

# MMBT4403L, SMMBT4403L

## Switching Transistor

### PNP Silicon

#### Features

- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### MAXIMUM RATINGS

| Rating                         | Symbol    | Value | Unit |
|--------------------------------|-----------|-------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | -40   | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | -40   | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | -5.0  | Vdc  |
| Collector Current - Continuous | $I_C$     | -600  | mAdc |
| Collector Current - Peak       | $I_{CM}$  | -900  | mAdc |

#### THERMAL CHARACTERISTICS

| Characteristic  | Symbol          | Max         | Unit                       |
|---|-----------------|-------------|----------------------------|
| Total Device Dissipation FR-5 Board<br>(Note 1) @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$         | $P_D$           | 225<br>1.8  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient   | $R_{\theta JA}$ | 556         | $^\circ\text{C/W}$         |
| Total Device Dissipation Alumina<br>Substrate, (Note 2) @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$           | 300<br>2.4  | mW<br>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 | $^\circ\text{C}$           |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

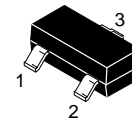
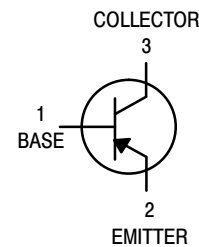
\*Transient pulses must not cause the junction temperature to be exceeded.

1. FR-5 =  $1.0 \times 0.75 \times 0.062$  in.
2. Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.



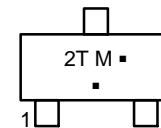
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**SOT-23 (TO-236)  
CASE 318  
STYLE 6**

#### MARKING DIAGRAM



2T = Specific Device Code\*  
M = Date Code\*  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*Specific Device Code, Date Code or overbar orientation and/or location may vary depending upon manufacturing location. This is a representation only and actual devices may not match this drawing exactly.

#### ORDERING INFORMATION

| Device        | Package             | Shipping†            |
|---------------|---------------------|----------------------|
| MMBT4403LT1G  | SOT-23<br>(Pb-Free) | 3000 / Tape & Reel   |
| SMMBT4403LT1G | SOT-23<br>(Pb-Free) | 3000 / Tape & Reel   |
| MMBT4403LT3G  | SOT-23<br>(Pb-Free) | 10,000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

| Characteristic                               | Symbol  | Min                  | Max  | Unit |                  |
|--|---|----------------------|------|------|------------------|
| <b>OFF CHARACTERISTICS</b>                   |   |                      |      |      |                  |
| Collector–Emitter Breakdown Voltage (Note 3) | (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , I <sub>B</sub> = 0)                     | V <sub>(BR)CEO</sub> | –40  | –    | V <sub>dc</sub>  |
| Collector–Base Breakdown Voltage             | (I <sub>C</sub> = –0.1 mA <sub>dc</sub> , I <sub>E</sub> = 0)                     | V <sub>(BR)CBO</sub> | –40  | –    | V <sub>dc</sub>  |
| Emitter–Base Breakdown Voltage               | (I <sub>E</sub> = –0.1 mA <sub>dc</sub> , I <sub>C</sub> = 0)                     | V <sub>(BR)EBO</sub> | –5.0 | –    | V <sub>dc</sub>  |
| Base Cutoff Current                          | (V <sub>CE</sub> = –35 V <sub>dc</sub> , V <sub>EB</sub> = –0.4 V <sub>dc</sub> ) | I <sub>BEV</sub>     | –    | –0.1 | μA <sub>dc</sub> |
| Collector Cutoff Current                     | (V <sub>CE</sub> = –35 V <sub>dc</sub> , V <sub>EB</sub> = –0.4 V <sub>dc</sub> ) | I <sub>CEX</sub>     | –    | –0.1 | μA <sub>dc</sub> |

