General Purpose Transistor

NPN Silicon

MMBT3904L, SMMBT3904L

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

MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector – Emitter Voltage</td>
<td>( V_{CEO} )</td>
<td>40</td>
<td>Vdc</td>
</tr>
<tr>
<td>Collector – Base Voltage</td>
<td>( V_{CBO} )</td>
<td>60</td>
<td>Vdc</td>
</tr>
<tr>
<td>Emitter – Base Voltage</td>
<td>( V_{EBO} )</td>
<td>6.0</td>
<td>Vdc</td>
</tr>
<tr>
<td>Collector Current – Continuous</td>
<td>( I_C )</td>
<td>200</td>
<td>mAdc</td>
</tr>
<tr>
<td>Collector Current – Peak (Note 3)</td>
<td>( I_{CM} )</td>
<td>900</td>
<td>mAdc</td>
</tr>
</tbody>
</table>

THERMAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Device Dissipation FR–5 Board (Note 1) @( T_A = 25^\circ )C</td>
<td>( P_D )</td>
<td>225</td>
<td>mW</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td>1.8</td>
<td>mW/°C</td>
</tr>
<tr>
<td>Thermal Resistance, Junction–to–Ambient</td>
<td>( R_{JUA} )</td>
<td>556</td>
<td>°C/W</td>
</tr>
<tr>
<td>Total Device Dissipation Alumina Substrate, (Note 2) @( T_A = 25^\circ )C</td>
<td>( P_D )</td>
<td>300</td>
<td>mW</td>
</tr>
<tr>
<td>Derate above 25°C</td>
<td></td>
<td>2.4</td>
<td>mW/°C</td>
</tr>
<tr>
<td>Thermal Resistance, Junction–to–Ambient</td>
<td>( R_{JUA} )</td>
<td>417</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction and Storage Temperature</td>
<td>( T_J, T_{stg} )</td>
<td>–55 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

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.

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.
3. Reference SOA curve.

MARKING DIAGRAM

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMBT3904LT1G SMT</td>
<td>SOT–23</td>
<td>3000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>SMMBT3904LT1G SMD</td>
<td>SOT–23</td>
<td>10,000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>MMBT3904LT3G SMT</td>
<td>SOT–23</td>
<td>3000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>SMMBT3904LT3G SMD</td>
<td>SOT–23</td>
<td>10,000 / Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†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.
MMBT3904L, SMMBT3904L

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector – Emitter Breakdown Voltage  ((I_C = 1.0\ mAdc, I_B = 0))</td>
<td>(V_{(BR)CEO})</td>
<td>40</td>
<td>–</td>
<td>Vdc</td>
</tr>
<tr>
<td>Collector – Base Breakdown Voltage  ((I_C = 10\ \mu Adc, I_B = 0))</td>
<td>(V_{(BR)CBO})</td>
<td>60</td>
<td>–</td>
<td>Vdc</td>
</tr>
<tr>
<td>Emitter – Base Breakdown Voltage  ((I_E = 10\ \mu Adc, I_C = 0))</td>
<td>(V_{(BR)EBO})</td>
<td>6.0</td>
<td>–</td>
<td>Vdc</td>
</tr>
<tr>
<td>Base Cutoff Current  ((V_{CE} = 30\ Vdc, V_{EB} = 3.0\ Vdc))</td>
<td>(I_{BL})</td>
<td>–</td>
<td>50</td>
<td>nAdc</td>
</tr>
<tr>
<td>Collector Cutoff Current  ((V_{CE} = 30\ Vdc, V_{EB} = 3.0\ Vdc))</td>
<td>(I_{CEX})</td>
<td>–</td>
<td>50</td>
<td>nAdc</td>
</tr>
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</table>

ON CHARACTERISTICS (Note 4)

