

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.

DEVICE MARKING AND ORDERING INFORMATION

Device	Marking	Package	Shipping
LMBT3904WT1	AM	SOT-323/SC-70	3000/Tape&Reel
LMBT3904WT1G	AM (Pb-Free)	SOT-323/SC-70	3000/Tape&Reel
LMBT3906WT1	2A	SOT-323/SC-70	3000/Tape&Reel
LMBT3906WT1G	2A (Pb-Free)	SOT-323/SC-70	3000/Tape&Reel

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Emitter Voltage	LMBT3904WT1	V_{CEO}	40	Vdc
	LMBT3906WT1		– 40	
Collector-Base Voltage	LMBT3904WT1	V_{CBO}	60	Vdc
	LMBT3906WT1		– 40	
Emitter-Base Voltage	LMBT3904WT1	V_{EBO}	6.0	Vdc
	LMBT3906WT1		– 5.0	
Collector Current — Continuous	LMBT3904WT1	I_C	200	mAdc
	LMBT3906WT1		– 200	

THERMAL CHARACTERISTICS

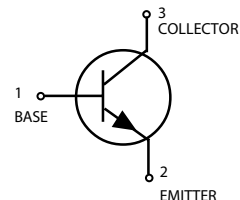
Characteristic	Symbol	Max	Unit
Total Device Dissipation (1) $T_A=25\text{ }^{\circ}\text{C}$	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	$^{\circ}\text{C/W}$
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	$^{\circ}\text{C}$

NPN
LMBT3904WT1
PNP
LMBT3906WT1

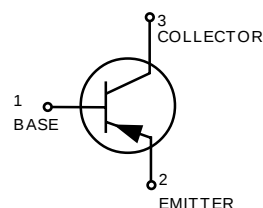
GENERAL PURPOSE
AMPLIFIER TRANSISTORS
SURFACE MOUNT



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



LMBT3904WT1



LMBT3906WT1

NPN LMBT3904WT1 PNP LMBT3906WT1
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

Collector–Emitter Breakdown Voltage (2)					
(I _C = 1.0 mAdc, I _B = 0)	LMBT3904WT1	V _{(BR)CEO}	40	—	Vdc
(I _C = −1.0 mAdc, I _B = 0)	LMBT3906WT1		− 40	—	
Collector–Base Breakdown Voltage					
(I _C = 10 μAdc, I _E = 0)	LMBT3904WT1	V _{(BR)CBO}	60	—	Vdc
(I _C = −10 μAdc, I _E = 0)	LMBT3906WT1		− 40	—	
Emitter–Base Breakdown Voltage					
(I _E = 10 μAdc, I _C = 0)	LMBT3904WT1	V _{(BR)EBO}	6.0	—	Vdc
(I _E = −10 μAdc, I _C = 0)	LMBT3906WT1		− 5.0	—	
Base Cutoff Current					
(V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	LMBT3904WT1	I _{BL}	—	50	nAdc
(V _{CE} = −30 Vdc, V _{EB} = −3.0 Vdc)	LMBT3906WT1		—	−50	
Collector Cutoff Current					
(V _{CE} = 30 Vdc, V _{EB} = 3.0 Vdc)	LMBT3904WT1	I _{CEX}	—	50	nAdc
(V _{CE} = −30 Vdc, V _{EB} = −3.0 Vdc)	LMBT3906WT1		—	− 50	

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

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

NPN LMBT3904WT1 PNP LMBT3906WT1

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}			—
($I_C = 0.1\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) LMBT3904WT1		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	—	
($I_C = -0.1\text{ mA}$, $V_{CE} = -1.0\text{ Vdc}$) LMBT3906WT1		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
($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) LMBT3904WT1		—	0.2	
($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$)		—	0.3	
($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$) LMBT3906WT1		—	-0.25	
($I_C = -50\text{ mA}$, $I_B = -5.0\text{ mA}$)		—	-0.4	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
($I_C = 10\text{ mA}$, $I_B = 1.0\text{ mA}$) LMBT3904WT1		0.65	0.85	
($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$)		—	0.95	
($I_C = -10\text{ mA}$, $I_B = -1.0\text{ mA}$) LMBT3906WT1		-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
($I_C = 10\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$) LMBT3904WT1		300	—	
($I_C = -10\text{ mA}$, $V_{CE} = -20\text{ Vdc}$, $f = 100\text{ MHz}$) LMBT3906WT1		250	—	
Output Capacitance	C_{obo}			pF
($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) LMBT3904WT1		—	4.0	
($V_{CB} = -5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) LMBT3906WT1		—	4.5	
Input Capacitance	C_{ibo}			pF
($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$) LMBT3904WT1		—	8.0	
($V_{EB} = -0.5\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$) LMBT3906WT1		—	10.0	
Input Impedance	h_{ie}			k Ω
($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3904WT1		1.0	10	
($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3906WT1		2.0	12	
Voltage Feedback Ratio	h_{re}			$\times 10^{-4}$
($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3904WT1		0.5	8.0	
($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3906WT1		0.1	10	
Small-Signal Current Gain	h_{fe}			—
($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3904WT1		100	400	
($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3906WT1		100	400	
Output Admittance	h_{oe}			μmhos
($V_{CE} = 10\text{ Vdc}$, $I_C = 1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3904WT1		1.0	40	
($V_{CE} = -10\text{ Vdc}$, $I_C = -1.0\text{ mA}$, $f = 1.0\text{ kHz}$) LMBT3906WT1		3.0	60	
Noise Figure	NF			dB
($V_{CE} = 5.0\text{ Vdc}$, $I_C = 100\mu\text{A}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) LMBT3904WT1		—	5.0	
($V_{CE} = -5.0\text{ Vdc}$, $I_C = -100\mu\text{A}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) LMBT3906WT1		—	4.0	