## ON CHARACTERISTICS

|   |   |                      |                              |                         |                 |
|---|---|----------------------|------------------------------|-------------------------|-----------------|
| DC Current Gain                               | (I <sub>C</sub> = –0.1 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> )<br>(I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> )<br>(I <sub>C</sub> = –10 mA <sub>dc</sub> , V <sub>CE</sub> = –1.0 V <sub>dc</sub> )<br>(I <sub>C</sub> = –150 mA <sub>dc</sub> , V <sub>CE</sub> = –2.0 V <sub>dc</sub> )<br>(I <sub>C</sub> = –500 mA <sub>dc</sub> , V <sub>CE</sub> = –2.0 V <sub>dc</sub> ) | h <sub>FE</sub>      | 30<br>60<br>100<br>100<br>20 | –<br>–<br>–<br>300<br>– | –               |
| Collector–Emitter Saturation Voltage (Note 3) | (I <sub>C</sub> = –150 mA <sub>dc</sub> , I <sub>B</sub> = –15 mA <sub>dc</sub> )<br>(I <sub>C</sub> = –500 mA <sub>dc</sub> , I <sub>B</sub> = –50 mA <sub>dc</sub> )  | V <sub>CE(sat)</sub> | –<br>–                       | –0.4<br>–0.75           | V <sub>dc</sub> |
| Base–Emitter Saturation Voltage (Note 3)      | (I <sub>C</sub> = –150 mA <sub>dc</sub> , I <sub>B</sub> = –15 mA <sub>dc</sub> )<br>(I <sub>C</sub> = –500 mA <sub>dc</sub> , I <sub>B</sub> = –50 mA <sub>dc</sub> )  | V <sub>BE(sat)</sub> | –0.75<br>–                   | –0.95<br>–1.3           | V <sub>dc</sub> |

## SMALL–SIGNAL CHARACTERISTICS

|                                  |  |                 |     |     |                    |
|----------------------------------|--|-----------------|-----|-----|--------------------|
| Current–Gain – Bandwidth Product | (I <sub>C</sub> = –20 mA <sub>dc</sub> , V <sub>CE</sub> = –10 V <sub>dc</sub> , f = 100 MHz)  | f <sub>T</sub>  | 200 | –   | MHz                |
| Collector–Base Capacitance       | (V <sub>CB</sub> = –10 V <sub>dc</sub> , I <sub>E</sub> = 0, f = 1.0 MHz)                      | C <sub>cb</sub> | –   | 8.5 | pF                 |
| Emitter–Base Capacitance         | (V <sub>BE</sub> = –0.5 V <sub>dc</sub> , I <sub>C</sub> = 0, f = 1.0 MHz)                     | C <sub>eb</sub> | –   | 30  | pF                 |
| Input Impedance                  | (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –10 V <sub>dc</sub> , f = 1.0 kHz) | h <sub>ie</sub> | 1.5 | 15  | kΩ                 |
| Voltage Feedback Ratio           | (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –10 V <sub>dc</sub> , f = 1.0 kHz) | h <sub>re</sub> | 0.1 | 8.0 | X 10 <sup>–4</sup> |
| Small–Signal Current Gain        | (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –10 V <sub>dc</sub> , f = 1.0 kHz) | h <sub>fe</sub> | 60  | 500 | –                  |
| Output Admittance                | (I <sub>C</sub> = –1.0 mA <sub>dc</sub> , V <sub>CE</sub> = –10 V <sub>dc</sub> , f = 1.0 kHz) | h <sub>oe</sub> | 1.0 | 100 | μMhos              |

## SWITCHING CHARACTERISTICS

|              |  |                |   |     |    |
|--------------|--|----------------|---|-----|----|
| Delay Time   | (V <sub>CC</sub> = –30 V <sub>dc</sub> , V <sub>EB</sub> = –2.0 V <sub>dc</sub> ,<br>I <sub>C</sub> = –150 mA <sub>dc</sub> , I <sub>B1</sub> = –15 mA <sub>dc</sub> ) | t <sub>d</sub> | – | 15  | ns |
| Rise Time    |  | t <sub>r</sub> | – | 20  |    |
| Storage Time | (V <sub>CC</sub> = –30 V <sub>dc</sub> , I <sub>C</sub> = –150 mA <sub>dc</sub> ,<br>I <sub>B1</sub> = I <sub>B2</sub> = –15 mA <sub>dc</sub> )                        | t <sub>s</sub> | – | 225 | ns |
| Fall Time    |  | t <sub>f</sub> | – | 30  |    |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

