

# General Purpose Transistor

- Pb-Free Package May be Available. The G-Suffix Denotes a Pb-Free Lead Finish

## ORDERING INFORMATION

Device	Package	Shipping
LMBT3904LT1	SOT-23	3000/Tape & Reel
LMBT3904LT1G	SOT-23	3000/Tape & Reel

## MAXIMUM RATINGS

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

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board, (1) $T_A = 25^\circ\text{C}$	$P_D$	225	mW
Derate above $25^\circ\text{C}$		1.8	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C/W}$
Total Device Dissipation Alumina Substrate, (2) $T_A = 25^\circ\text{C}$	$P_D$	300	mW
Derate above $25^\circ\text{C}$		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C/W}$
Junction and Storage Temperature	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

## DEVICE MARKING

LMBT3904LT1 = 1AM

## 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(3) ( $I_C = 1.0 \text{ mAdc}$ )	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ( $I_C = 10 \mu\text{Adc}$ )	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 10 \mu\text{Adc}$ )	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current ( $V_{CE} = 30 \text{ Vdc}, V_{EB} = 3.0 \text{ Vdc}$ )	$I_{BL}$	—	50	nAdc
Collector Cutoff Current ( $V_{CE} = 30 \text{ Vdc}, V_{BE} = 3.0 \text{ Vdc}$ )	$I_{CEX}$	—	50	nAdc

1. FR-5 =  $1.0 \times 0.75 \times 0.062 \text{ in.}$

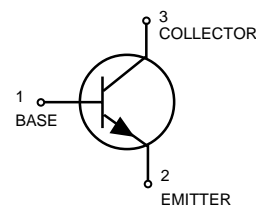
2. Alumina =  $0.4 \times 0.3 \times 0.024 \text{ in.}$  99.5% alumina.

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

**LMBT3904LT1**



**SOT-23**



## LMBT3904LT1

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
<b>ON CHARACTERISTICS (3)</b>				
DC Current Gain(1) ( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) ( $I_C = 100 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )	$h_{FE}$	40 70 100 60 30	— — 300 — —	—
Collector-Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ )(3) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{CE(sat)}$	— —	0.2 0.3	Vdc
Base-Emitter Saturation Voltage(3) ( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )	$V_{BE(sat)}$	0.65 —	0.85 0.95	Vdc

### SMALL-SIGNAL CHARACTERISTICS

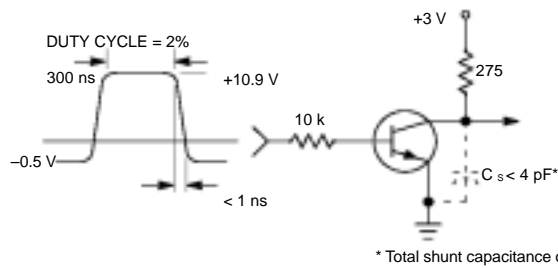
Current-Gain — Bandwidth Product ( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )	$f_T$	300	—	MHz
Output Capacitance ( $V_{CB} = 5.0 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{obo}$	—	4.0	pF
Input Capacitance ( $V_{BE} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{ibo}$	—	8.0	pF
Input Impedancen ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{ie}$	1.0	10	pF
Voltage Feedback Ratio ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{re}$	0.5	8.0	$\times 10^{-4}$
Small-Signal Current Gain ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{fe}$	100	400	—
Output Admittance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 1.0 \text{ mAdc}$ , $f = 1.0 \text{ kHz}$ )	$h_{oe}$	1.0	40	$\text{mhos}$
Noise Figure ( $V_{CE} = 5.0 \text{ Vdc}$ , $I_C = 100 \mu\text{Adc}$ , $R_S = 1.0 \text{ k}\Omega$ , $f = 1.0 \text{ kHz}$ )	NF	—	5.0	dB

