

# 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.

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- 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	$V_{CE0}$	40	Vdc
		-40	
Collector-Base Voltage	$V_{CBO}$	60	Vdc
		-40	
Emitter-Base Voltage	$V_{EBO}$	6.0	Vdc
		-5.0	
Collector Current — Continuous	$I_C$	200	mAdc
		-200	

### THERMAL CHARACTERISTICS

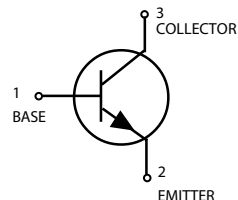
Characteristic	Symbol	Max	Unit
Total Device Dissipation (1) $T_A=25\text{ }^\circ\text{C}$	$P_D$	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	$^\circ\text{C/W}$
Junction and Storage Temperature	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

**NPN**  
**LMBT3904WT1**  
**PNP**  
**LMBT3906WT1**

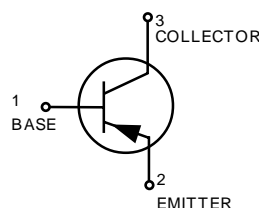
**GENERAL PURPOSE**  
**AMPLIFIER TRANSISTORS**  
**SURFACE MOUNT**



**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**

<b>Collector–Emitter Breakdown Voltage (2)</b>					
( $I_C = 1.0 \text{ mAdc}$ , $I_B = 0$ )	LMBT3904WT1	$V_{(BR)CEO}$	40	—	Vdc
( $I_C = -1.0 \text{ mAdc}$ , $I_B = 0$ )	LMBT3906WT1		-40	—	
<b>Collector–Base Breakdown Voltage</b>					
( $I_C = 10 \text{ }\mu\text{Adc}$ , $I_E = 0$ )	LMBT3904WT1	$V_{(BR)CBO}$	60	—	Vdc
( $I_C = -10 \text{ }\mu\text{Adc}$ , $I_E = 0$ )	LMBT3906WT1		-40	—	
<b>Emitter–Base Breakdown Voltage</b>					
( $I_E = 10 \text{ }\mu\text{Adc}$ , $I_C = 0$ )	LMBT3904WT1	$V_{(BR)EBO}$	6.0	—	Vdc
( $I_E = -10 \text{ }\mu\text{Adc}$ , $I_C = 0$ )	LMBT3906WT1		-5.0	—	
<b>Base Cutoff Current</b>					
( $V_{CE} = 30 \text{ Vdc}$ , $V_{EB} = 3.0 \text{ Vdc}$ )	LMBT3904WT1	$I_{BL}$	—	50	nAdc
( $V_{CE} = -30 \text{ Vdc}$ , $V_{EB} = -3.0 \text{ Vdc}$ )	LMBT3906WT1		—	-50	
<b>Collector Cutoff Current</b>					
( $V_{CE} = 30 \text{ Vdc}$ , $V_{EB} = 3.0 \text{ Vdc}$ )	LMBT3904WT1	$I_{CEX}$	—	50	nAdc
( $V_{CE} = -30 \text{ Vdc}$ , $V_{EB} = -3.0 \text{ Vdc}$ )	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
<b>ON CHARACTERISTICS (2)</b>				
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 $\Omega$
( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mA}$ , $f = 1.0\text{ kHz}$ )	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		$h_{oe}$		$\mu\text{mhos}$
( $V_{CE} = 10\text{ Vdc}$ , $I_C = 1.0\text{ mA}$ , $f = 1.0\text{ kHz}$ )	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	

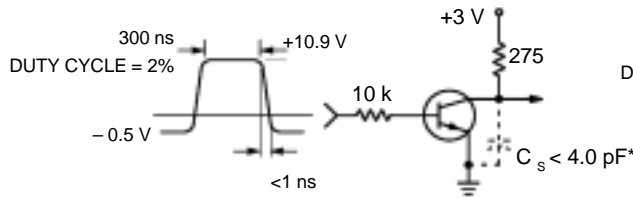
**NPN LMBT3904WT1 PNP LMBT3906WT1**

**SWITCHING CHARACTERISTICS**

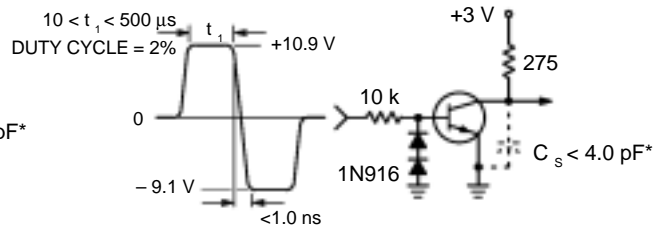
Delay Time ( $V_{CC} = 3.0 \text{ Vdc}, V_{BE} = -0.5 \text{ Vdc}$ )	LMBT3904WT1	$t_d$	—	3.5
( $V_{CC} = -3.0 \text{ Vdc}, V_{BE} = 0.5 \text{ Vdc}$ )	LMBT3906WT1		—	35 ns
Rise Time ( $I_C = 10 \text{ mAdc}, I_{B1} = 1.0 \text{ mAdc}$ )	LMBT3904WT1	$t_r$	—	3.5
( $I_C = -10 \text{ mAdc}, I_{B1} = -1.0 \text{ mAdc}$ )	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	$t_f$	—	5.0
( $I_{B1} = I_{B2} = -1.0 \text{ mAdc}$ )	LMBT3906WT1		—	75 ns

