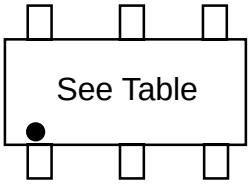
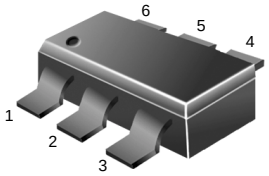
Dual General Purpose Transistors

MBT3904DW1T1
MBT3906DW1T1
MBT3946DW1T1

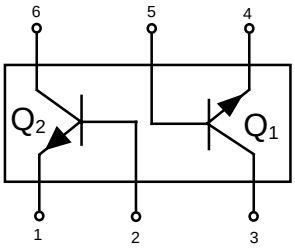
The MBT3904DW1T1, MBT3906DW1T1, and MBT3946DW1T1 devices are spin–offs of our popular SOT–23/SOT–323 three–leaded devices. They are designed for general purpose amplifier applications and are housed in the SOT–363 six–leaded surface mount package. By putting two discrete devices in one package, these devices are ideal for low–power surface mount applications where board space is at a premium.

- h_{FE}, 100–300
- Low $V_{CE(sat)}$, 3 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7–inch/3,000 Unit Tape and Reel

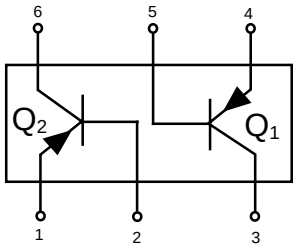




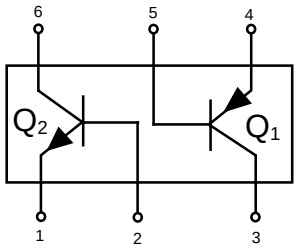
SOT–363/SC–88
CASE 419B STYLE 1



MBT3904DW1T1



MBT3906DW1T1



MBT3946DW1T1

*Q_1 same as MBT3906DW1T1
Q_2 same as MBT3904DW1T1

MAXIMUM RATINGS

Rating	Symbol	Voltage	Unit
Collector–Emitter Voltage	V_{CEO}		V
MBT3904DW1T1 (NPN)		40	
MBT3906DW1T1 (PNP)		–40	
Collector–Base Voltage	V_{CBO}		V
MBT3904DW1T1 (NPN)		60	
MBT3906DW1T1 (PNP)		–40	
Emitter–Base Voltage	V_{EBO}		V
MBT3904DW1T1 (NPN)		6.0	
MBT3906DW1T1 (PNP)		–5.0	
Collector Current –Continuous	I_C		mAdc
MBT3904DW1T1 (NPN)		200	
MBT3906DW1T1 (PNP)		–200	
Electrostatic Discharge	ESD	HBM>16000, MM>2000	V

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

ORDERING INFORMATION

Device	Package	Shipping
MBT3904DW1T1	SOT–363	3000 Units/Reel
MBT3906DW1T1	SOT–363	3000 Units/Reel
MBT3946DW1T1	SOT–363	3000 Units/Reel

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

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (2)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MBT3904DW1T1 (NPN)		40	—	
(I_C = –1.0 mAdc, I_B = 0)	MBT3906DW1T1 (PNP)		–40	—	
Collector–Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 µAdc, I_E = 0)	MBT3904DW1T1 (NPN)		60	—	
(I_C = –10 µAdc, I_E = 0)	MBT3906DW1T1 (PNP)		–40	—	
Emitter–Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 µAdc, I_C = 0)	MBT3904DW1T1 (NPN)		6.0	—	
(I_E = –10 µAdc, I_C = 0)	MBT3906DW1T1 (PNP)		–5.0	—	
Base Cutoff Current		I_{BL}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MBT3904DW1T1 (NPN)		—	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MBT3906DW1T1 (PNP)		—	–50	
Collector Cutoff Current		I_{CEX}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	MBT3904DW1T1 (NPN)		—	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	MBT3906DW1T1 (PNP)		—	–50	
ON CHARACTERISTICS (2)					
DC Current Gain		h_{FE}			Vdc
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MBT3904DW1T1 (NPN)		40	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			70	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	—	
(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)	MBT3906DW1T1 (PNP)		60	—	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)			80	—	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)			100	—	
(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)	MBT3904DW1T1 (NPN)		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.3	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MBT3906DW1T1 (PNP)		—	– 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)	MBT3904DW1T1 (NPN)		0.65	0.85	
(I C = 50 mAdc, I B = 5.0 mAdc)			—	0.95	
(I C = –10 mAdc, I B = –1.0 mAdc)	MBT3906DW1T1 (PNP)		–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)	MBT3904DW1T1 (NPN)		300	—	
(I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	MBT3906DW1T1 (PNP)		250	—	
Output Capacitance		C_{obo}			pF
(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MBT3904DW1T1 (NPN)		—	4.0	
(V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	MBT3906DW1T1 (PNP)		—	4.5	
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MBT3904DW1T1 (NPN)		—	8.0	
(V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	MBT3906DW1T1 (PNP)		—	10.0	