### SWITCHING CHARACTERISTICS

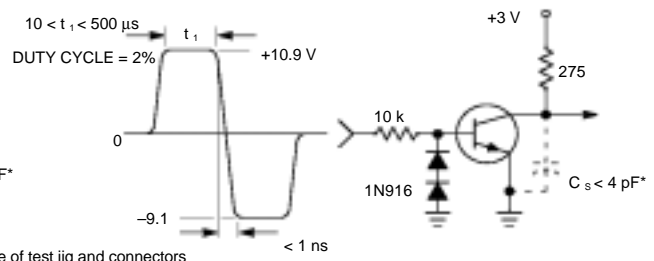
Delay Time ( $V_{CC} = 3.0 \text{ Vdc}$ , $V_{BE} = -0.5 \text{ Vdc}$ )	$t_d$	—	35	ns
Rise Time ( $I_C = 10 \text{ mAdc}$ , $I_{B1} = 1.0 \text{ mAdc}$ )	$t_r$	—	35	ns
Storage Time ( $V_{CC} = 3.0 \text{ Vdc}$ )	$t_s$	—	200	ns
Fall Time ( $I_C = 10 \text{ mAdc}$ , $I_{B1} = I_{B2} = 10 \text{ mAdc}$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

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

## LMBT3904LT1

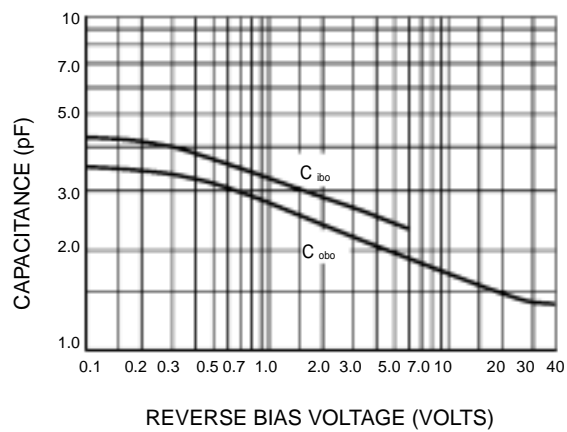


**Figure 1. Delay and Rise Time  
Equivalent Test Circuit**

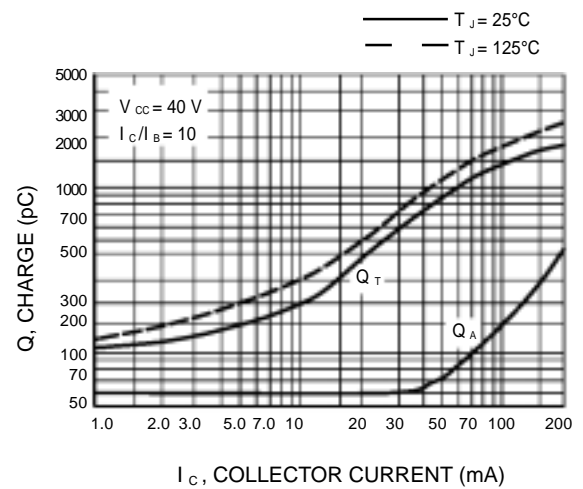