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

**LMBT3904WT1**



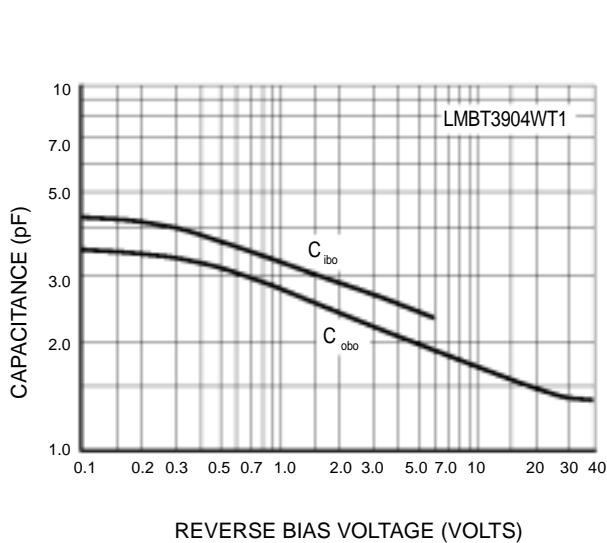
**Figure 1. Delay and Rise Time Equivalent Test Circuit**



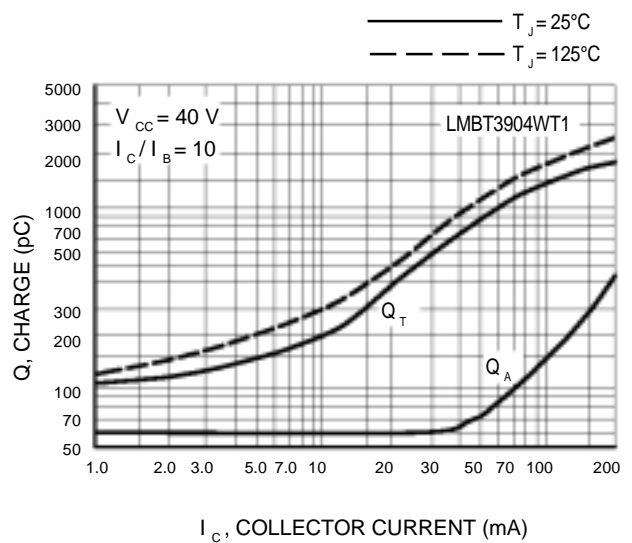
**Figure 2. Storage and Fall Time Equivalent Test Circuit**