NPN LMBT3904WT1 PNP LMBT3906WT1

SWITCHING CHARACTERISTICS

Delay Time ($V_{CC} = 3.0 \text{ Vdc}$, $V_{BE} = -0.5 \text{ Vdc}$)	LMBT3904WT1	t_d	—	35	
($V_{CC} = -3.0 \text{ Vdc}$, $V_{BE} = 0.5 \text{ Vdc}$)	LMBT3906WT1		—	35	ns
Rise Time ($I_C = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$)	LMBT3904WT1	t_r	—	35	
($I_C = -10 \text{ mAdc}$, $I_{B1} = -1.0 \text{ mAdc}$)	LMBT3906WT1		—	35	ns
Storage Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_C = 10 \text{ mAdc}$)	LMBT3904WT1	t_s	—	200	
($V_{CC} = -3.0 \text{ Vdc}$, $I_C = -10 \text{ mAdc}$)	LMBT3906WT1		—	225	ns
Fall Time ($I_{B1} = I_{B2} = 1.0 \text{ mAdc}$)	LMBT3904WT1	t_f	—	50	
($I_{B1} = I_{B2} = -1.0 \text{ mAdc}$)	LMBT3906WT1		—	75	ns

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

LMBT3904WT1

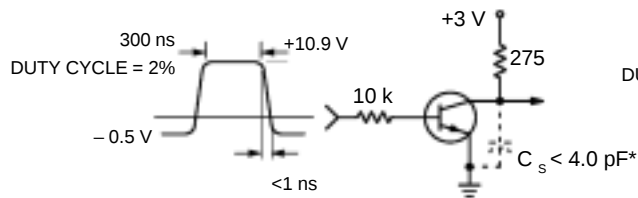


Figure 1. Delay and Rise Time
Equivalent Test Circuit

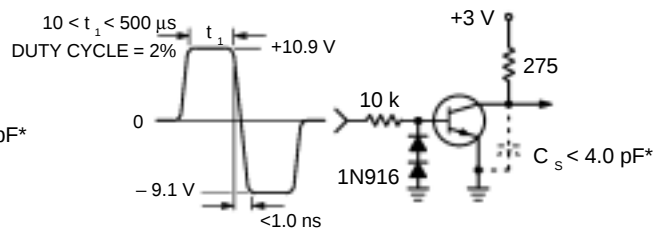


Figure 2. Storage and Fall Time
Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