**Figure 2. Storage and Fall Time  
Equivalent Test Circuit**

## TYPICAL TRANSIENT CHARACTERISTICS



**Figure 3. Capacitance**



**Figure 4. Charge Data**

## LMBT3904LT1

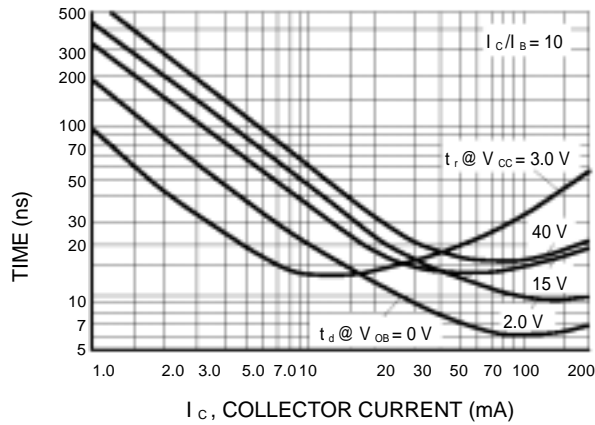


Figure 5. Turn-On Time

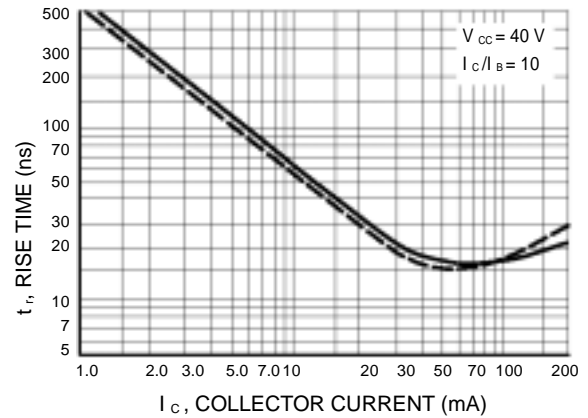


Figure 6. Rise Time

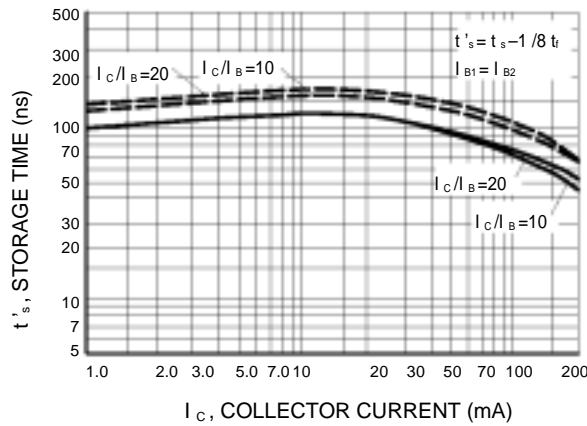


Figure 7. Storage Time

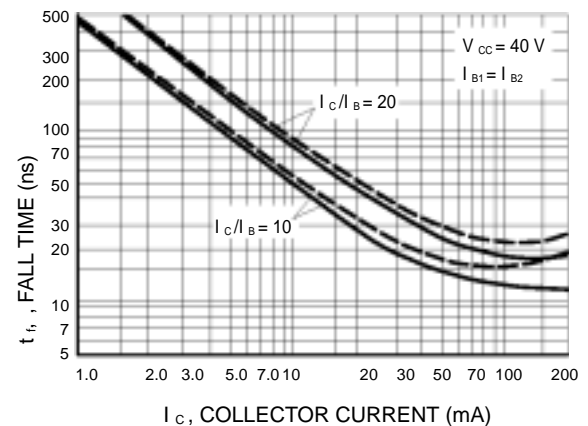


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

### NOISE FIGURE VARIATIONS

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

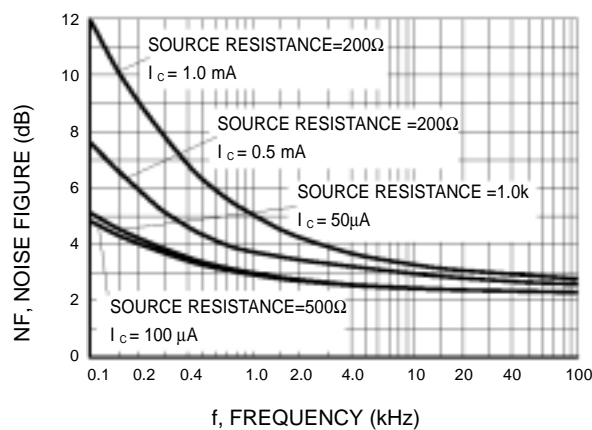


Figure 9.