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

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

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

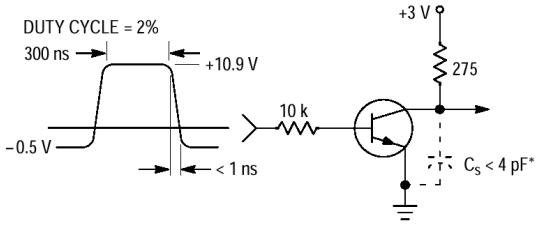
Characteristic		Symbol	Min	Max	Unit
Input Impedance		h_{ie}			k Ω
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MBT3904DW1T1 (NPN)		1.0	10	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MBT3906DW1T1 (PNP)		2.0	12	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MBT3904DW1T1 (NPN)		0.5	8.0	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MBT3906DW1T1 (PNP)		0.1	10	
Small–Signal Current Gain		h_{fe}			—
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MBT3904DW1T1 (NPN)		100	400	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MBT3906DW1T1 (PNP)		100	400	
Output Admittance		h_{oe}			µmhos
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MBT3904DW1T1 (NPN)		1.0	40	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MBT3906DW1T1 (PNP)		3.0	60	
Noise Figure		NF			dB
(V_{CE} = 5.0 Vdc, I_C = 100 µAdc, R_S = 1.0 k W, f = 1.0 kHz)	MBT3904DW1T1 (NPN)		—	5.0	
(V_{CE} = –5.0 Vdc, I_C = –100 µAdc, R_S = 1.0 k W, f = 1.0 kHz)	MBT3906DW1T1 (PNP)		—	4.0	

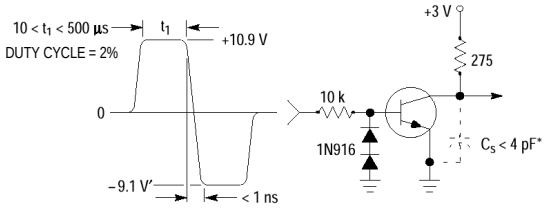
SWITCHING CHARACTERISTICS

Delay Time (V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	MBT3904DW1T1 (NPN)	t_d	—	35	ns
(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	MBT3906DW1T1 (PNP)		—	35	
Rise Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	MBT3904DW1T1 (NPN)	t_r	—	35	ns
(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	MBT3906DW1T1 (PNP)		—	35	
Storage Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	MBT3904DW1T1 (NPN)	t_s	—	200	ns
(V_{CC} = –3.0 Vdc, I_C = –10 mAdc)	MBT3906DW1T1 (PNP)		—	225	
Fall Time (I_{B1} = I_{B2} = 1.0 mAdc)	MBT3904DW1T1 (NPN)	t_f	—	50	ns
(I_{B1} = I_{B2} = –1.0 mAdc)	MBT3906DW1T1 (PNP)		—	70	

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3904DW1T1 (NPN)





* Total shunt capacitance of test jig and connectors

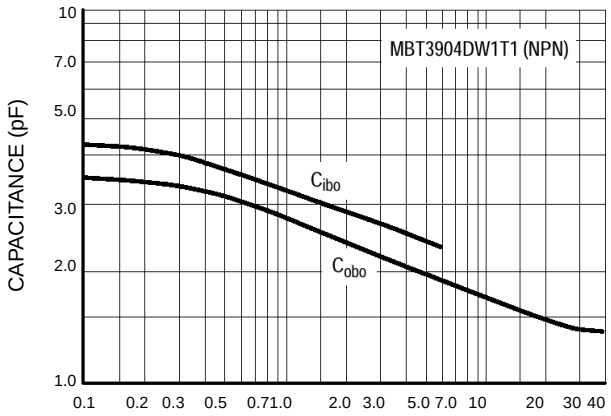
Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

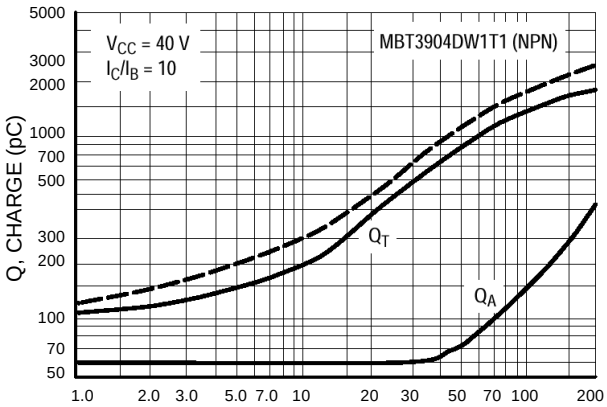
T J = 25°C

T J = 125°C



REVERSE BIAS VOLTAGE (VOLTS)

Figure 3. Capacitancere

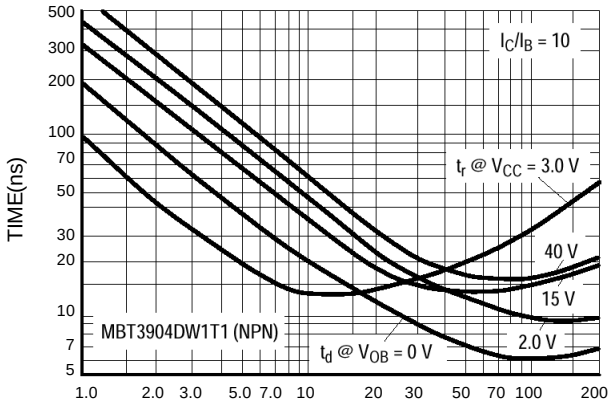


I C , COLLECTOR CURRENT (mA)