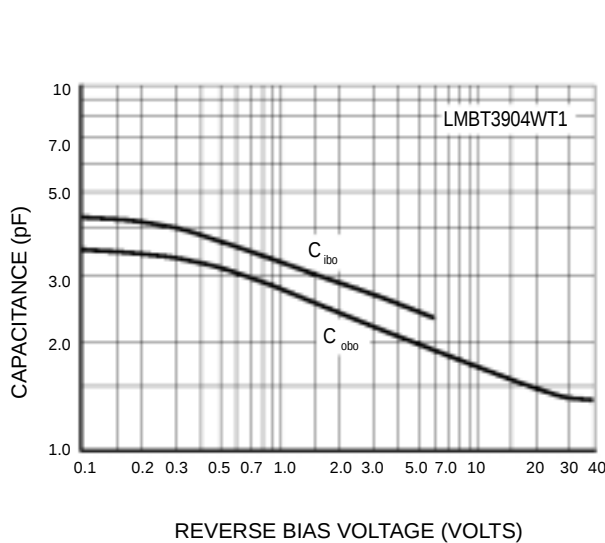


Figure 3. Capacitance

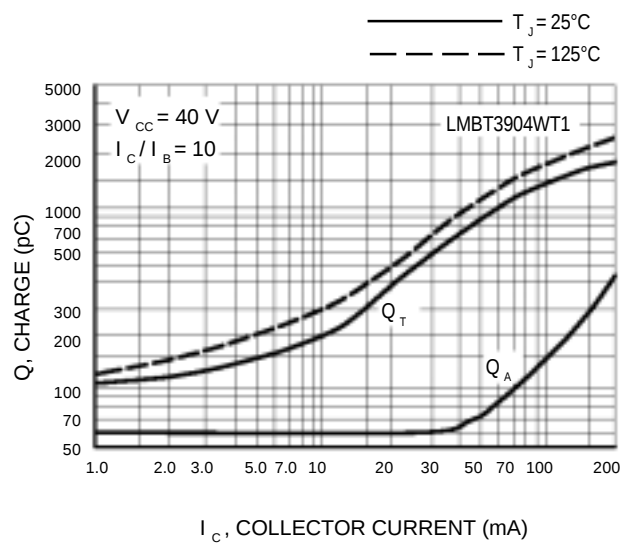


Figure 4. Charge Data

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3904WT1

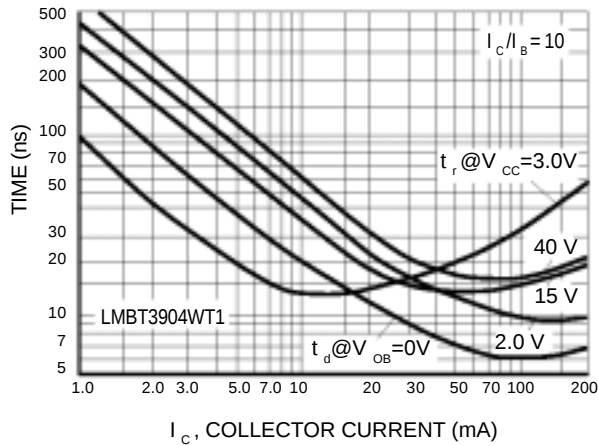


Figure 5. Turn-On Time

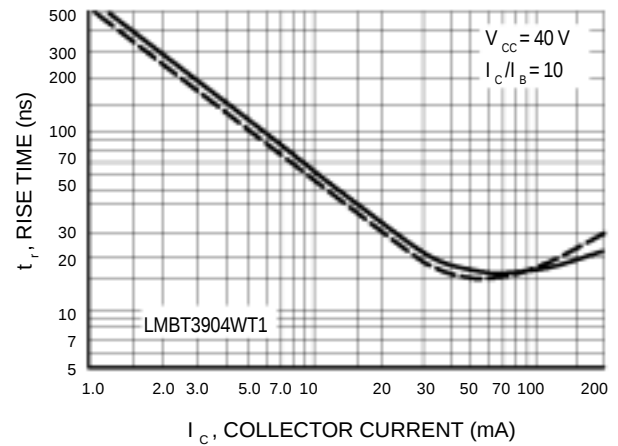


Figure 6. Rise Time

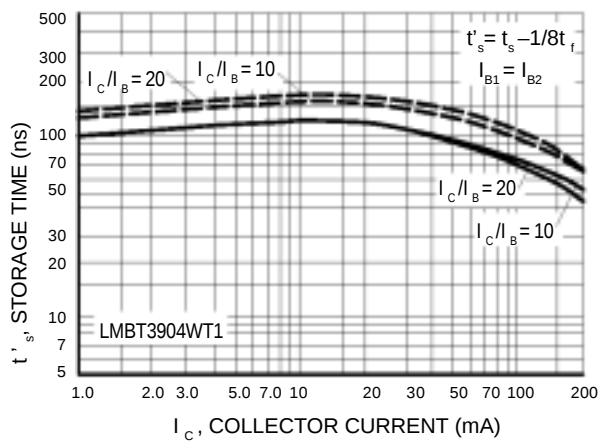


Figure 7. Storage Time

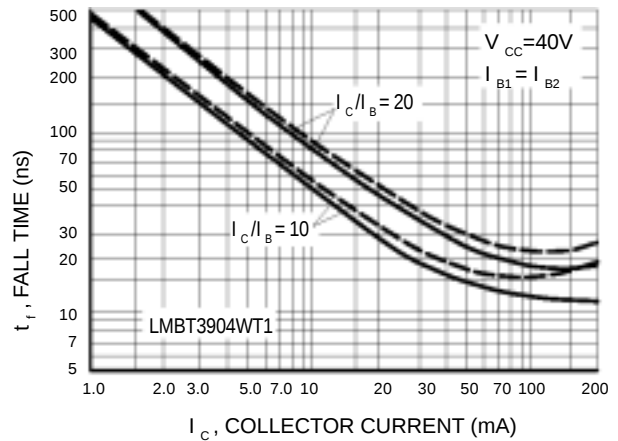


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

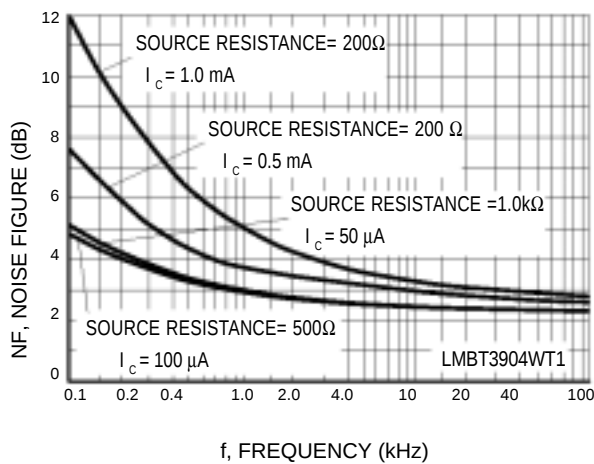


Figure 9. Noise Figure