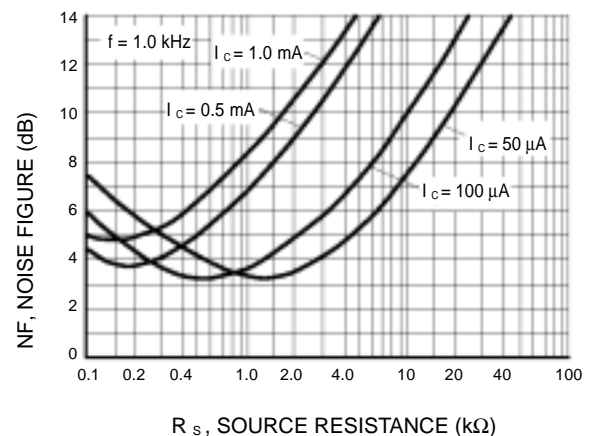


Figure 10.

## LMBT3904LT1

### h PARAMETERS

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

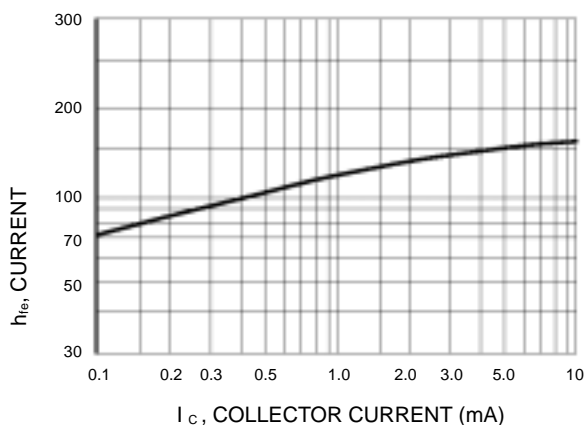


Figure 11. Current Gain

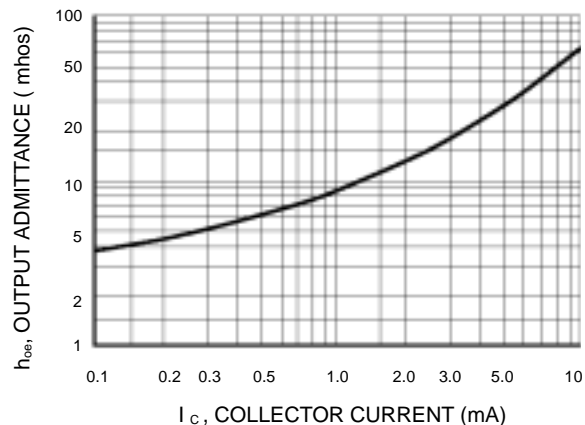


Figure 12. Output Admittance

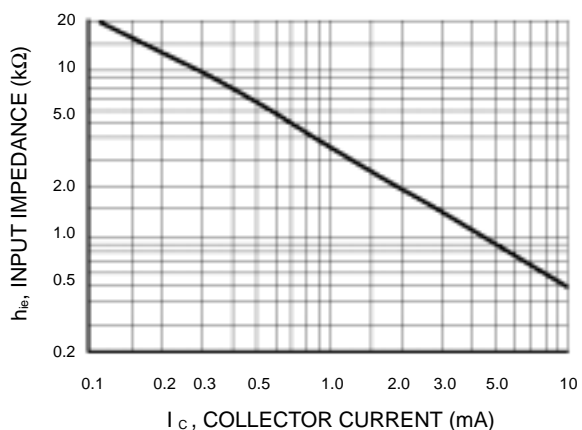


Figure 13. Input Impedance

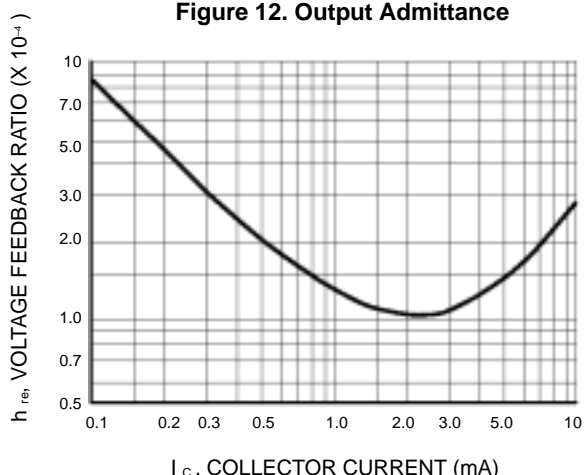


Figure 14. Voltage Feedback Ratio