## SWITCHING TIME EQUIVALENT TEST CIRCUIT

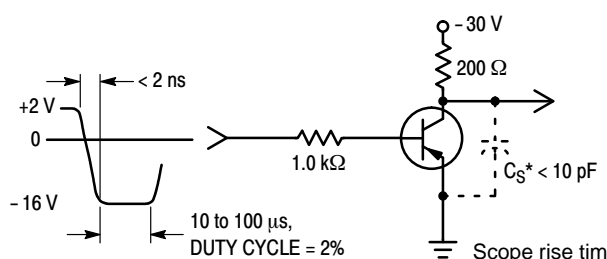


Figure 1. Turn–On Time

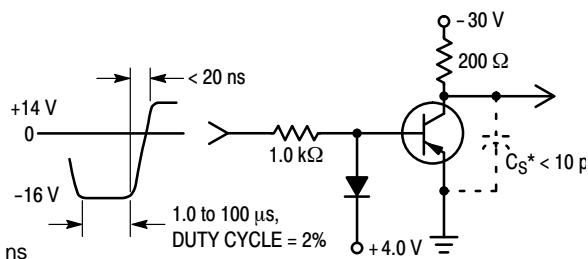


Figure 2. Turn–Off Time

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## TRANSIENT CHARACTERISTICS