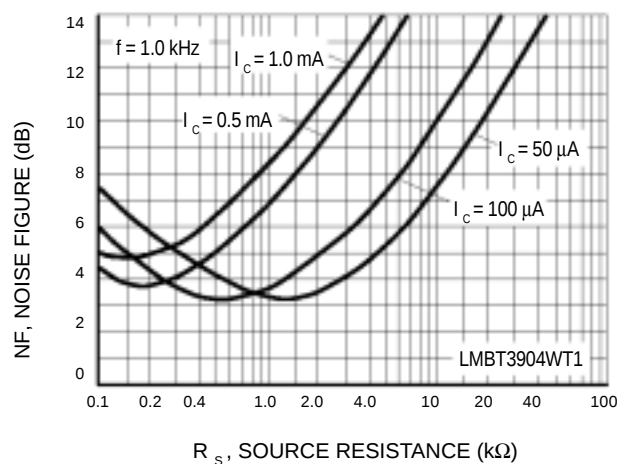


Figure 10. Noise Figure

NPN LMBT3904WT1 PNP LMBT3906WT1

h PARAMETERS

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

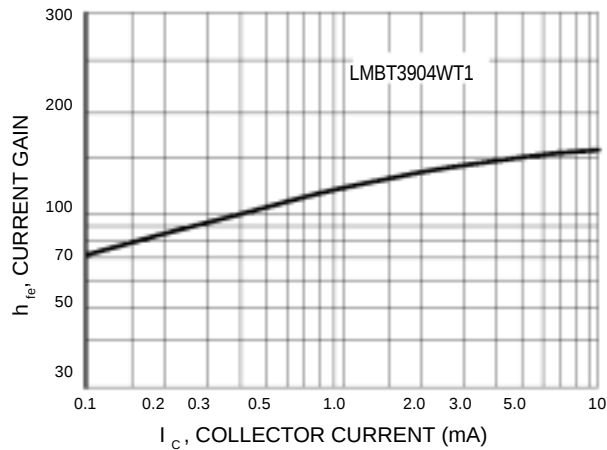


Figure 11. Current Gain

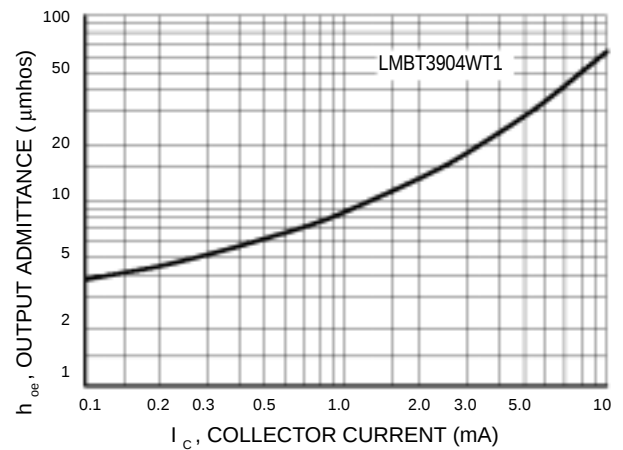


Figure 12. Output Admittance

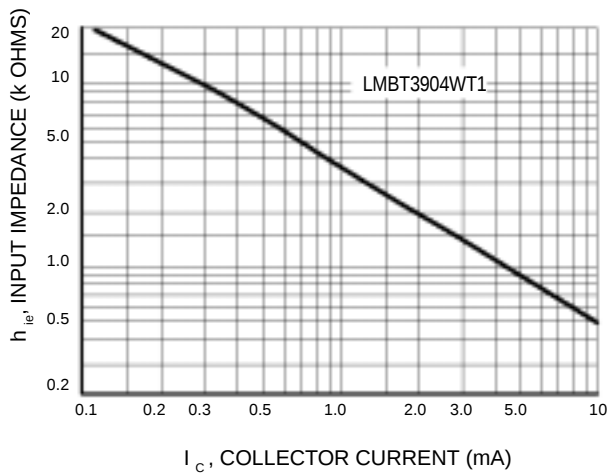


Figure 13. Input Impedance

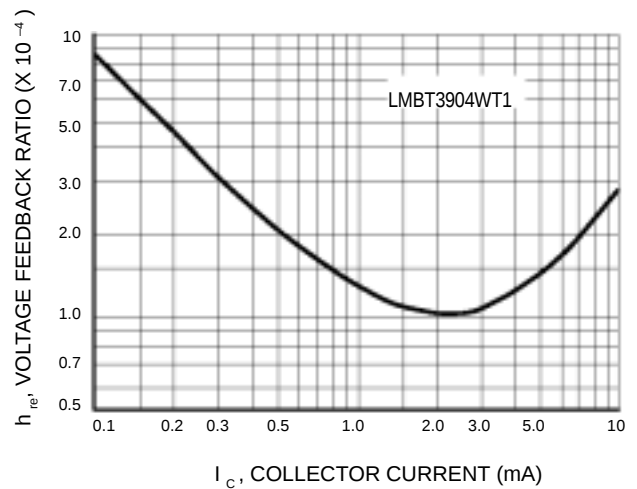


Figure 14. Voltage Feedback Ratio

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3904WT1
TYPICAL STATIC CHARACTERISTICS