Figure 4. Charge Data

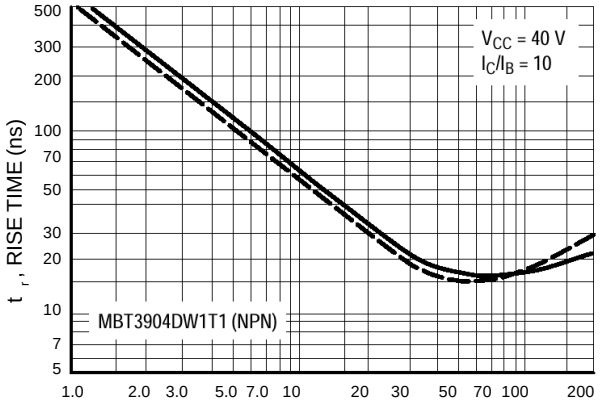
MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3904DW1T1 (NPN)



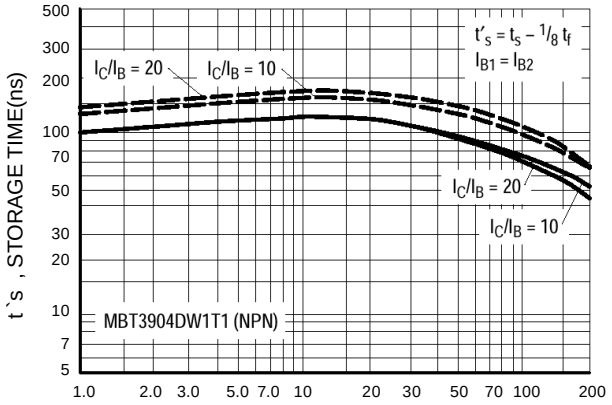
I C , COLLECTOR CURRENT (mA)

Figure 5. Turn–On Time



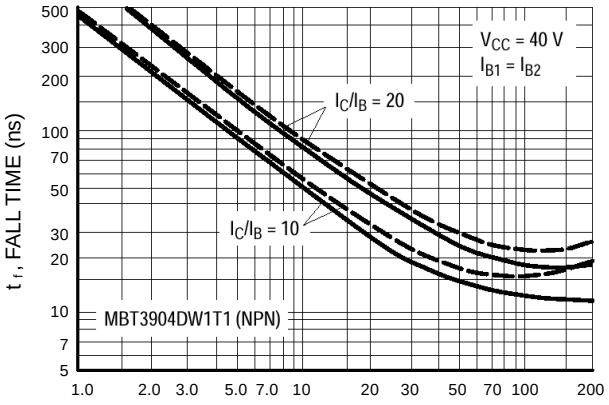
I C , COLLECTOR CURRENT (mA)

Figure 6. Rise Time



I C , COLLECTOR CURRENT (mA)

Figure 7. Storage Time



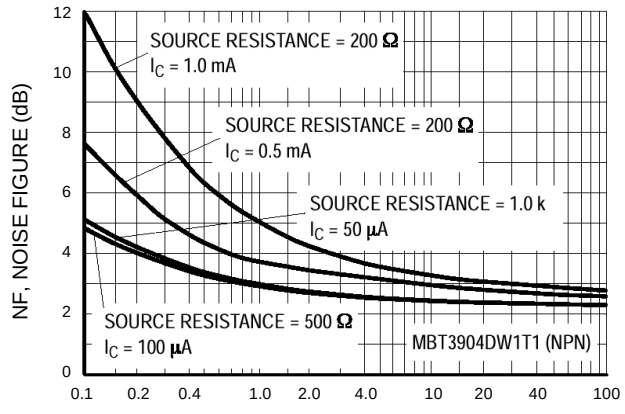
I C , COLLECTOR CURRENT (mA)

Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS

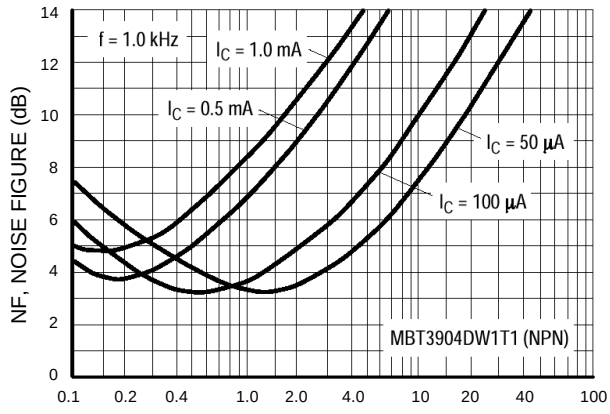
NOISE FIGURE VARIATIONS

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



f,FREQUENCY (kHz)

Figure 9. Noise Figure



R S , SOURCE RESISTANCE (kΩ)

Figure 10. Noise Figure

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3904DW1T1 (NPN)
h PARAMETERS
(V CE = 10 Vdc, f = 1.0 kHz, T A = 25°C)