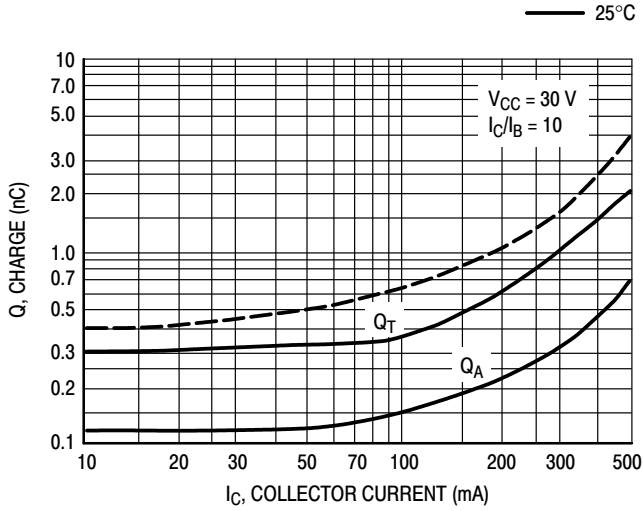


Figure 3. Charge Data

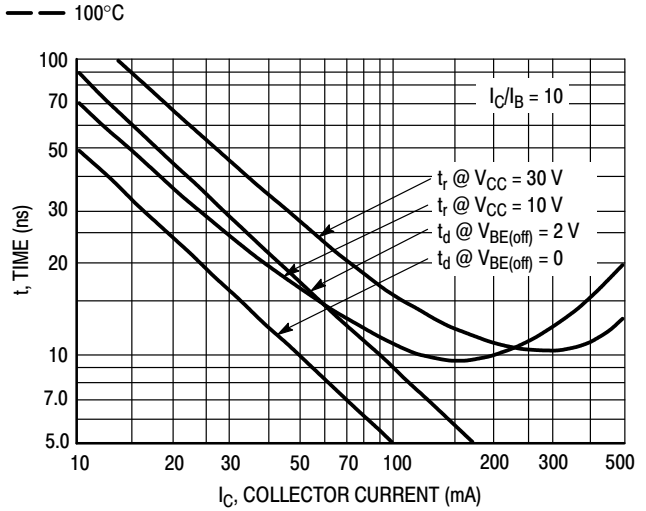


Figure 4. Turn-On Time

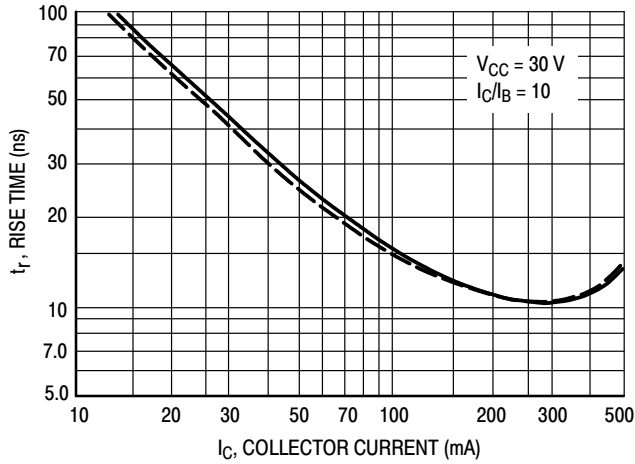


Figure 5. Rise Time

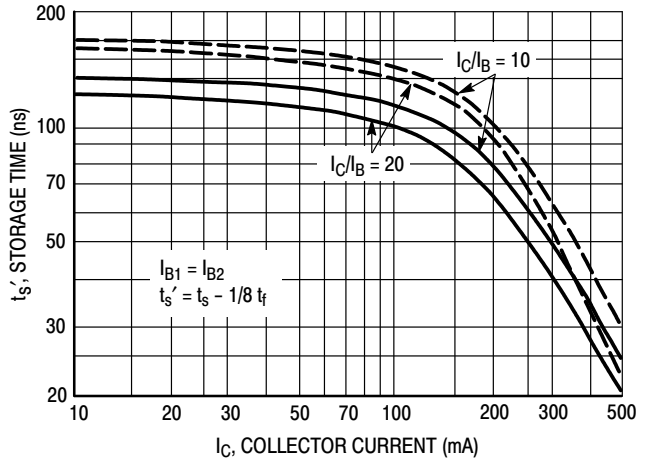


Figure 6. Storage Time

## SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE

$V_{CE} = -10$  Vdc,  $T_A = 25^\circ\text{C}$ ; Bandwidth = 1.0 Hz

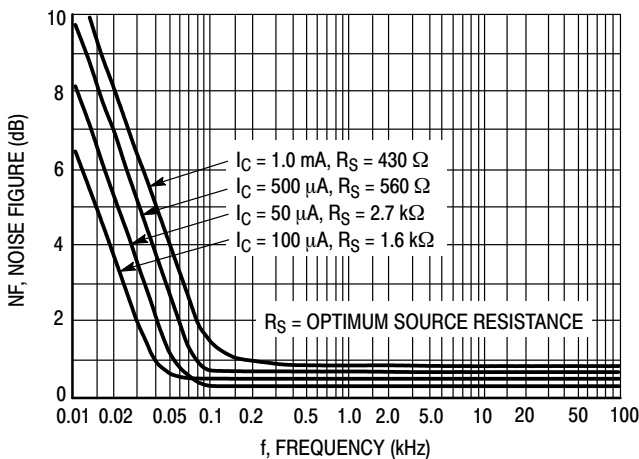


Figure 7. Frequency Effects

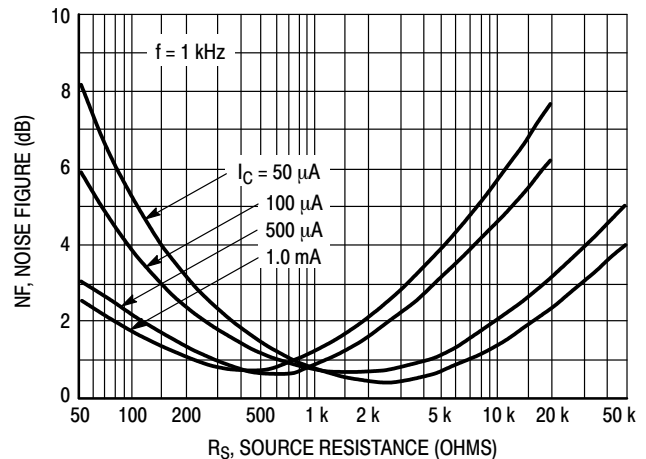


Figure 8. Source Resistance Effects

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## h PARAMETERS

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

This group of graphs illustrates the relationship between  $h_{fe}$  and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from the MMBT4403LT1 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