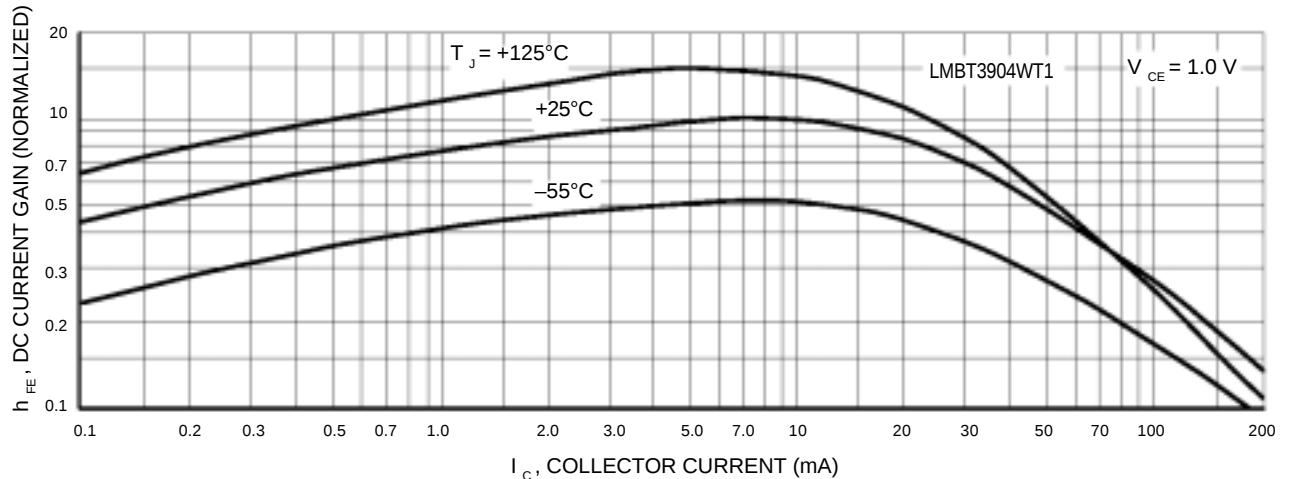


Figure 15. DC Current Gain

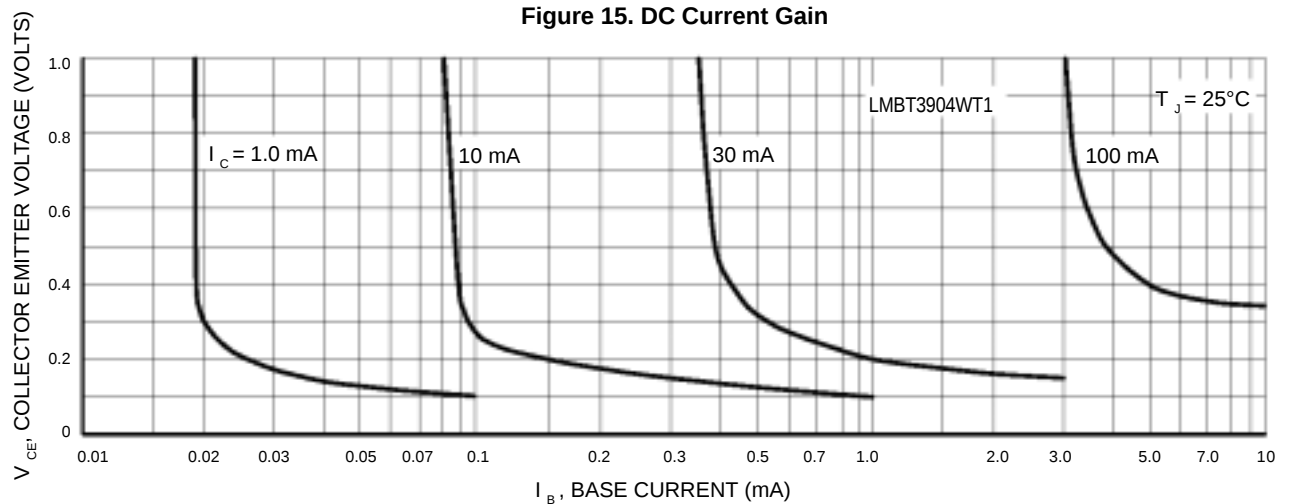


Figure 16. Collector Saturation Region

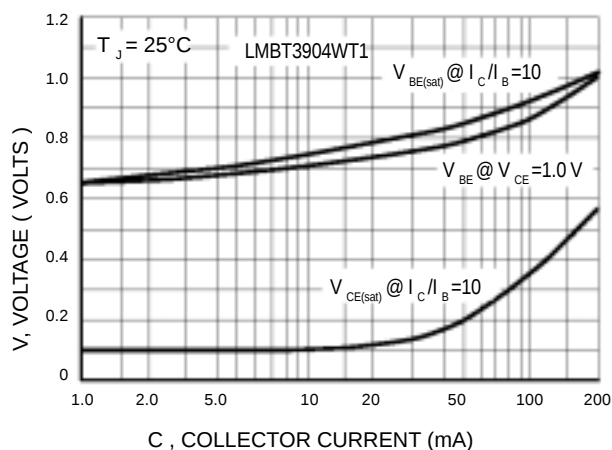


Figure 17. "ON" Voltages

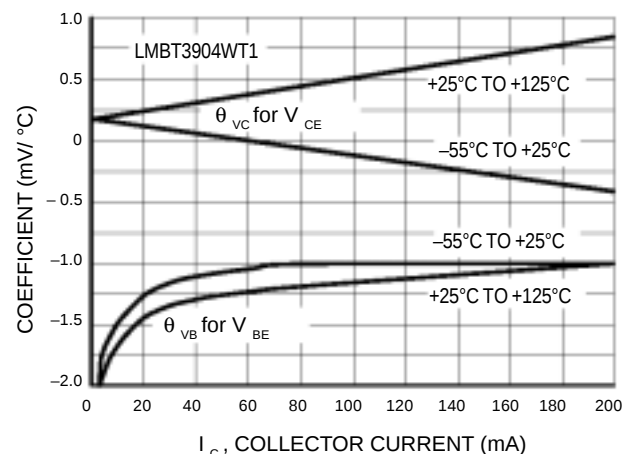
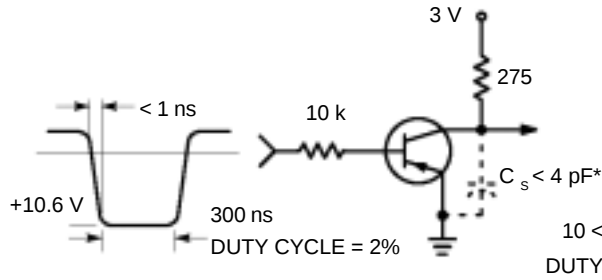


Figure 18. Temperature Coefficients

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3906WT1



* Total shunt capacitance of test jig and connectors

Figure 19. Delay and Rise Time
Equivalent Test Circuit

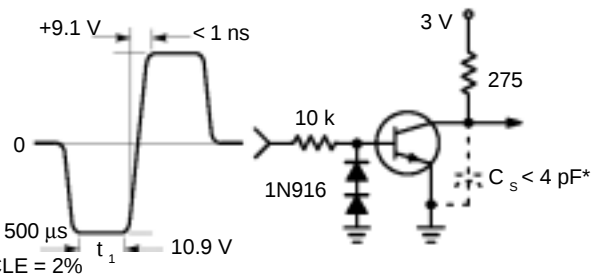


Figure 20. Storage and Fall Time
Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