\*Total shunt capacitance of test jig and connectors

**TYPICAL TRANSIENT CHARACTERISTICS**



**Figure 3. Capacitance**



**Figure 4. Charge Data**

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3904WT1

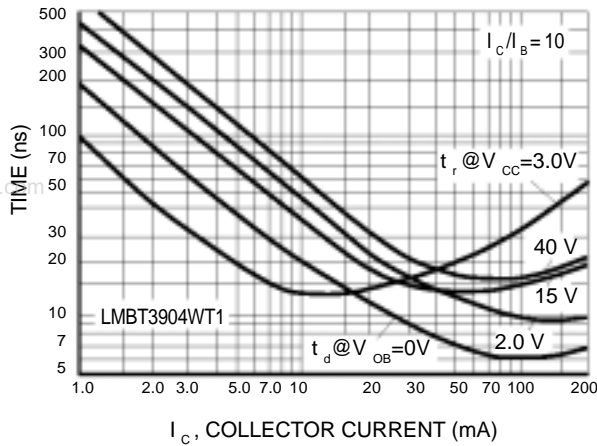


Figure 5. Turn-On Time

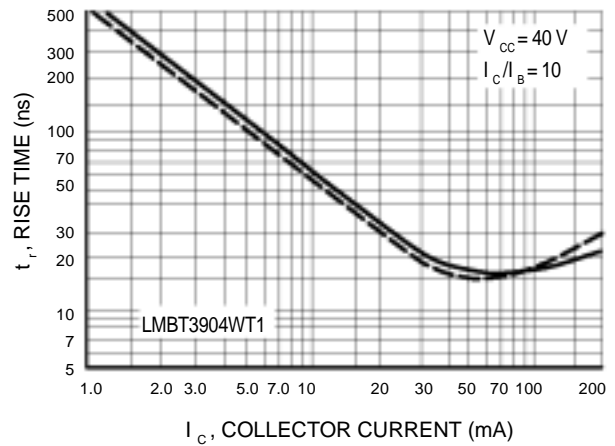


Figure 6. Rise Time

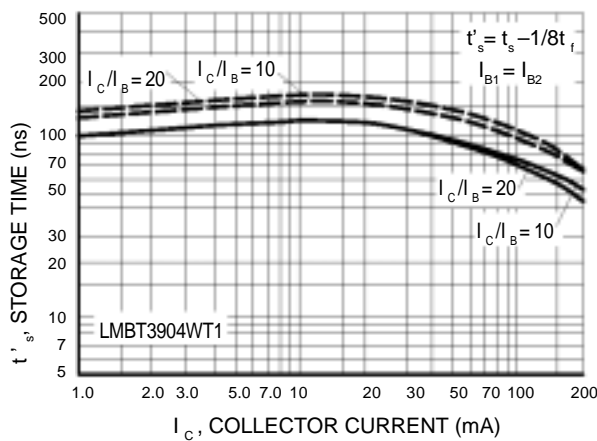


Figure 7. Storage Time

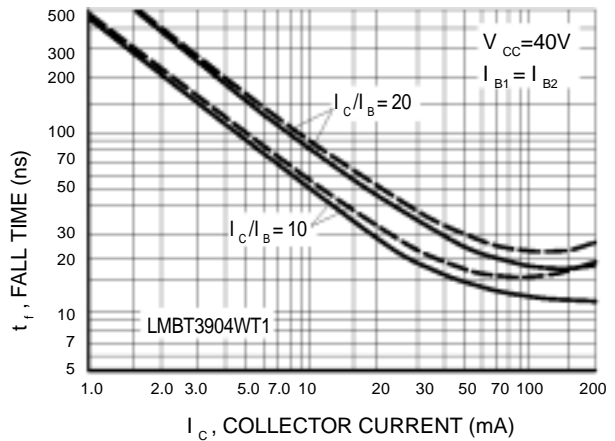


Figure 8. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS  
NOISE FIGURE VARIATIONS

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

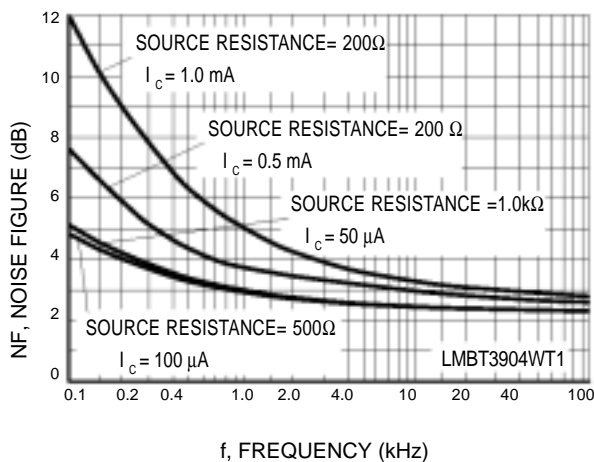


Figure 9. Noise Figure

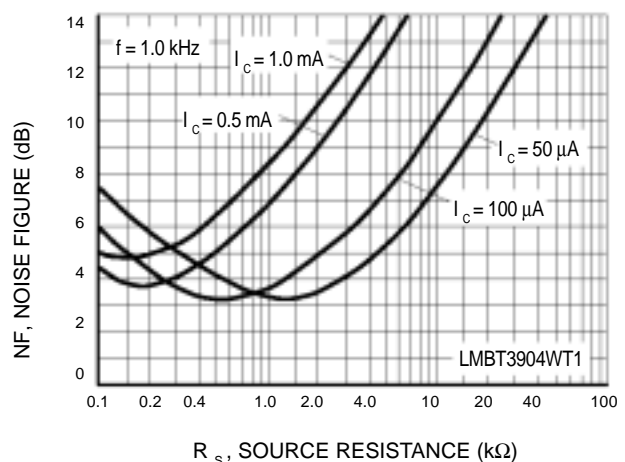
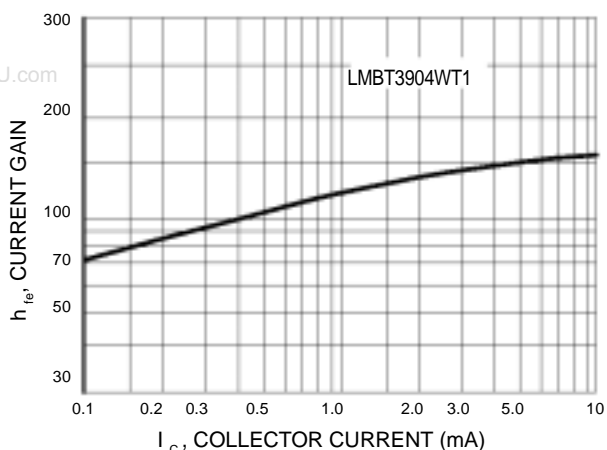


Figure 10. Noise Figure

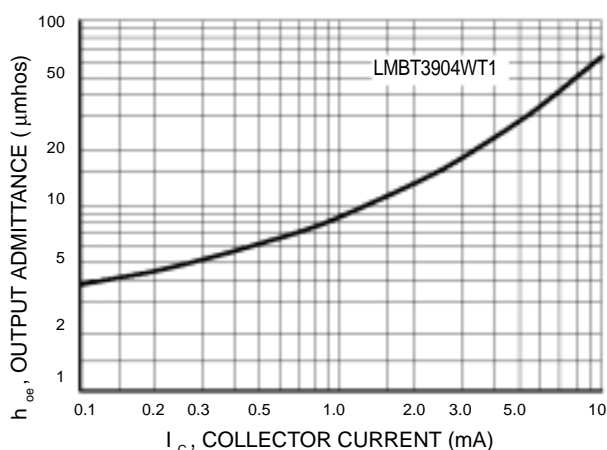
**NPN LMBT3904WT1 PNP LMBT3906WT1**

**h PARAMETERS**

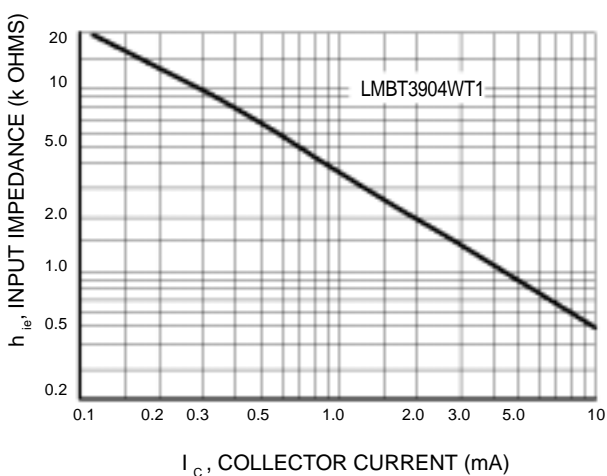
( $V_{CE} = 10 \text{ Vdc}$ ,  $f = 1.0 \text{ kHz}$ ,  $T_A = 25^\circ\text{C}$ )



