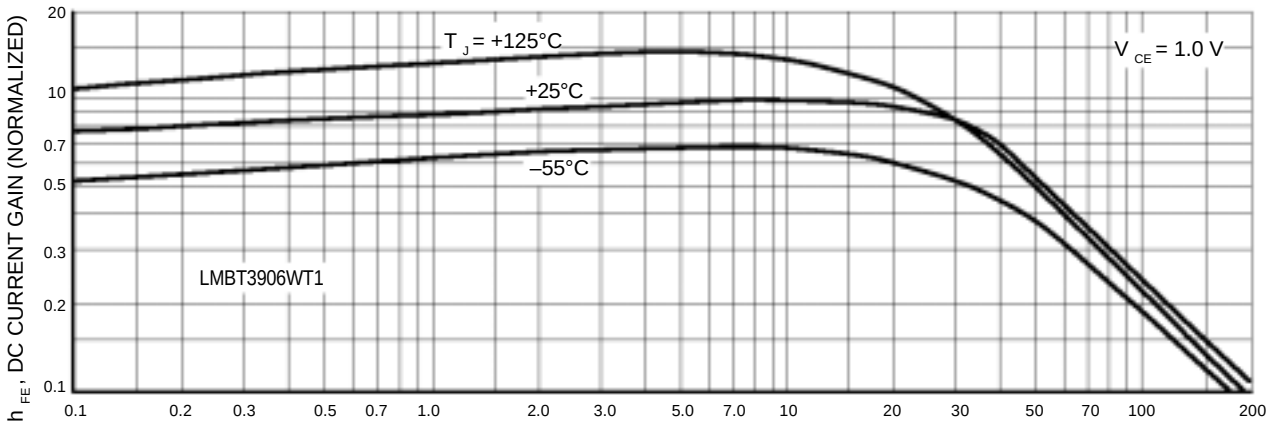


Figure 31. DC Current Gain

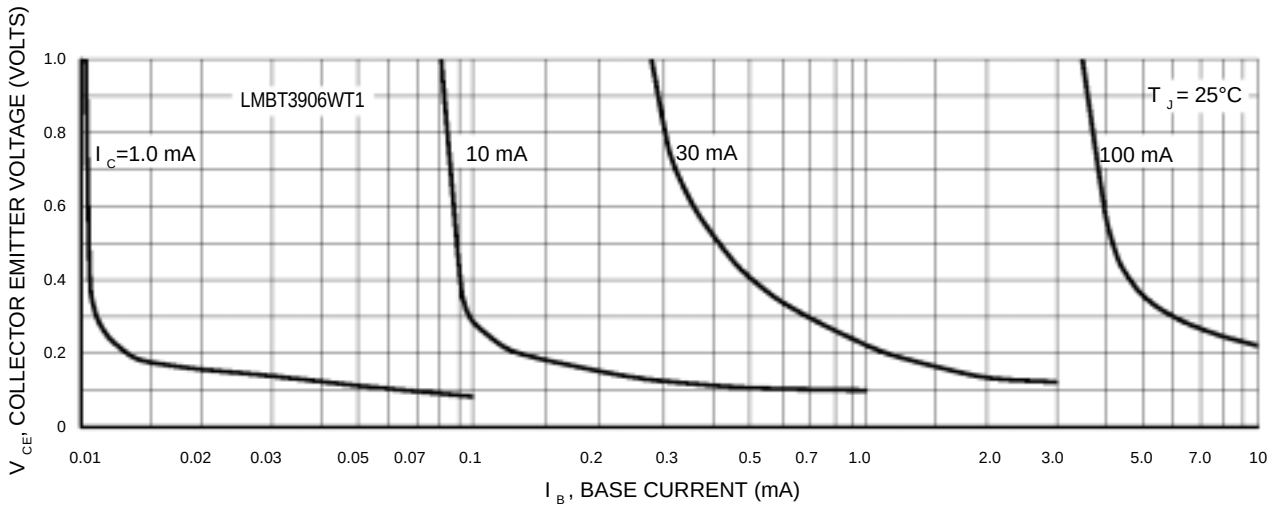


Figure 32. Collector Saturation Region

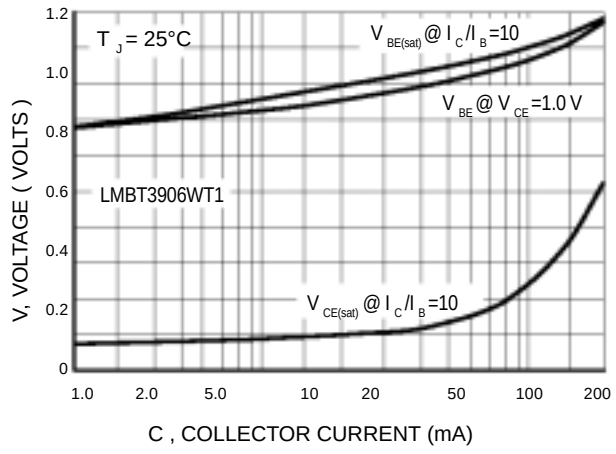


Figure 33. "ON" Voltages

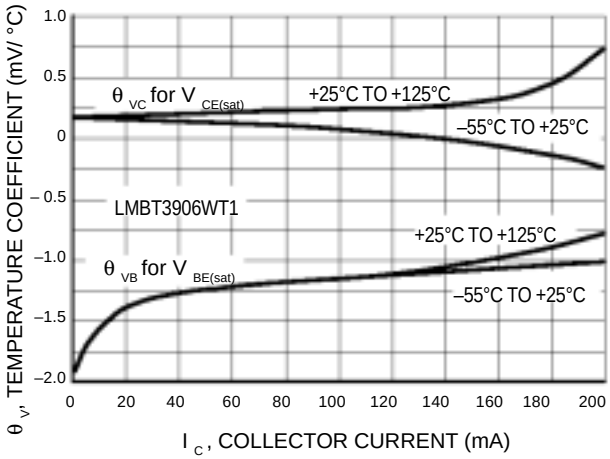


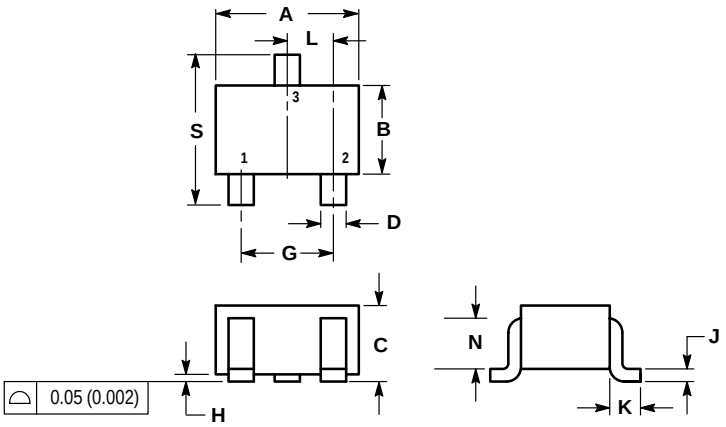
Figure 34. Temperature Coefficients

PACKAGE OUTLINE & DIMENSIONS

MMBT3904W-MMBT3906W

SC–70 / SOT–323

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



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.032	0.040	0.80	1.00
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.650 BSC	
N	0.028 REF		0.700 REF	
S	0.079	0.095	2.00	2.40