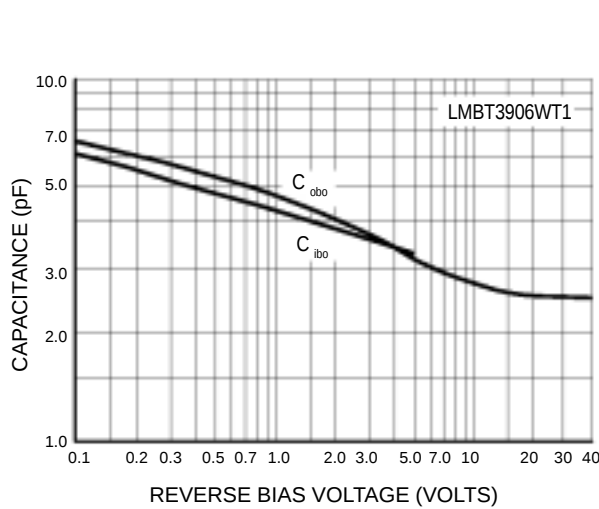


Figure 21. Capacitance

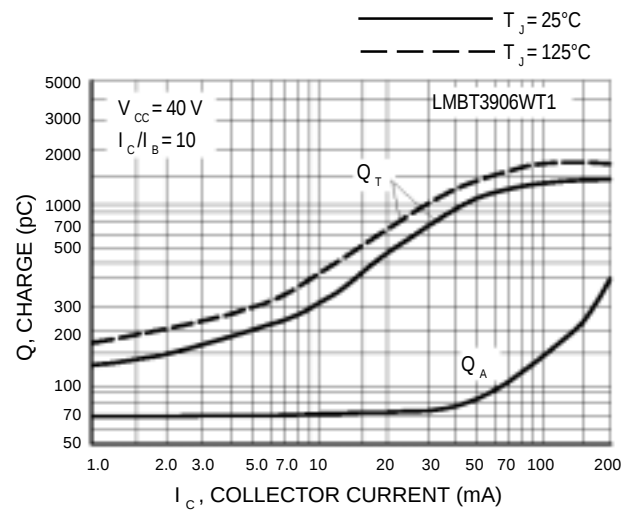


Figure 22. Charge Data

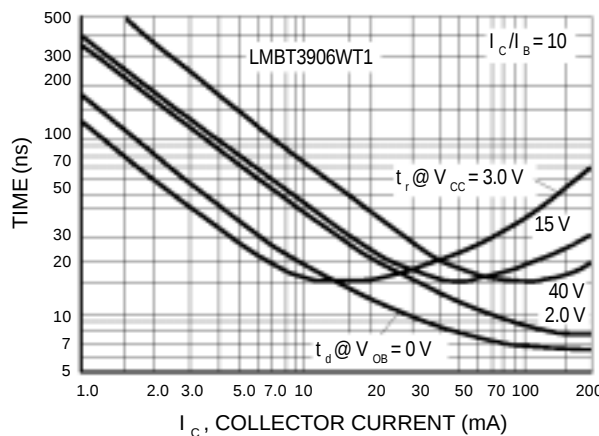


Figure 23. Turn-On Time

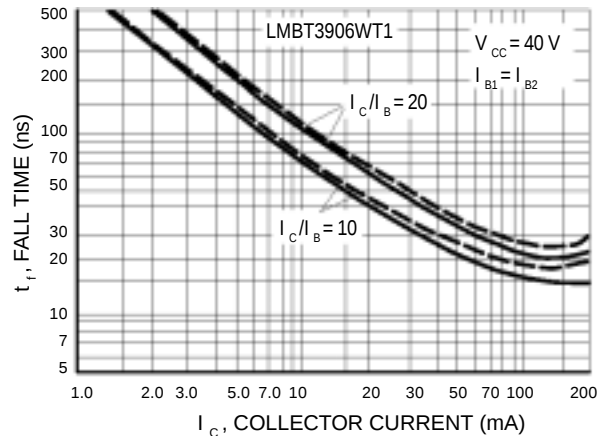


Figure 24. Fall Time

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3906WT1

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

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

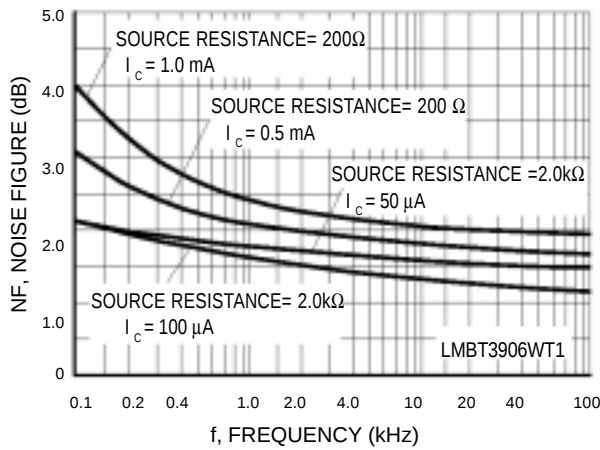


Figure 25