### TYPICAL STATIC CHARACTERISTICS

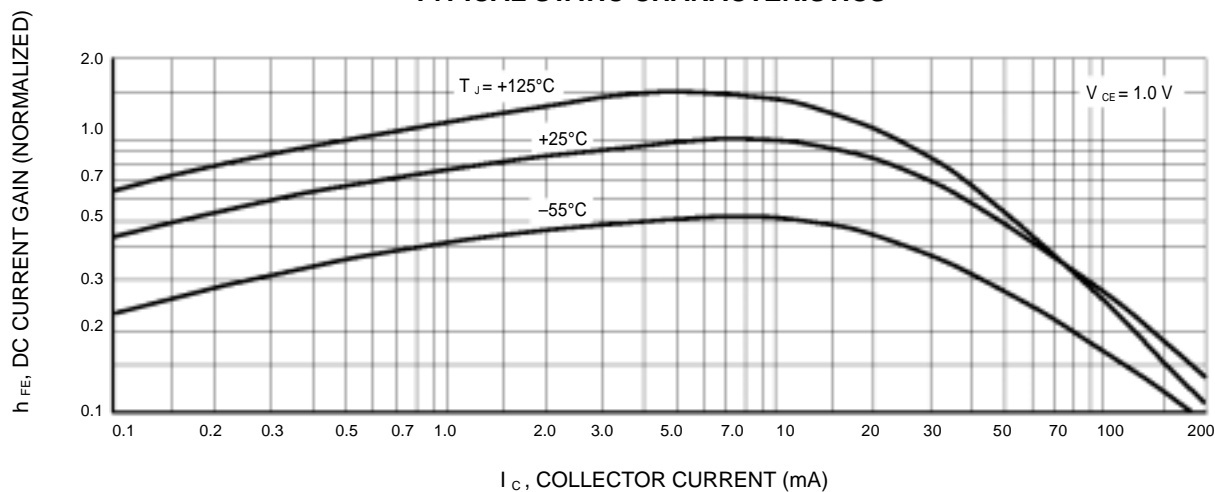


Figure 15. DC Current Gain

## LMBT3904LT1

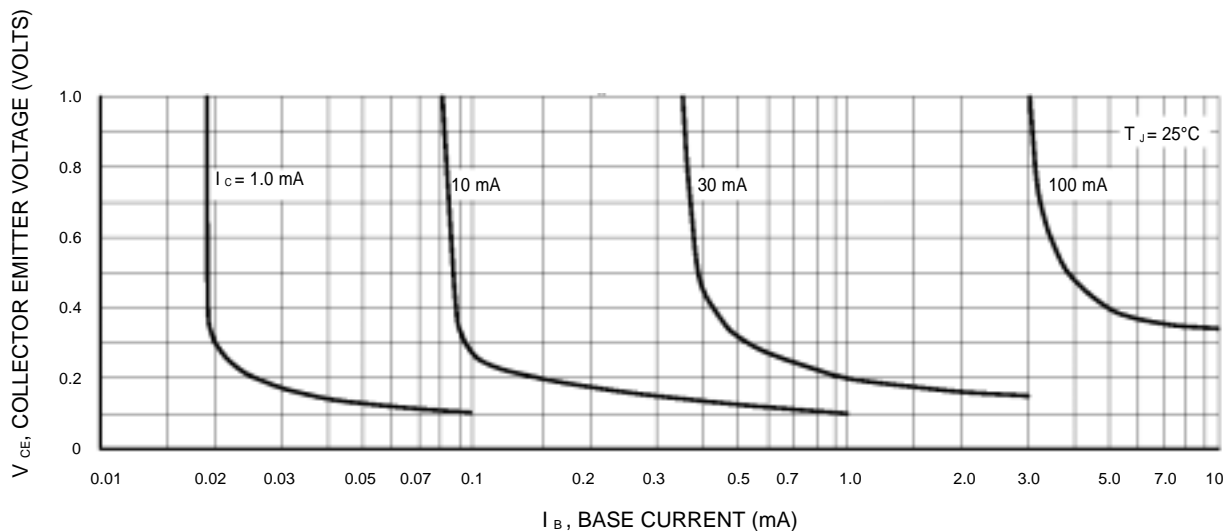


Figure 16. Collector Saturation Region

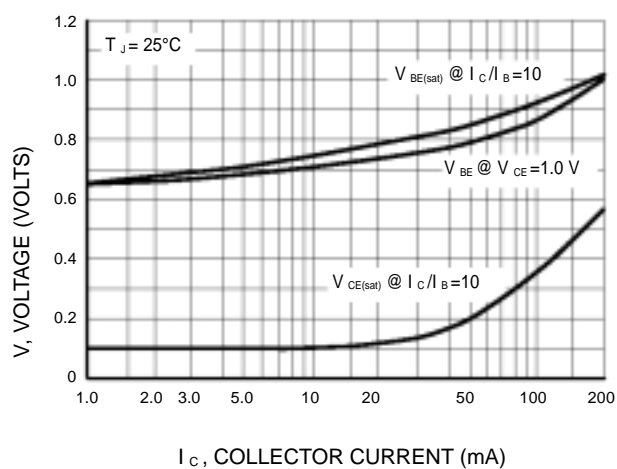


Figure 17. "ON" Voltages

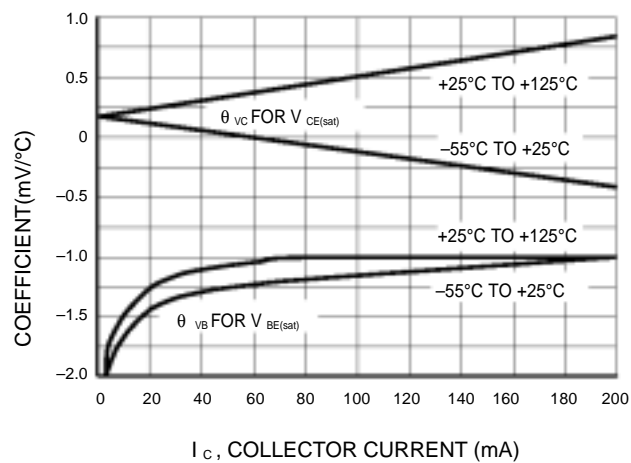
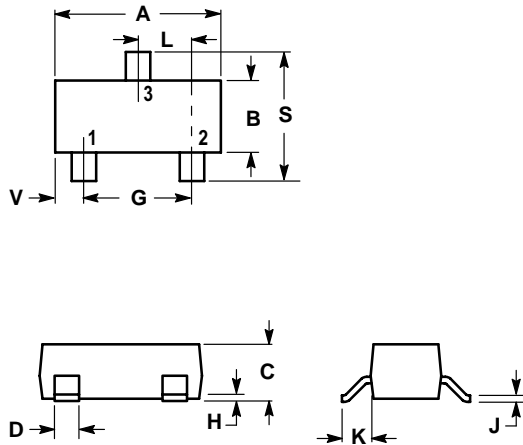


Figure 18. Temperature Coefficients

**LMBT3904LT1**
**SOT-23**

**NOTES:**

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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
<b>A</b>	0.1102	0.1197	2.80	3.04
<b>B</b>	0.0472	0.0551	1.20	1.40
<b>C</b>	0.0350	0.0440	0.89	1.11
<b>D</b>	0.0150	0.0200	0.37	0.50
<b>G</b>	0.0701	0.0807	1.78	2.04
<b>H</b>	0.0005	0.0040	0.013	0.100
<b>J</b>	0.0034	0.0070	0.085	0.177
<b>K</b>	0.0140	0.0285	0.35	0.69
<b>L</b>	0.0350	0.0401	0.89	1.02
<b>S</b>	0.0830	0.1039	2.10	2.64
<b>V</b>	0.0177	0.0236	0.45	0.60

- PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