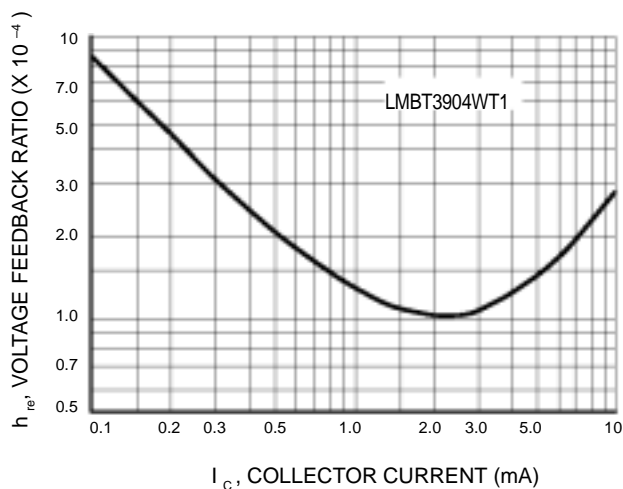
**Figure 11. Current Gain**



**Figure 12. Output Admittance**



**Figure 13. Input Impedance**



**Figure 14. Voltage Feedback Ratio**

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3904WT1  
TYPICAL STATIC CHARACTERISTICS

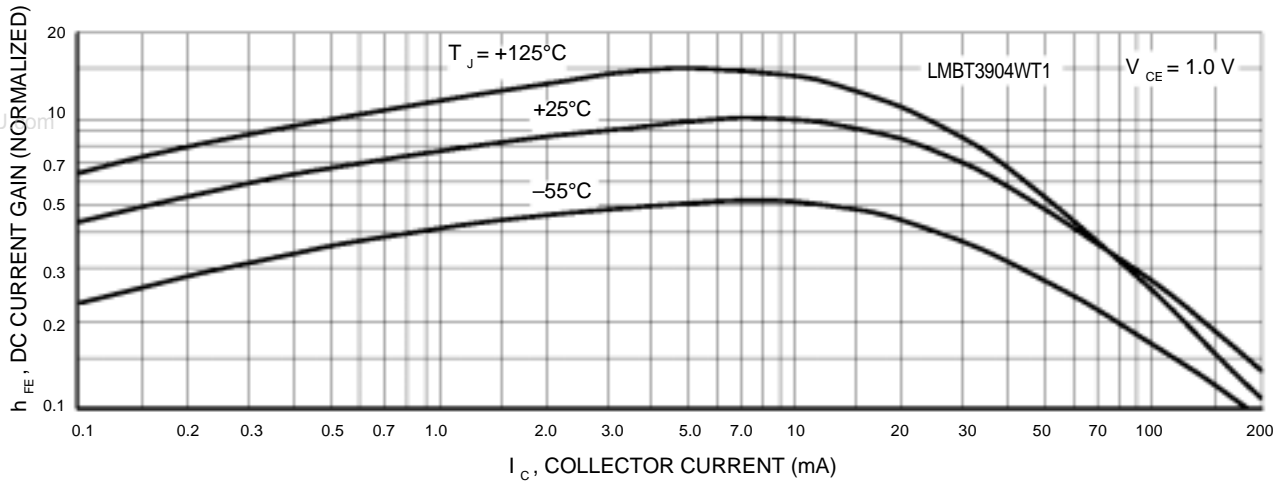


Figure 15. DC Current Gain

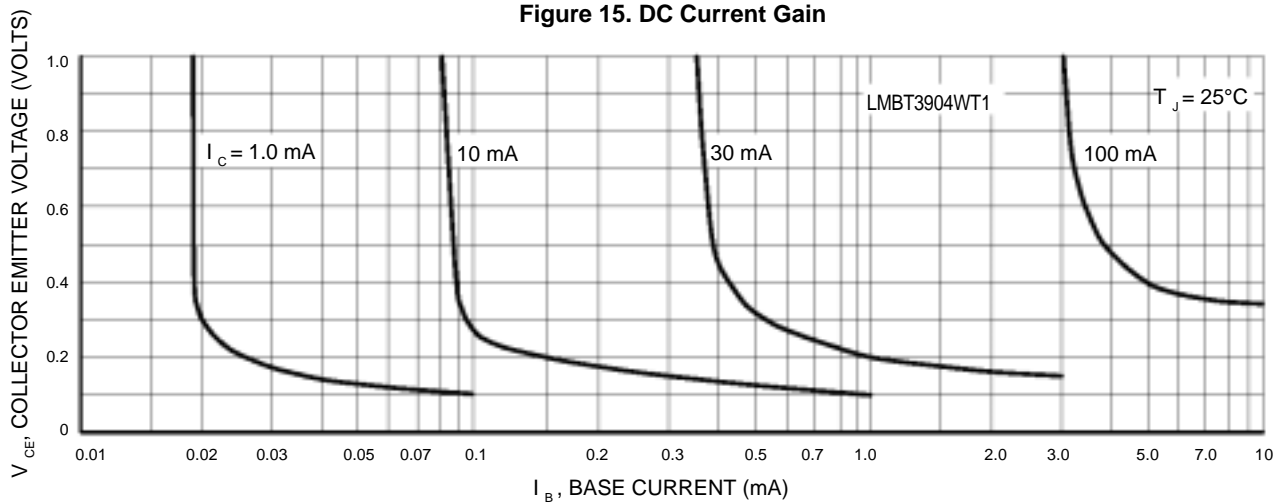


Figure 16. Collector Saturation Region

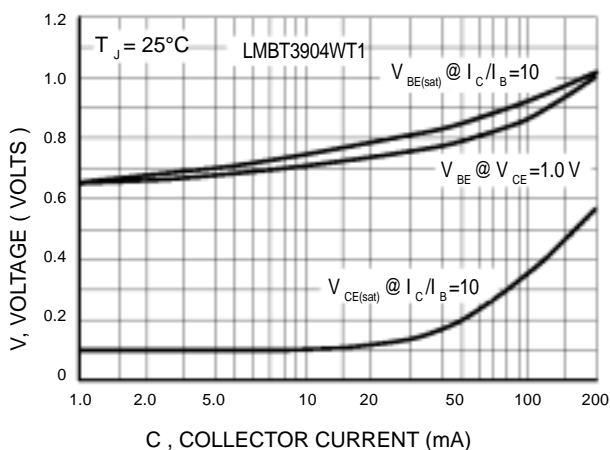