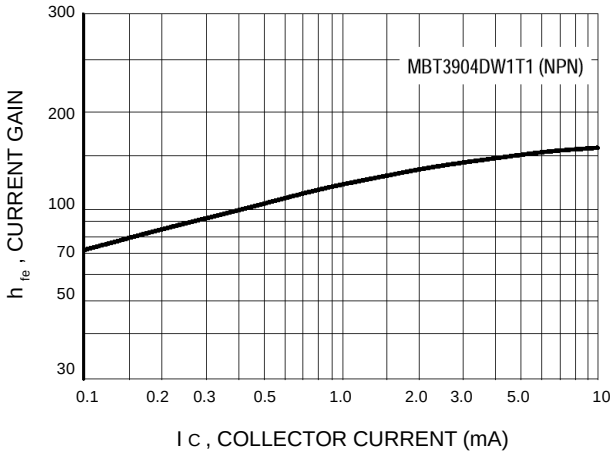


Figure 11. Current Gain

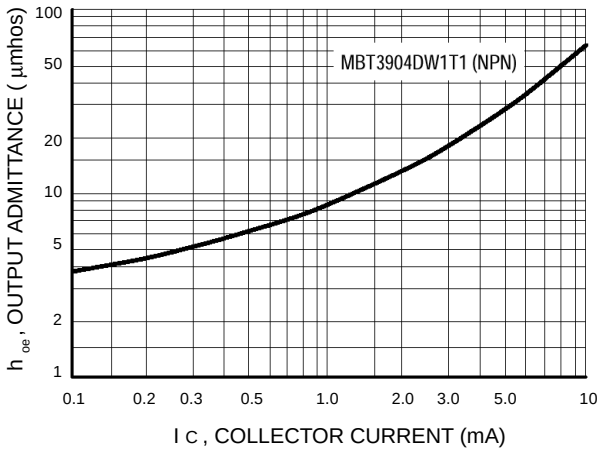


Figure 12. Output Admittance

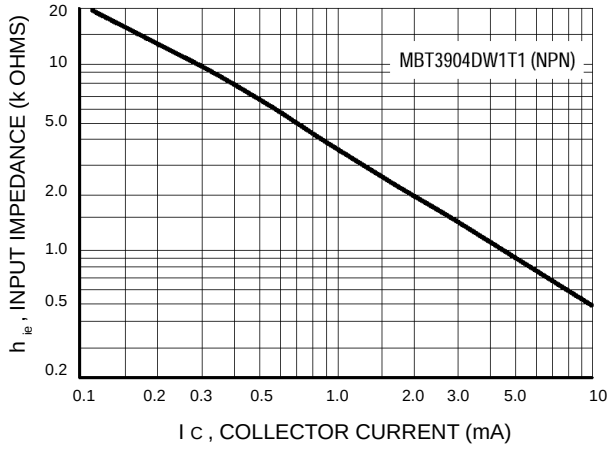


Figure 13. Input Impedance

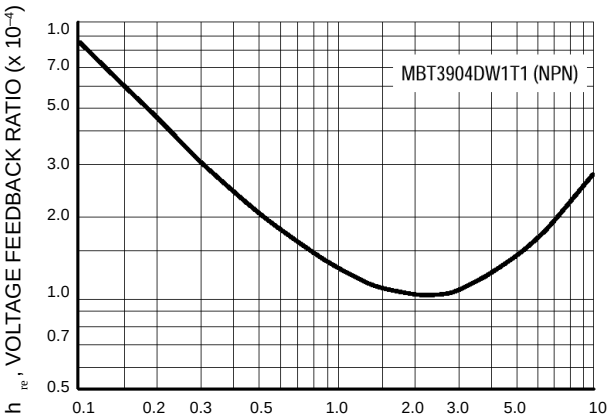


Figure 14. Voltage Feedback Ratio

MBT3904DW1T1 (NPN)
TYPICAL STATIC CHARACTERISTICS

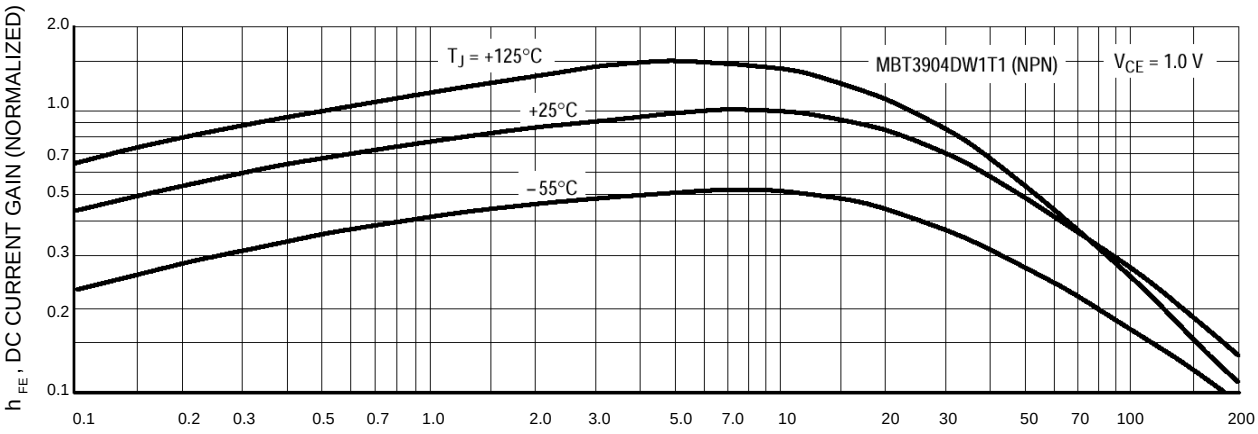


Figure 15. DC Current Gain