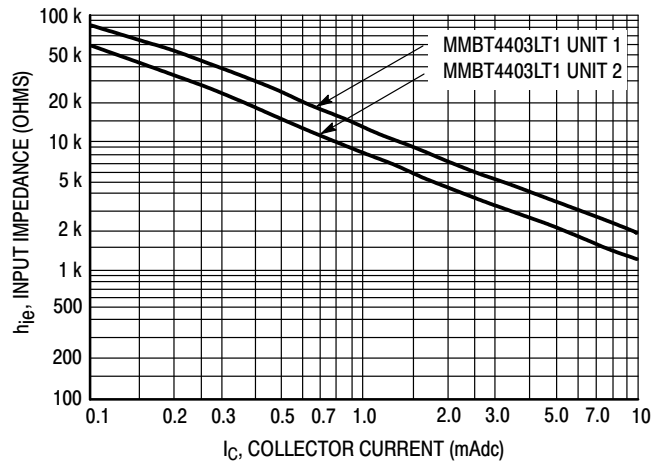


Figure 9. Input Impedance

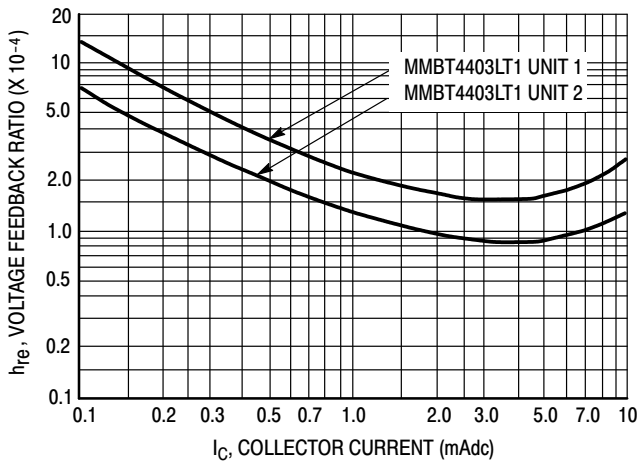


Figure 10. Voltage Feedback Ratio

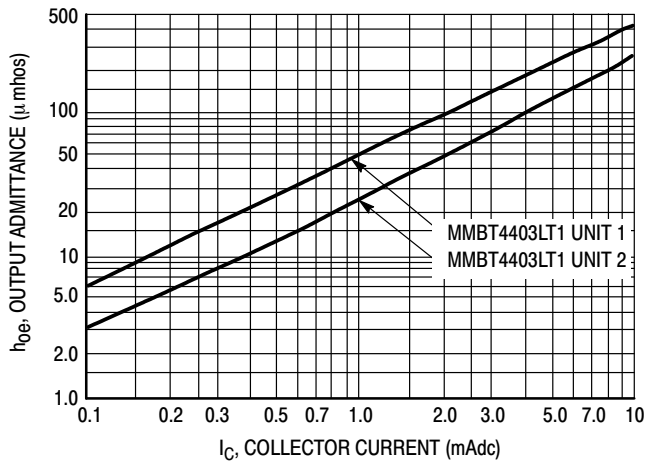


Figure 11. Output Admittance

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## STATIC CHARACTERISTICS

