

# General Purpose Transistor

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

**LMBT3904LT1**

## 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)<br>$T_A = 25^\circ\text{C}$        | $P_D$           | 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<br>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 |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

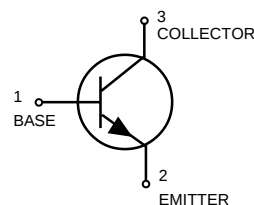
## OFF CHARACTERISTICS

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

- FR-5 =  $1.0 \times 0.75 \times 0.062 \text{ in.}$
- Alumina =  $0.4 \times 0.3 \times 0.024 \text{ in.}$  99.5% alumina.
- Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .



**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)<br>( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )<br>( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )<br>( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )<br>( $I_C = 50 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ )<br>( $I_C = 100 \text{ mAdc}$ , $V_{CE} = 1.0 \text{ Vdc}$ ) | $h_{FE}$      | 40<br>70<br>100<br>60<br>30 | —<br>—<br>300<br>—<br>— | —    |
| Collector-Emitter Saturation Voltage<br>( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ )(3)<br>( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )                                                                                                                                                                       | $V_{CE(sat)}$ | —<br>—                      | 0.2<br>0.3              | Vdc  |
| Base-Emitter Saturation Voltage(3)<br>( $I_C = 10 \text{ mAdc}$ , $I_B = 1.0 \text{ mAdc}$ )<br>( $I_C = 50 \text{ mAdc}$ , $I_B = 5.0 \text{ mAdc}$ )                                                                                                                                                                            | $V_{BE(sat)}$ | 0.65<br>—                   | 0.85<br>0.95            | Vdc  |