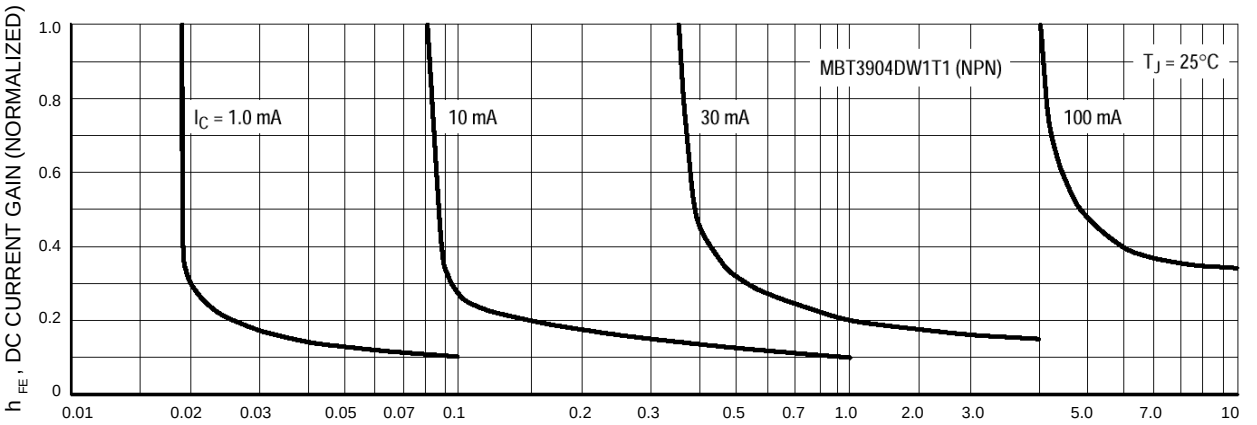


Figure 16. Collector Saturation Region

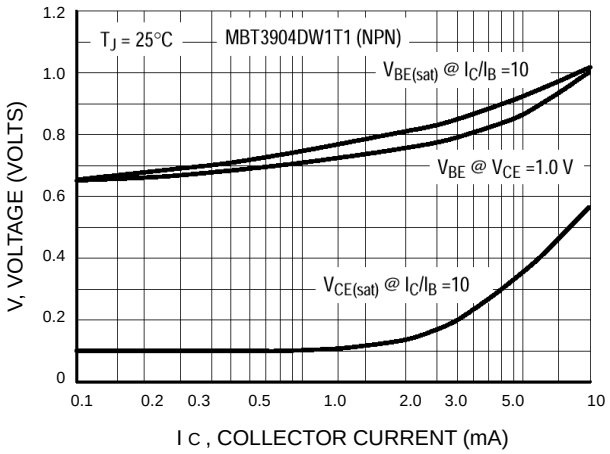


Figure 17. “ON” Voltages

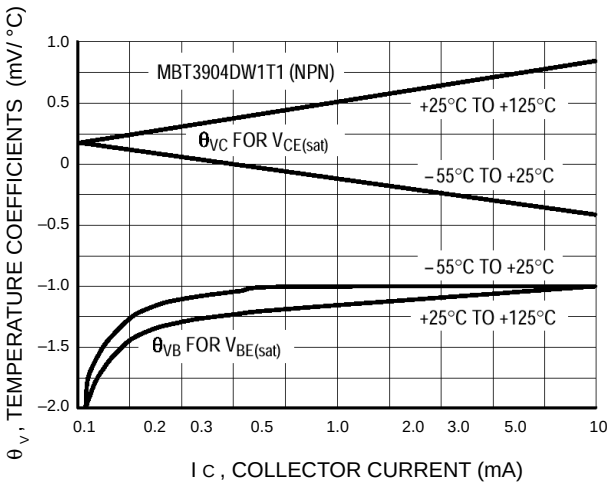
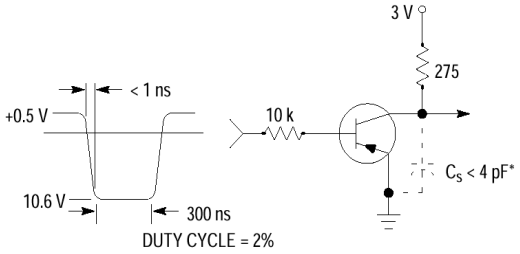
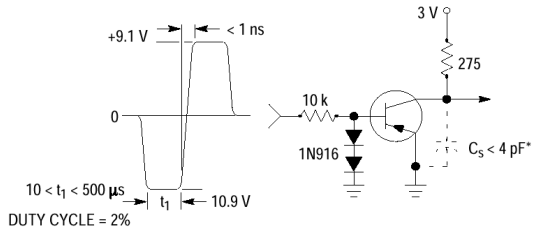


Figure 18. Temperature Coefficients

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3906DW1T1 (PNP)