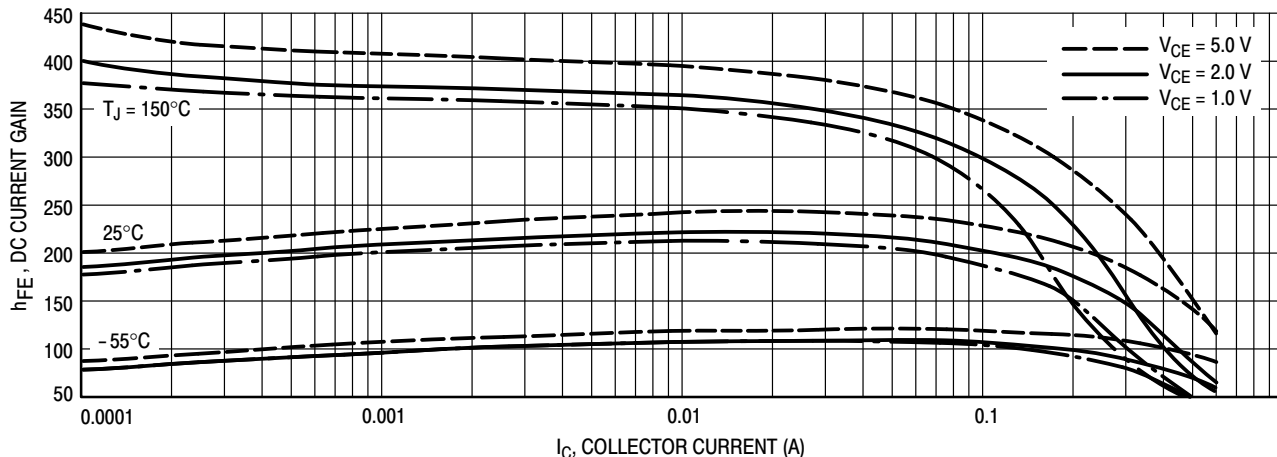


Figure 12. DC Current Gain

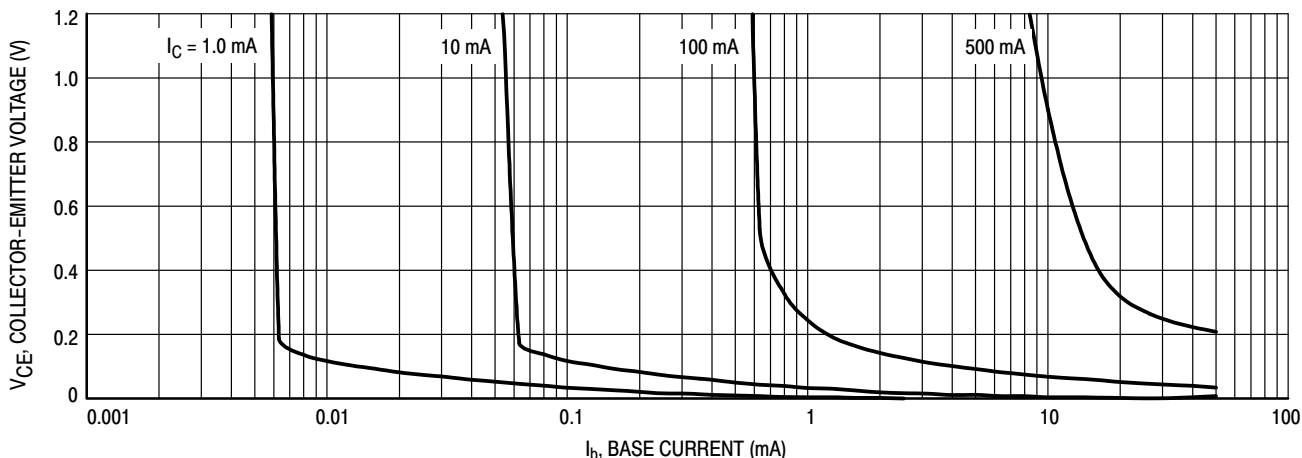


Figure 13. Collector Saturation Region

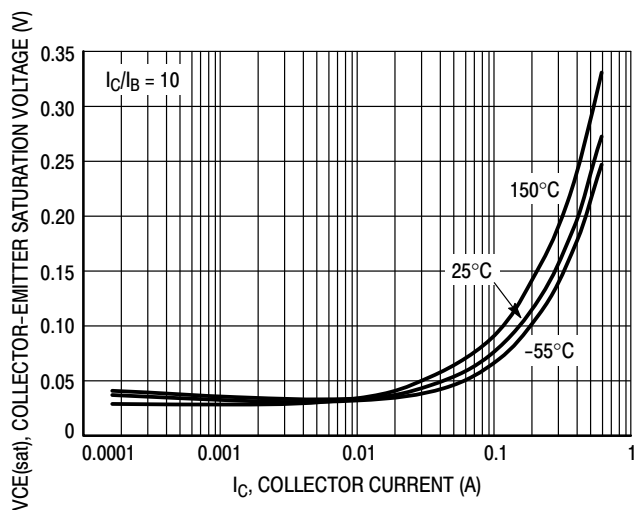


Figure 14. Collector-Emitter Saturation Voltage vs. Collector Current