### SMALL-SIGNAL CHARACTERISTICS

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

### SWITCHING CHARACTERISTICS

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

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

## LMBT3904LT1

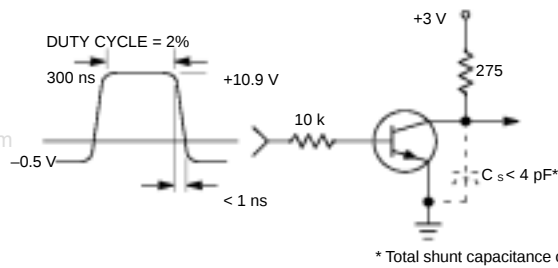


Figure 1. Delay and Rise Time  
Equivalent Test Circuit

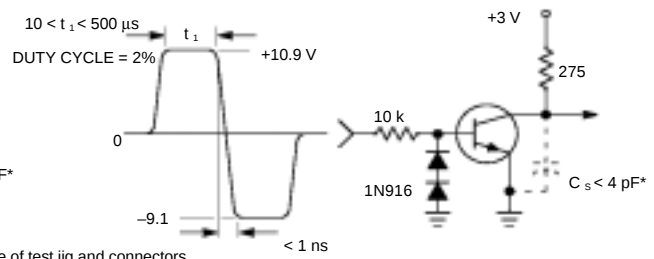


Figure 2. Storage and Fall Time  
Equivalent Test Circuit

## TYPICAL TRANSIENT CHARACTERISTICS

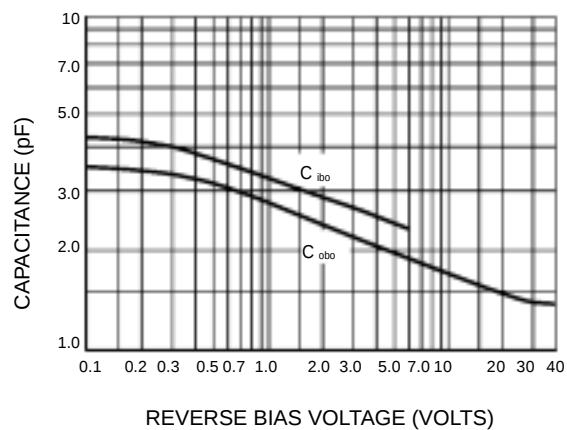


Figure 3. Capacitance

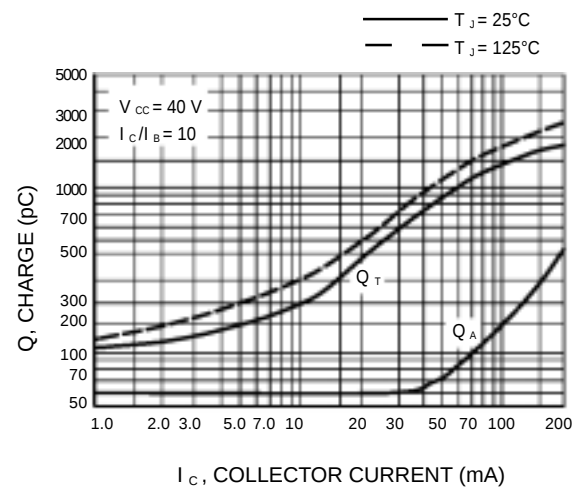


Figure 4. Charge Data

# LMBT3904LT1

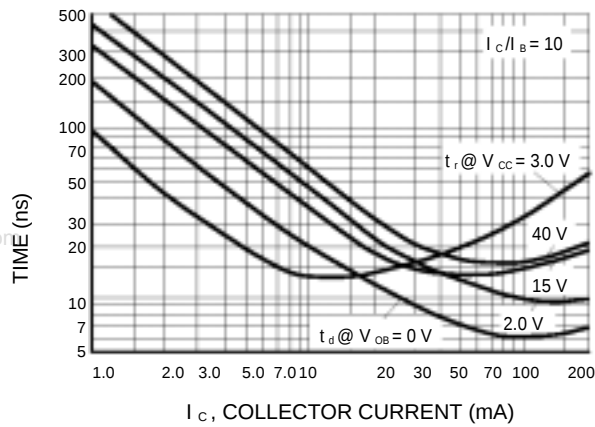


Figure 5. Turn-On Time