* 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

——— T_J = 25°C

– – – – T_J = 125°C

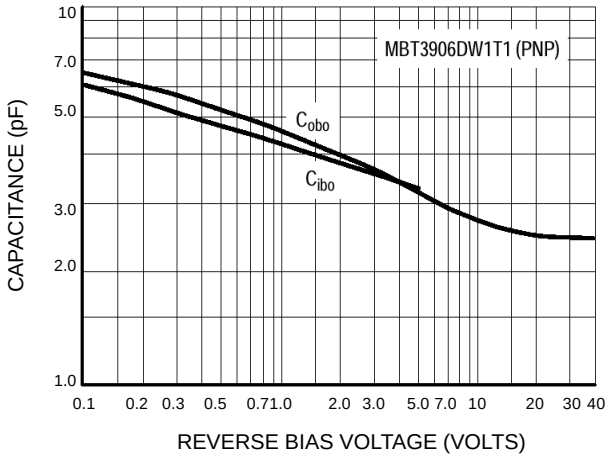


Figure 21. Capacitancere

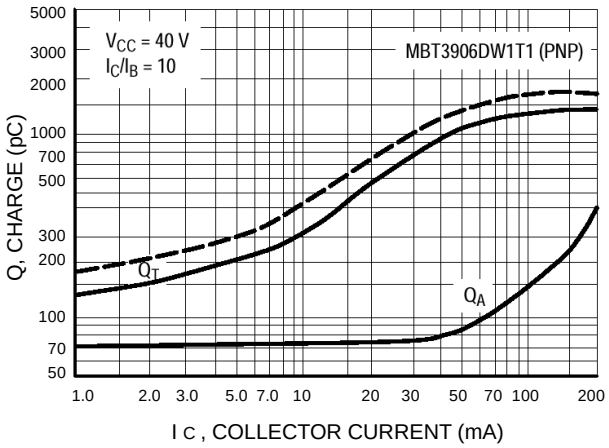


Figure 22. Charge Data

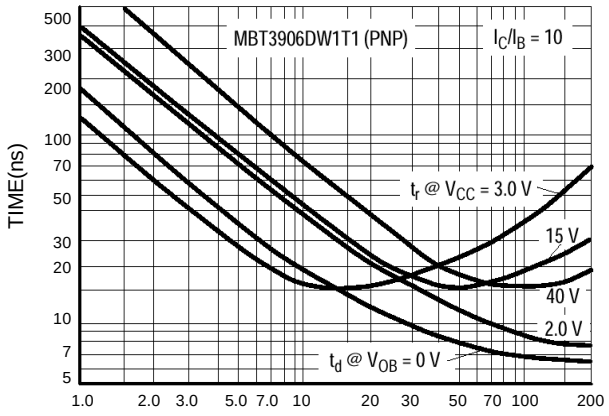


Figure 23. Turn–On Time

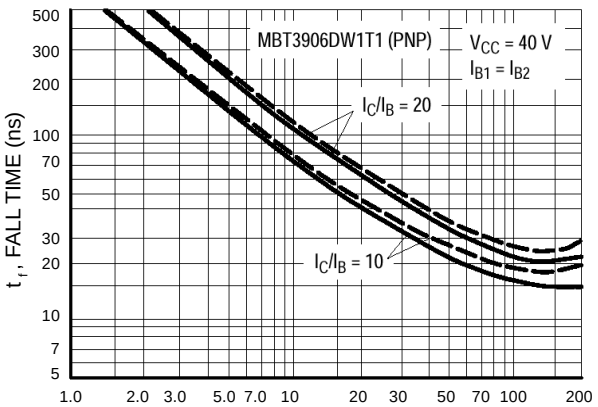


Figure 24. Fall Time

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3906DW1T1 (PNP)
TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

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

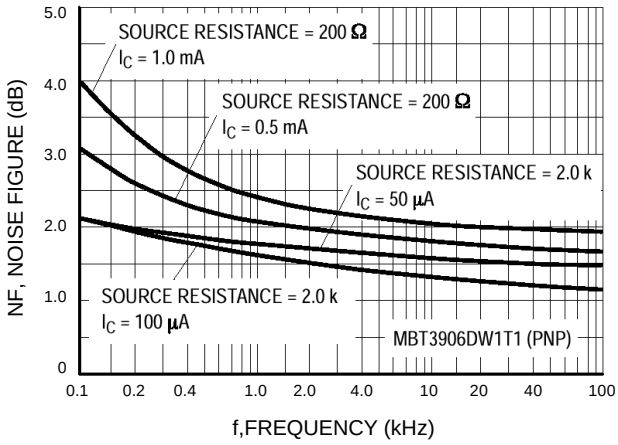


Figure 25. Noise Figure

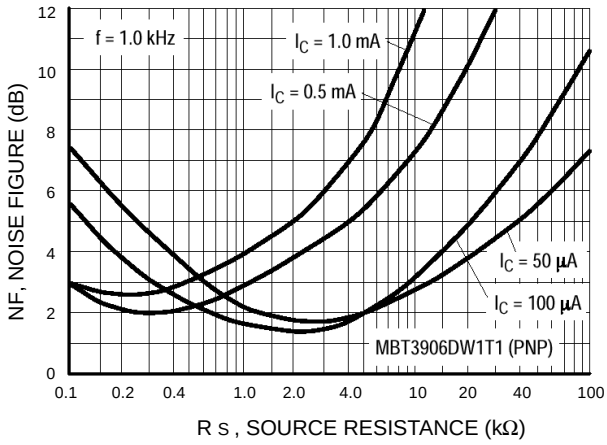


Figure 26. Noise Figure

h PARAMETERS

(V CE = –10 Vdc, f = 1.0 kHz, T A = 25°C)