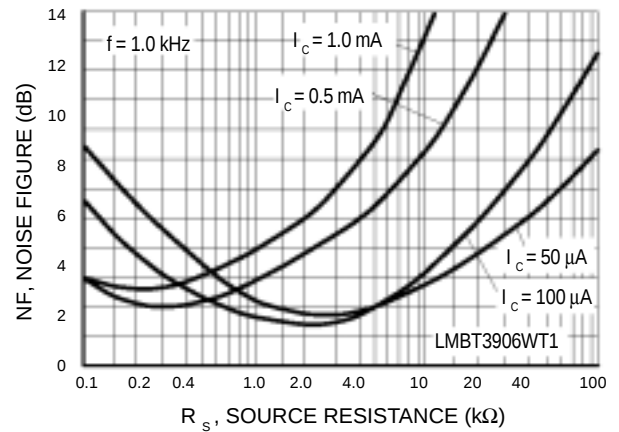


Figure 26

h PARAMETERS

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

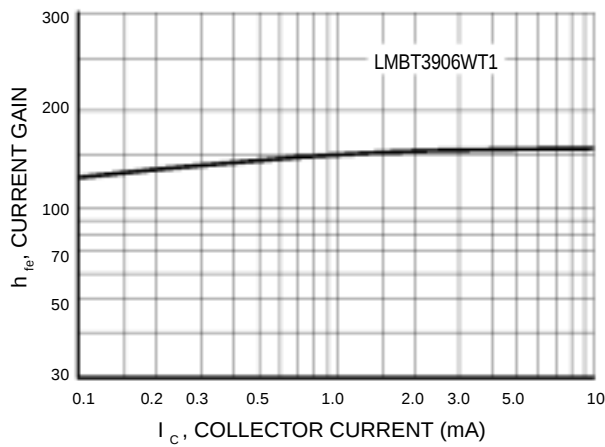


Figure 27. Current Gain

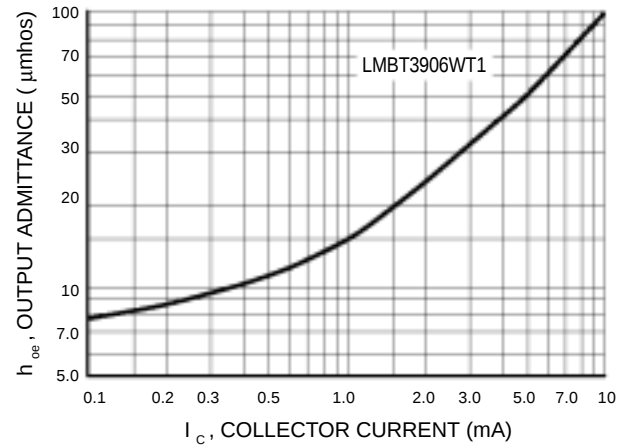


Figure 28. Output Admittance

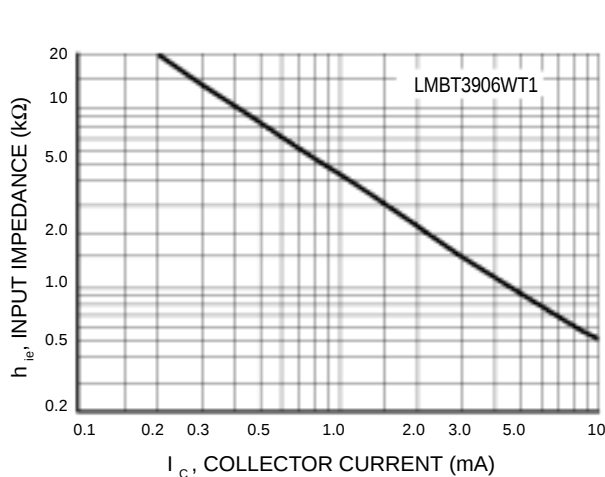


Figure 29. Input Impedance

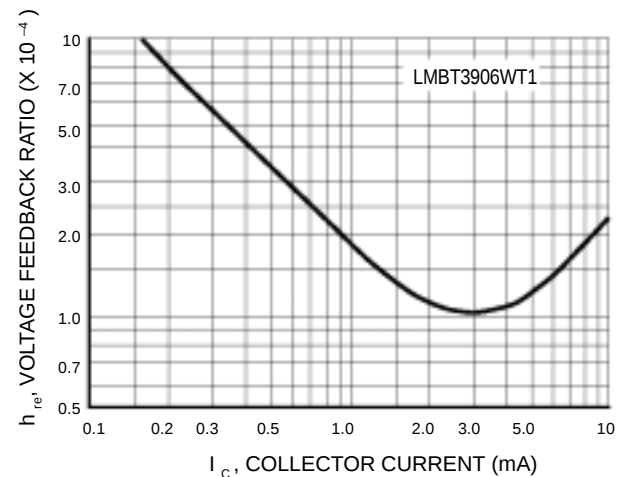


Figure 30. Voltage Feedback Ratio

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3906WT1
STATIC CHARACTERISTICS