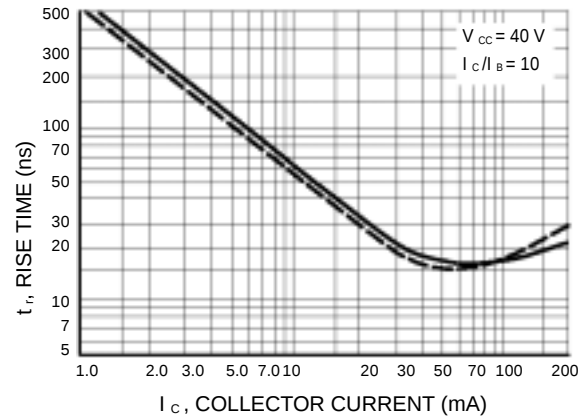


Figure 6. Rise Time

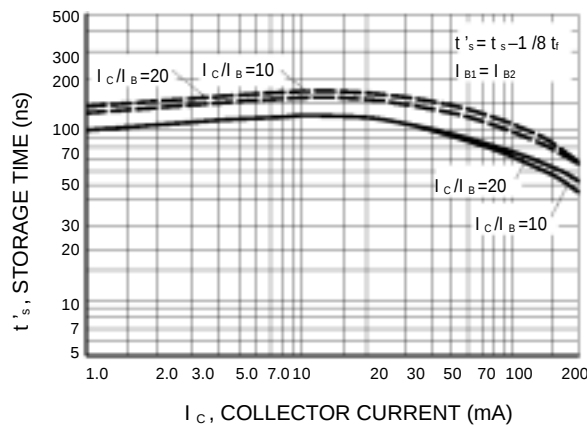


Figure 7. Storage Time

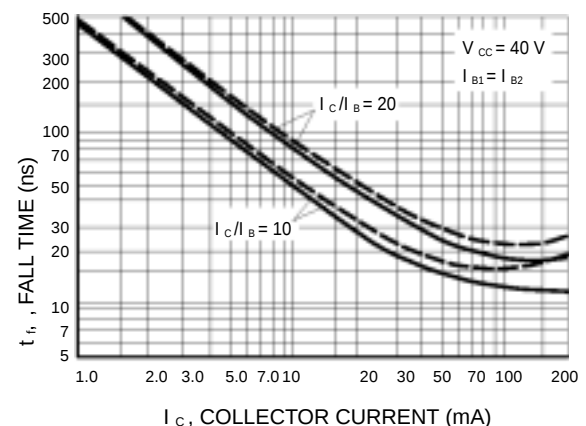


Figure 8. Fall Time

## TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

### NOISE FIGURE VARIATIONS

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

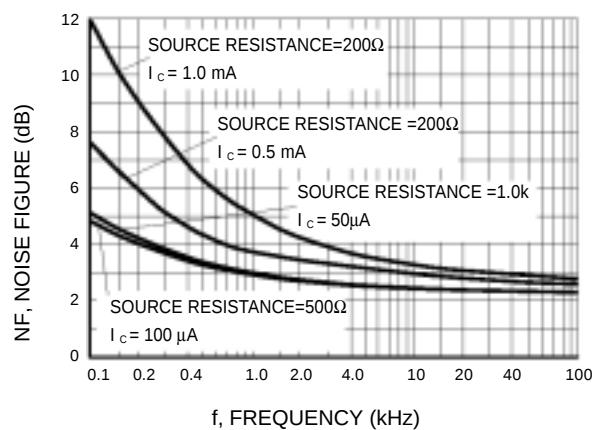


Figure 9.

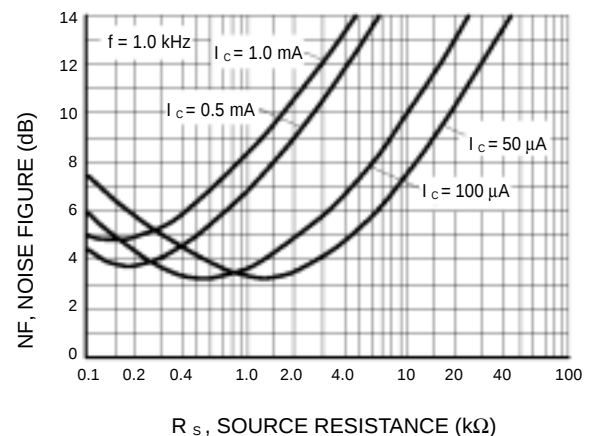
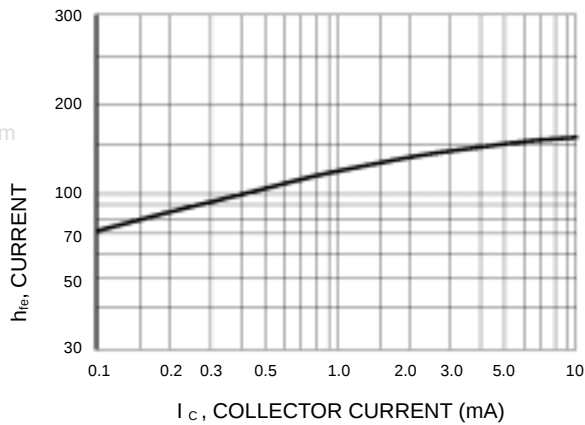


Figure 10.

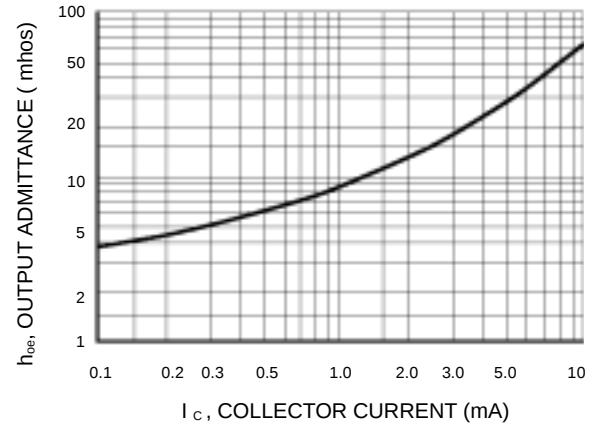
**LMBT3904LT1**

**h PARAMETERS**

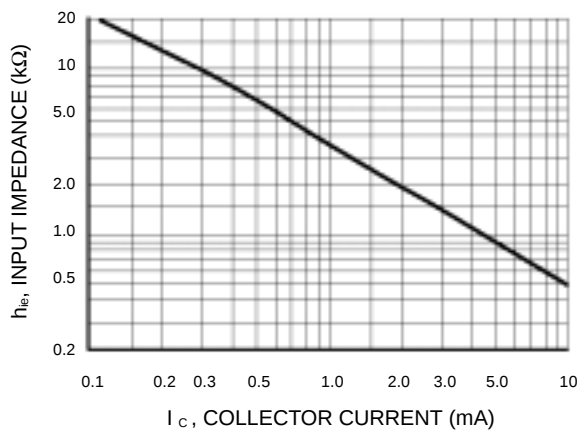
( $V_{CE} = 10 \text{ Vdc}$ ,  $f = 1.0 \text{ kHz}$ ,  $T_A = 25^\circ\text{C}$ )