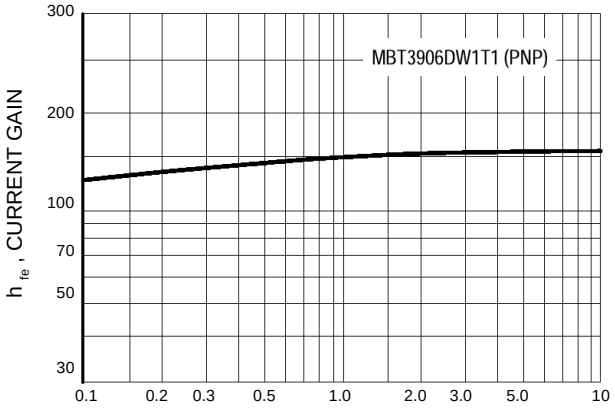


Figure 27. Current Gain

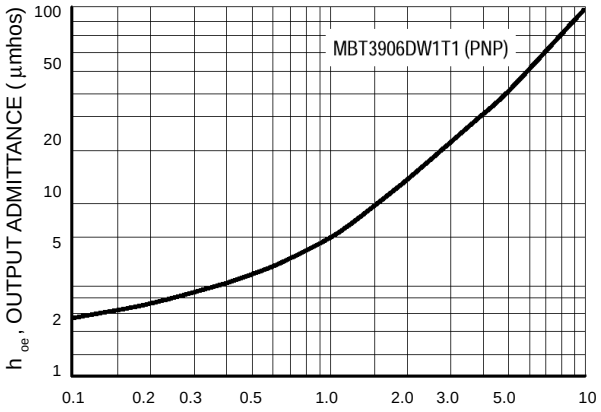


Figure 28. Output Admittance

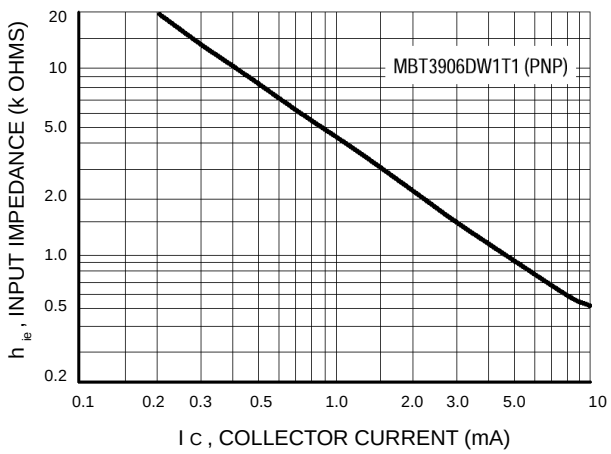


Figure 29. Input Impedance

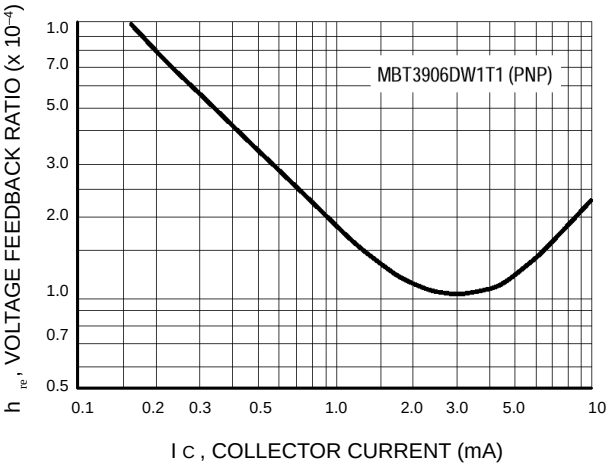


Figure 30. Voltage Feedback Ratio

MBT3904DW1T1, MBT3906DW1T1, MBT3946DW1T1

MBT3906DW1T1 (PNP)