Figure 17. "ON" Voltages

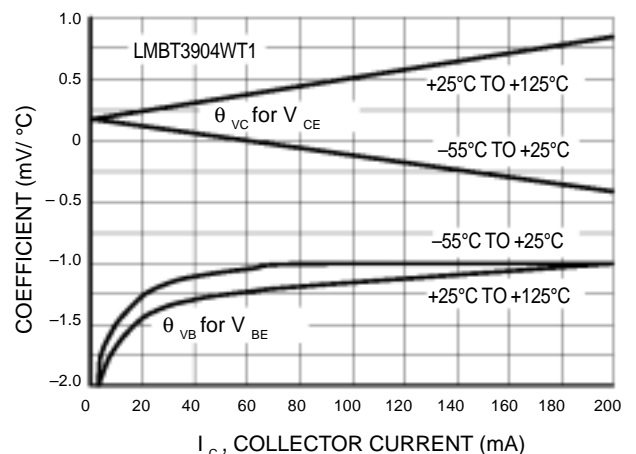


Figure 18. Temperature Coefficients

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3906WT1

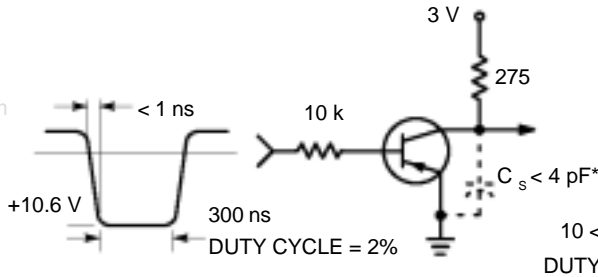


Figure 19. Delay and Rise Time Equivalent Test Circuit

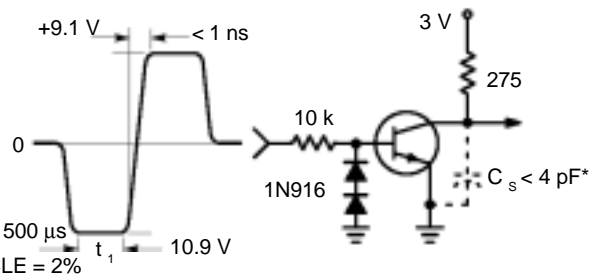


Figure 20. Storage and Fall Time Equivalent Test Circuit

\* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