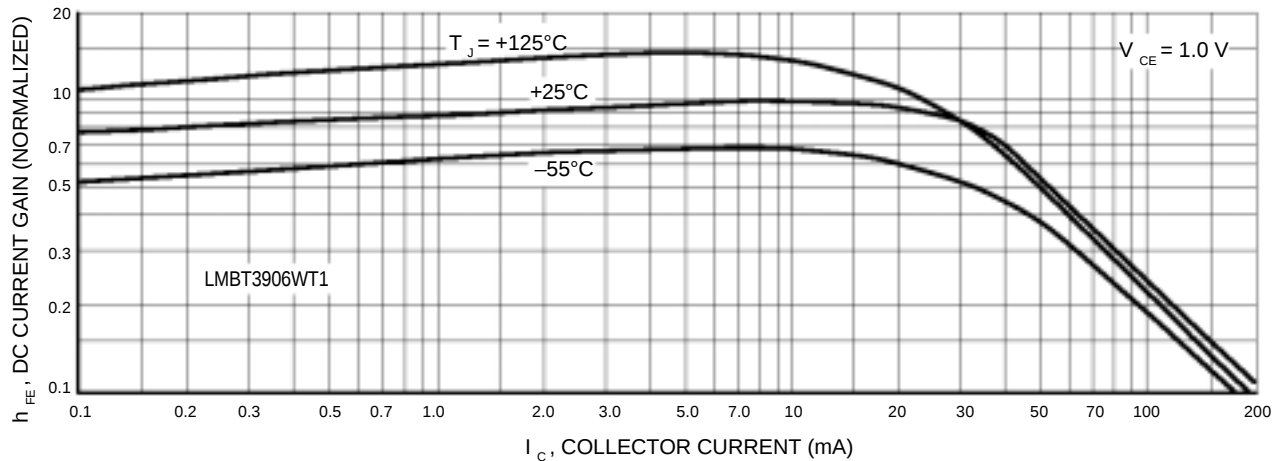


Figure 31. DC Current Gain

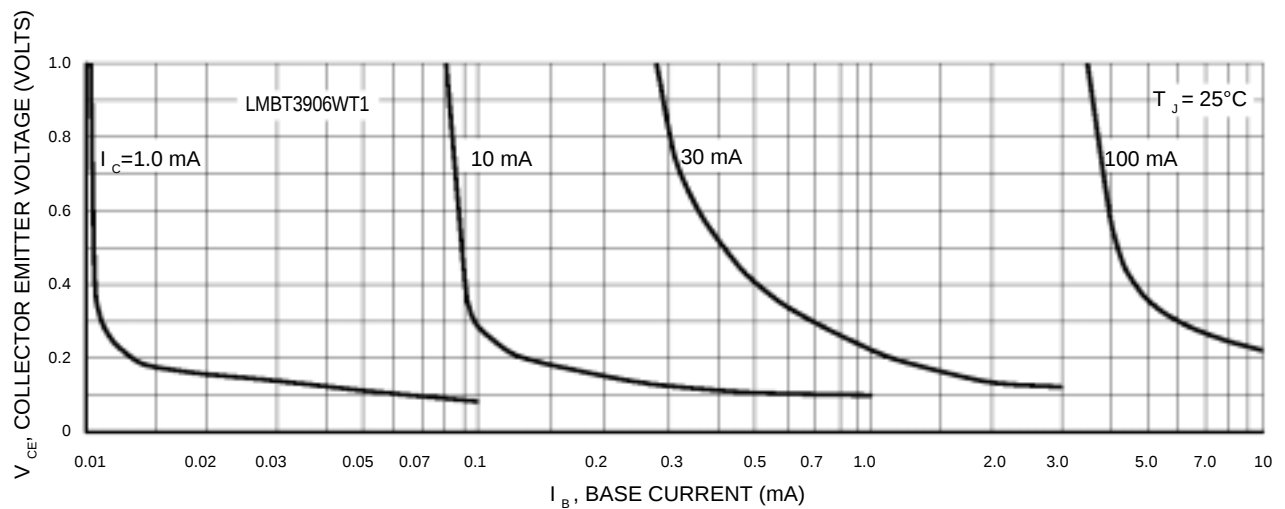


Figure 32. Collector Saturation Region

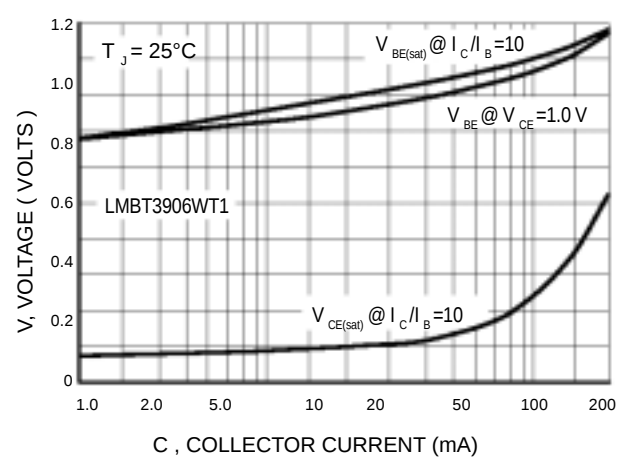


Figure 33. "ON" Voltages

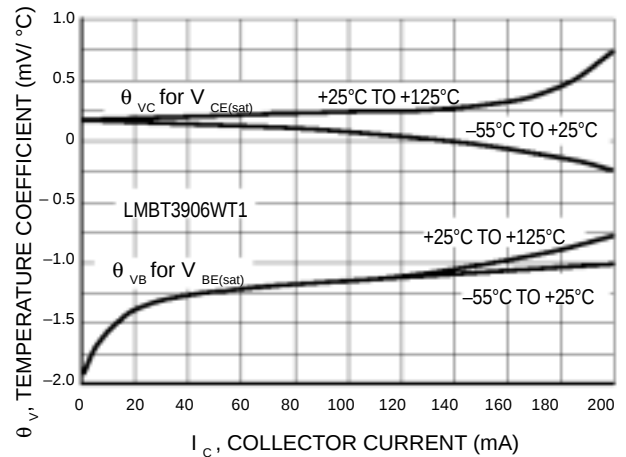
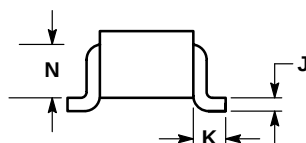
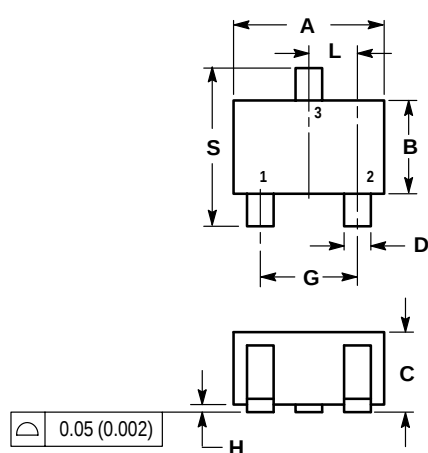


Figure 34. Temperature Coefficients

NPN LMBT3904WT1 PNP LMBT3906WT1
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