TYPICAL STATIC CHARACTERISTICS

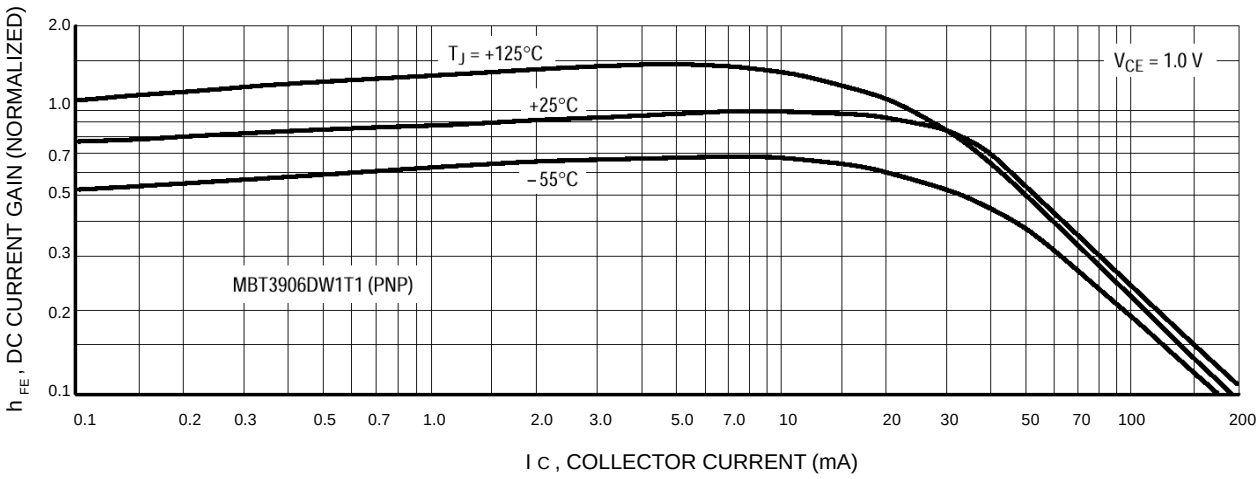


Figure 31. DC Current Gain

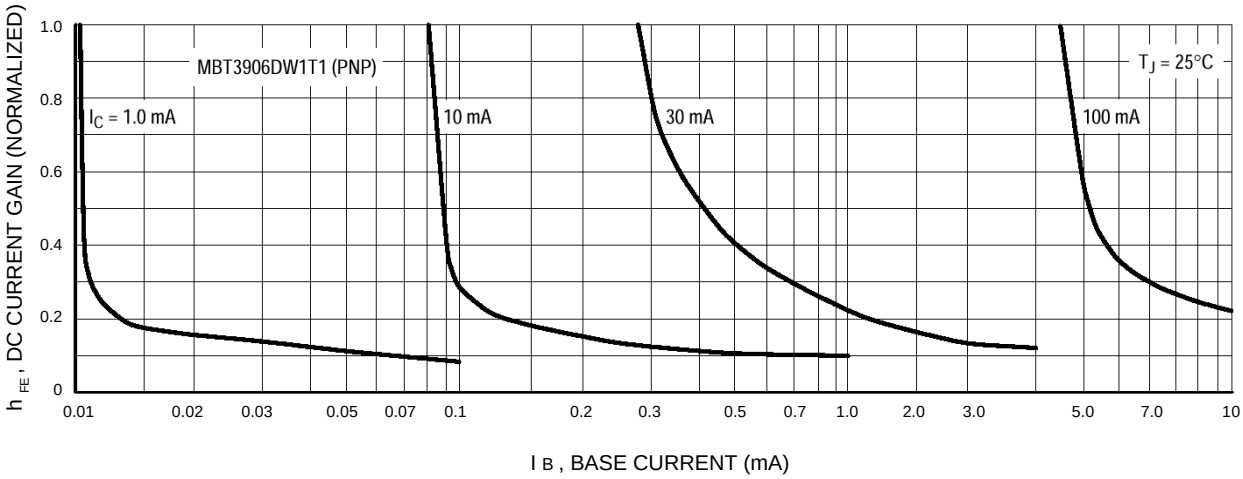


Figure 32. Collector Saturation Region

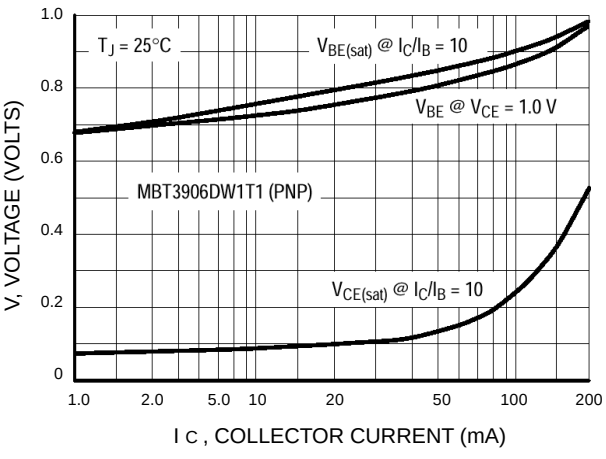


Figure 33. “ON” Voltages

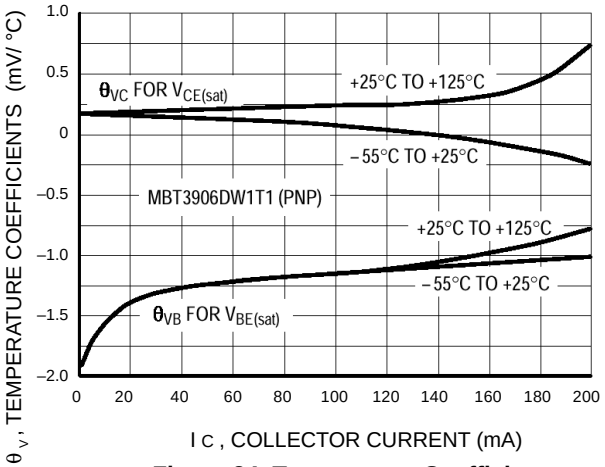


Figure 34. Temperature Coefficients