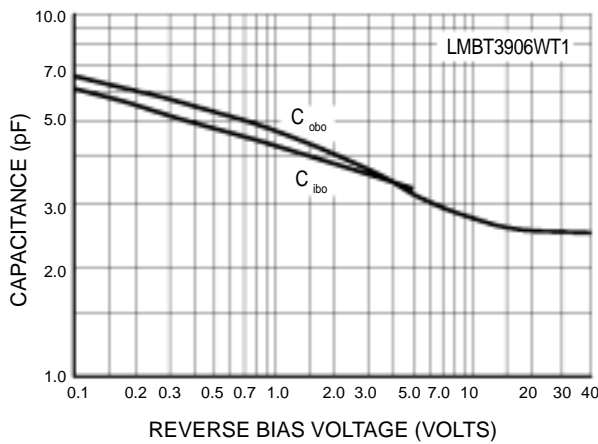


Figure 21. Capacitance

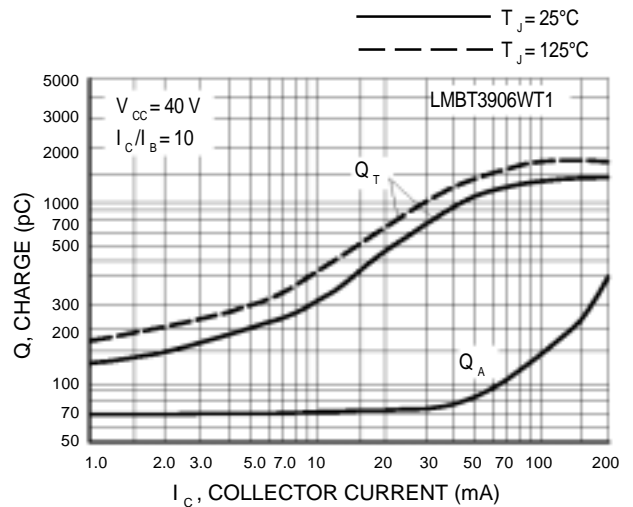


Figure 22. Charge Data

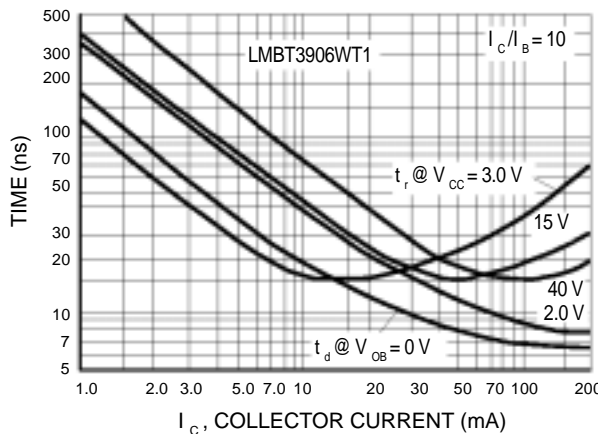


Figure 23. Turn-On Time

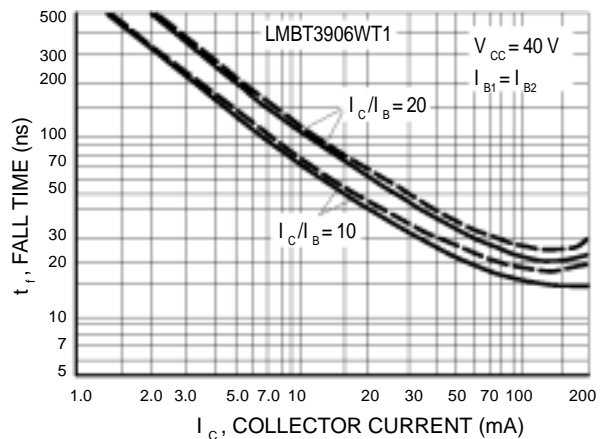


Figure 24. Fall Time



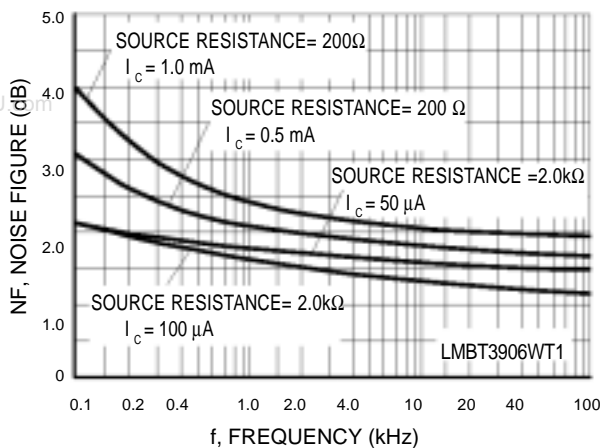
**NPN LMBT3904WT1 PNP LMBT3906WT1**

**LMBT3906WT1**

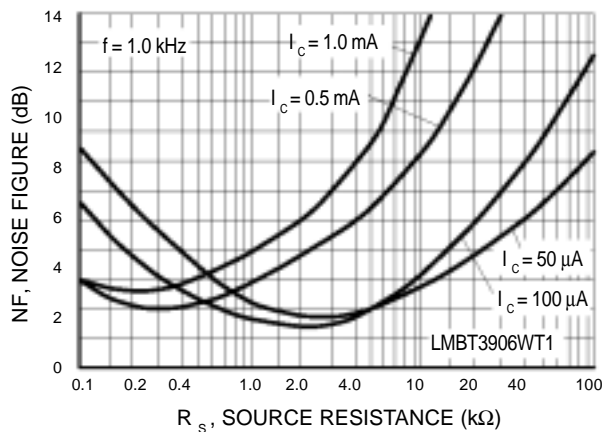
**TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS**