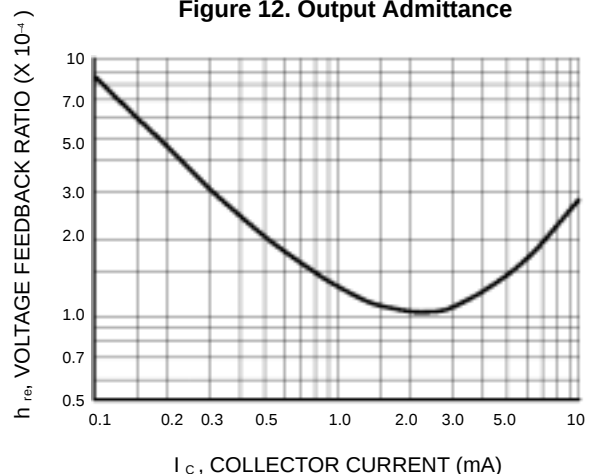
**Figure 11. Current Gain**



**Figure 12. Output Admittance**

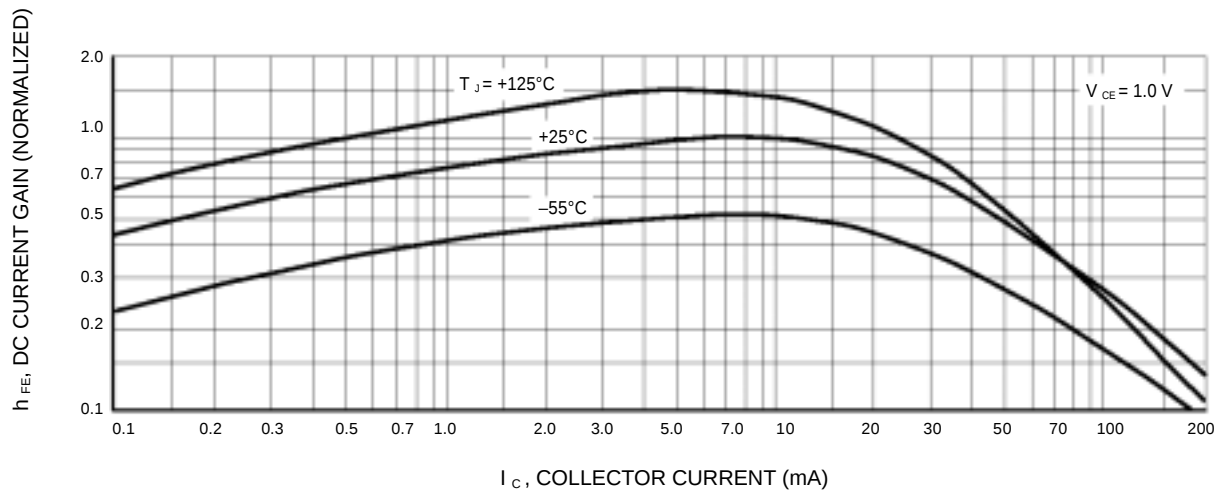


**Figure 13. Input Impedance**



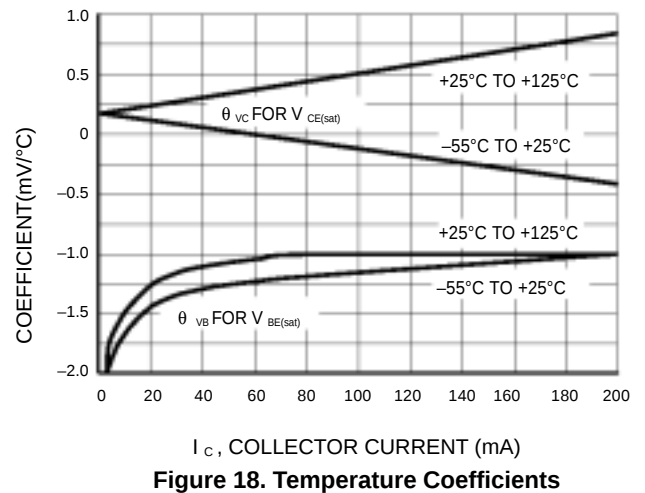
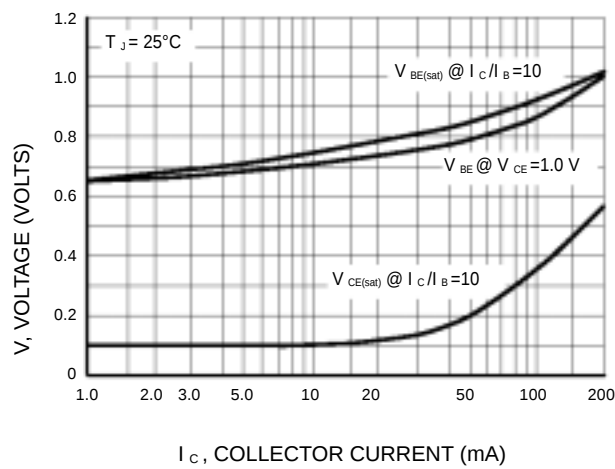
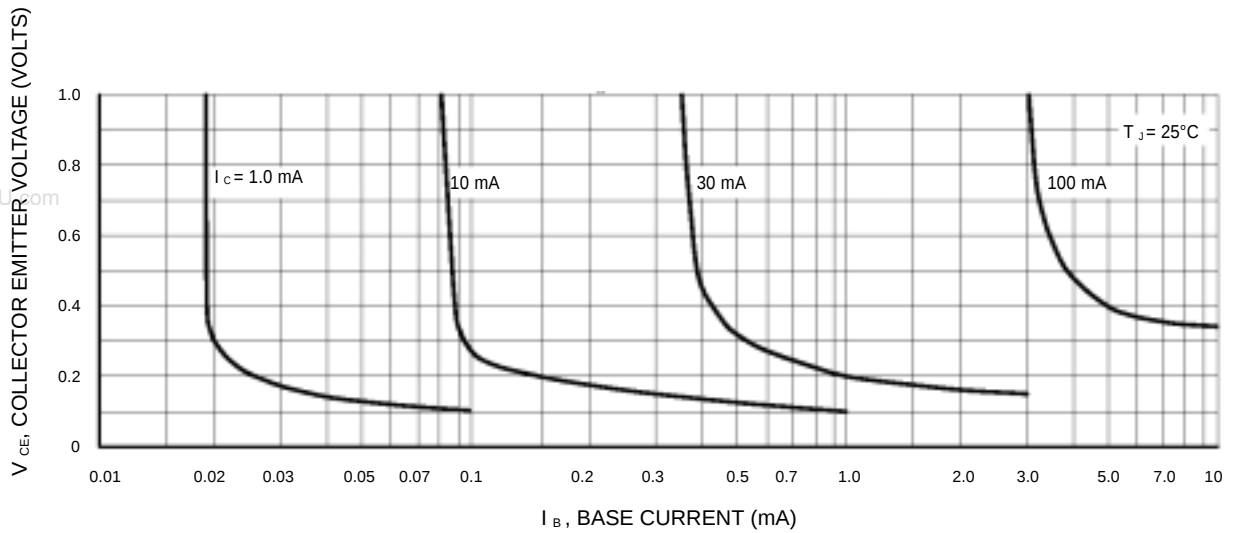
**Figure 14. Voltage Feedback Ratio**

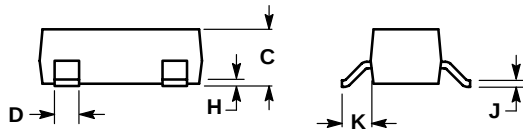
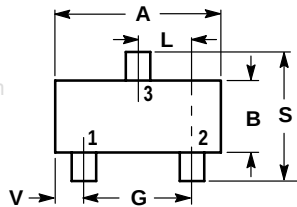
**TYPICAL STATIC CHARACTERISTICS**



**Figure 15. DC Current Gain**

## LMBT3904LT1



**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