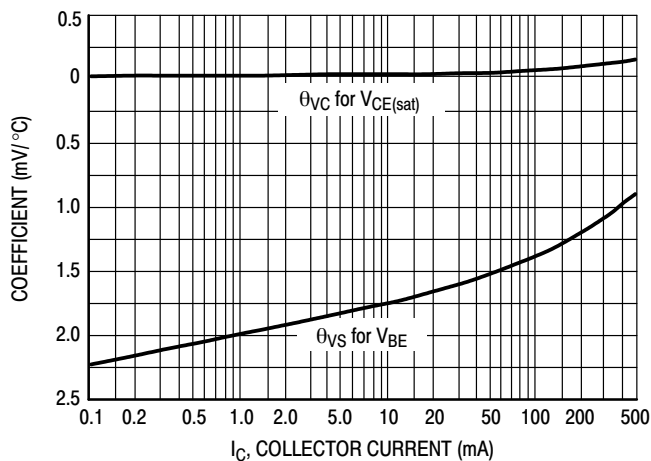
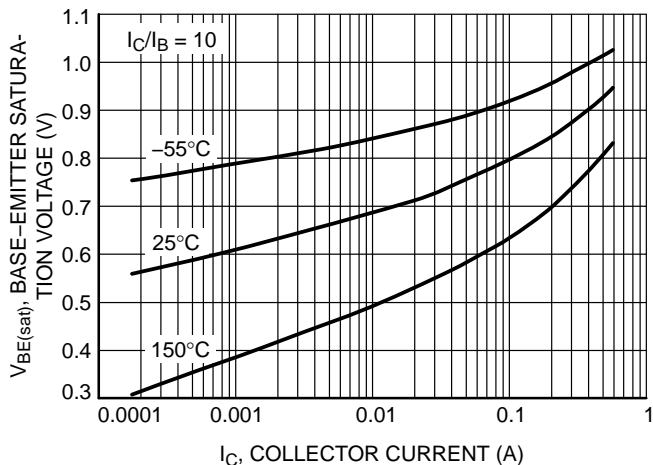


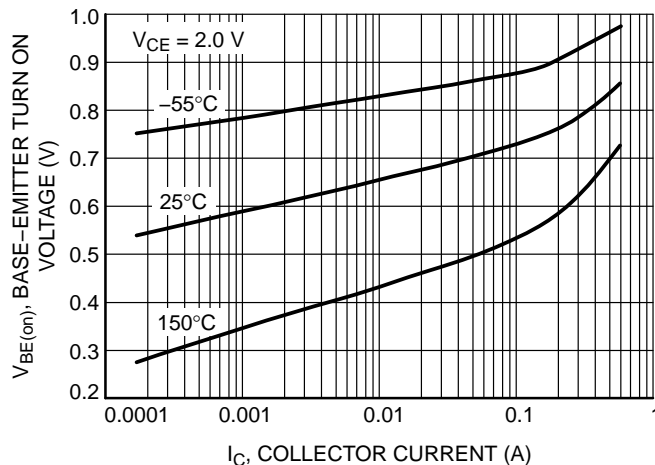
Figure 15. Temperature Coefficients

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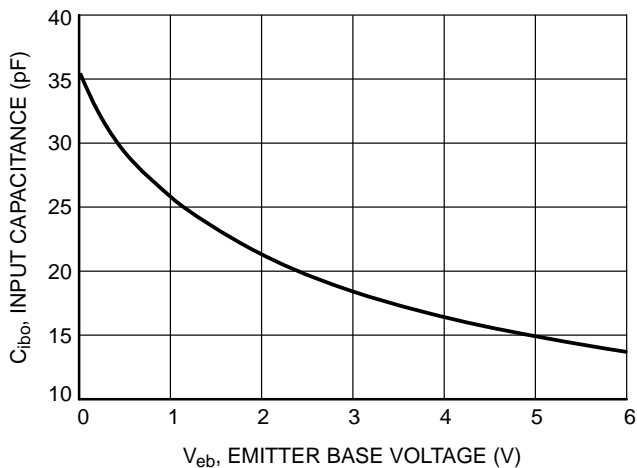
## STATIC CHARACTERISTICS