**NOISE FIGURE VARIATIONS**

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



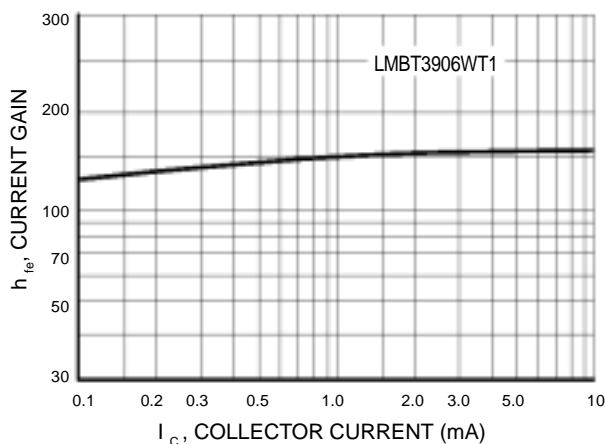
**Figure 25**



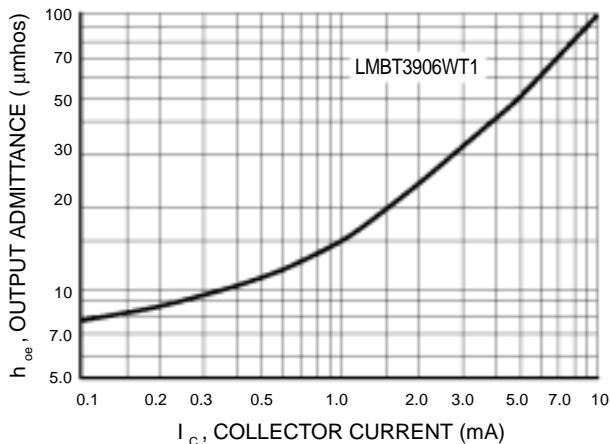
**Figure 26**

**h PARAMETERS**

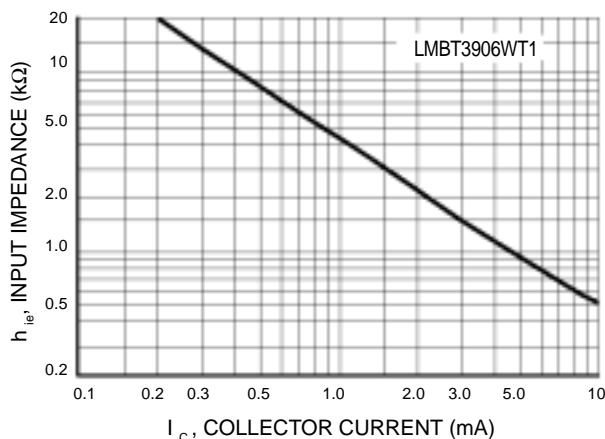
( $V_{CE} = -10$  Vdc,  $f = 1.0$  kHz,  $T_A = 25^\circ\text{C}$ )



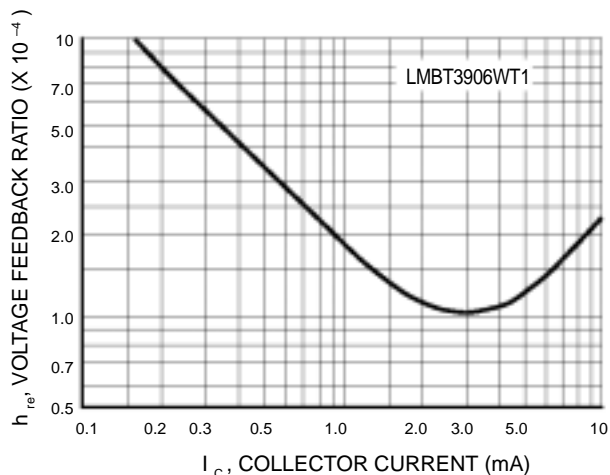
**Figure 27. Current Gain**



**Figure 28. Output Admittance**



**Figure 29. Input Impedance**



**Figure 30. Voltage Feedback Ratio**

NPN LMBT3904WT1 PNP LMBT3906WT1

LMBT3906WT1  
STATIC CHARACTERISTICS

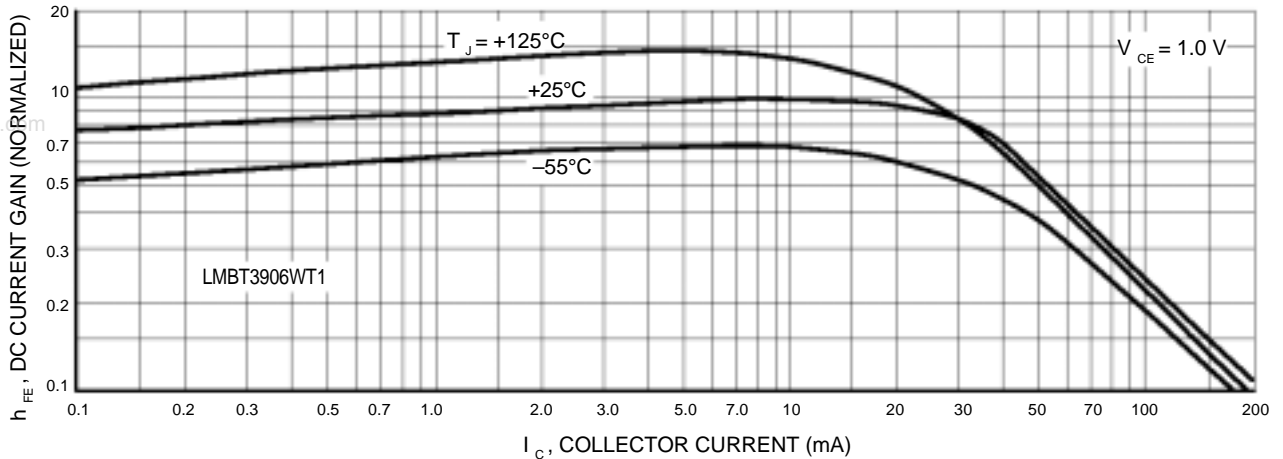


Figure 31. DC Current Gain

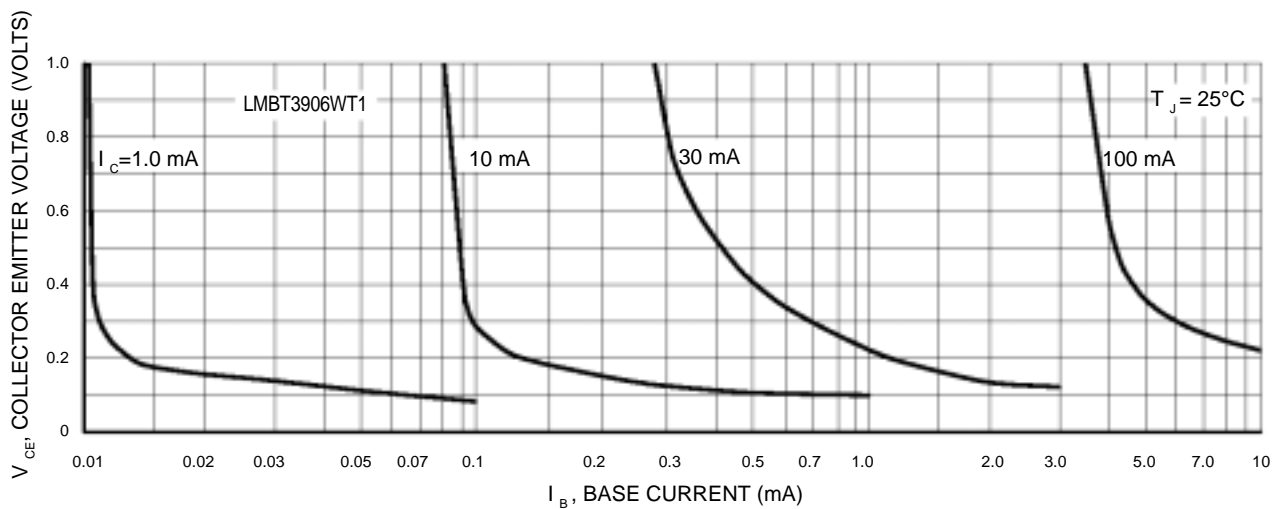


Figure 32. Collector Saturation Region

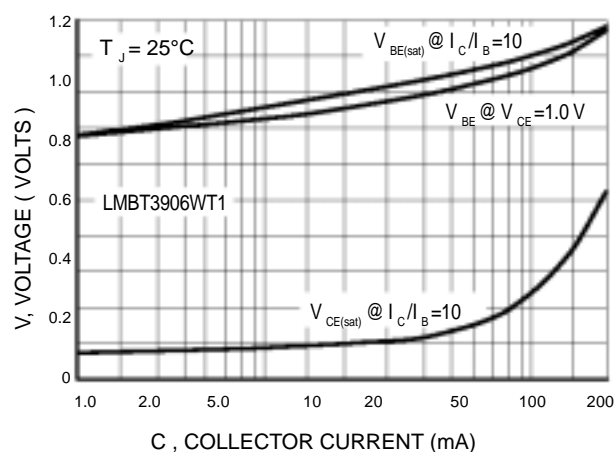


Figure 33. "ON" Voltages

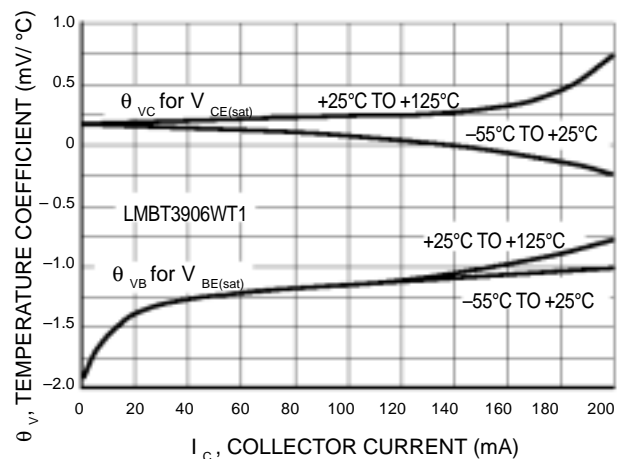


Figure 34. Temperature Coefficients

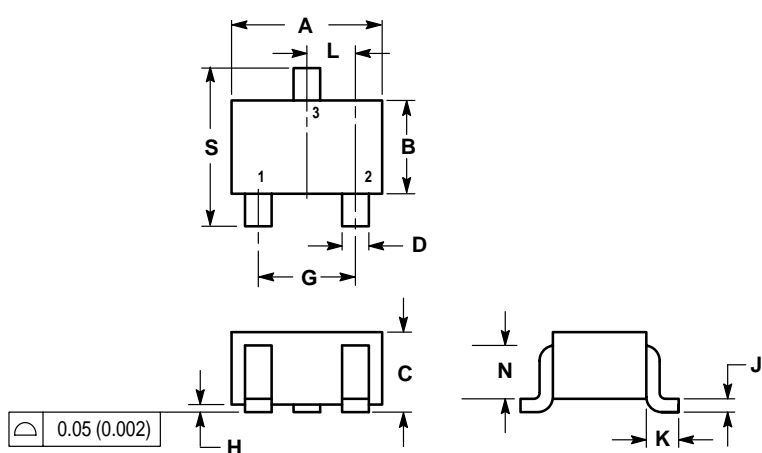
NPN LMBT3904WT1 PNP LMBT3906WT1

SC-70 / SOT-323

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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