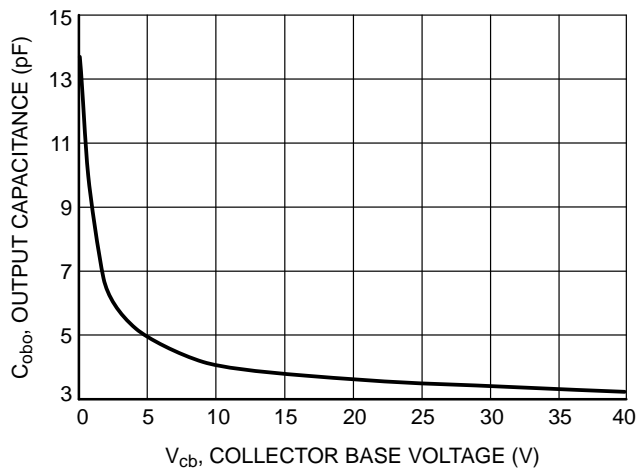
**Figure 16. Base-Emitter Saturation Voltage vs. Collector Current**



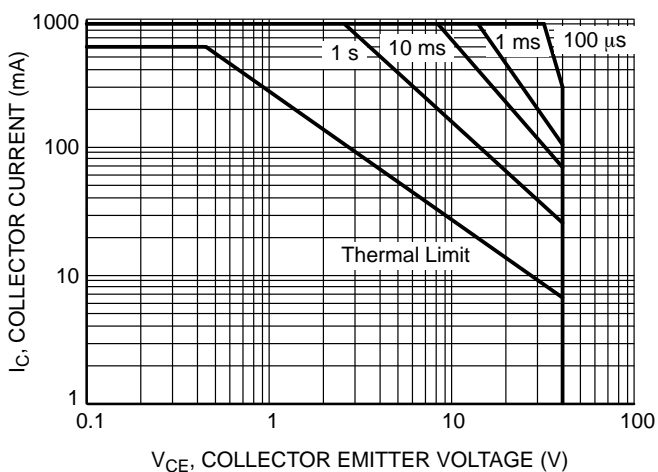
**Figure 17. Base-Emitter Turn On Voltage vs. Collector Current**



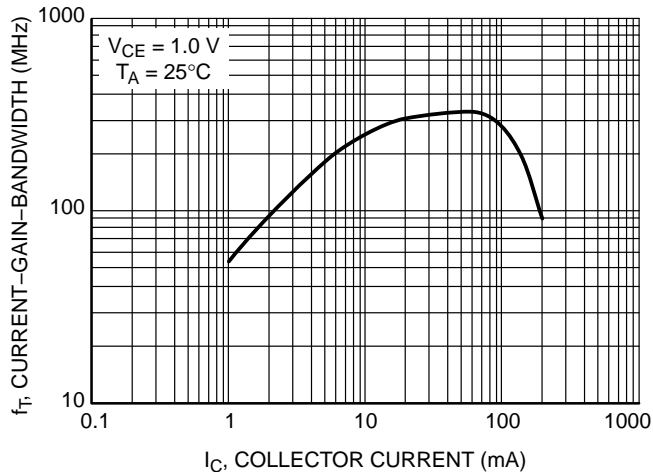
**Figure 18. Input Capacitance vs. Emitter Base Voltage**



**Figure 19. Output Capacitance vs. Collector Base Voltage**



**Figure 20. Safe Operating Area**



**Figure 21. Current-Gain-Bandwidth Product**

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