<table>
<thead>
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<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Current Gain</td>
<td>(H_F)</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>((I_C = 0.1\ mAdc, V_{CE} = 1.0\ Vdc))</td>
<td>(H_F)</td>
<td>70</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>((I_C = 10\ mAdc, V_{CE} = 1.0\ Vdc))</td>
<td>(H_F)</td>
<td>100</td>
<td>300</td>
<td>–</td>
</tr>
<tr>
<td>((I_C = 50\ mAdc, V_{CE} = 1.0\ Vdc))</td>
<td>(H_F)</td>
<td>60</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>((I_C = 100\ mAdc, V_{CE} = 1.0\ Vdc))</td>
<td>(H_F)</td>
<td>30</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Collector – Emitter Saturation Voltage ((I_C = 10\ mAdc, I_B = 1.0\ mAdc))</td>
<td>(V_{CE(sat)})</td>
<td>–</td>
<td>0.2</td>
<td>Vdc</td>
</tr>
<tr>
<td>((I_C = 50\ mAdc, I_B = 5.0\ mAdc))</td>
<td>(V_{CE(sat)})</td>
<td>–</td>
<td>0.3</td>
<td>Vdc</td>
</tr>
<tr>
<td>Base – Emitter Saturation Voltage ((I_C = 10\ mAdc, I_B = 1.0\ mAdc))</td>
<td>(V_{BE(sat)})</td>
<td>0.65</td>
<td>0.85</td>
<td>Vdc</td>
</tr>
<tr>
<td>((I_C = 50\ mAdc, I_B = 5.0\ mAdc))</td>
<td>(V_{BE(sat)})</td>
<td>–</td>
<td>0.95</td>
<td>Vdc</td>
</tr>
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</table>

SMALL–SIGNAL CHARACTERISTICS

<table>
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<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current – Gain – Bandwidth Product  ((I_C = 10\ mAdc, V_{CE} = 20\ Vdc, f = 100\ MHz))</td>
<td>(f_T)</td>
<td>300</td>
<td>–</td>
<td>MHz</td>
</tr>
<tr>
<td>Output Capacitance  ((V_{CB} = 5.0\ Vdc, I_E = 0, f = 1.0\ MHz))</td>
<td>(C_{obo})</td>
<td>–</td>
<td>4.0</td>
<td>pF</td>
</tr>
<tr>
<td>Input Capacitance  ((V_{EB} = 0.5\ Vdc, I_C = 0, f = 1.0\ MHz))</td>
<td>(C_{ibo})</td>
<td>–</td>
<td>8.0</td>
<td>pF</td>
</tr>
<tr>
<td>Input Impedance  ((V_{CE} = 10\ Vdc, I_E = 1.0\ mAdc, f = 1.0\ kHz))</td>
<td>(h_{ie})</td>
<td>1.0</td>
<td>10</td>
<td>kΩ</td>
</tr>
<tr>
<td>Voltage Feedback Ratio  ((V_{CE} = 10\ Vdc, I_C = 1.0\ mAdc, f = 1.0\ kHz))</td>
<td>(h_{re})</td>
<td>0.5</td>
<td>8.0</td>
<td>X 10^-4</td>
</tr>
<tr>
<td>Small – Signal Current Gain  ((V_{CE} = 10\ Vdc, I_C = 1.0\ mAdc, f = 1.0\ kHz))</td>
<td>(h_{ie})</td>
<td>100</td>
<td>400</td>
<td>–</td>
</tr>
<tr>
<td>Output Admittance  ((V_{CE} = 10\ Vdc, I_C = 1.0\ mAdc, f = 1.0\ kHz))</td>
<td>(h_{oe})</td>
<td>1.0</td>
<td>40</td>
<td>(\mu mhos)</td>
</tr>
<tr>
<td>Noise Figure  ((V_{CE} = 5.0\ Vdc, I_C = 100\ \mu Adc, R_S = 1.0\ k\ ohms, f = 1.0\ kHz))</td>
<td>(NF)</td>
<td>–</td>
<td>5.0</td>
<td>dB</td>
</tr>
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</table>

SWITCHING CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay Time ((V_{CC} = 3.0\ Vdc, V_{BE} = -0.5\ Vdc, I_C = 10\ mAdc, I_{B1} = 1.0\ mAdc))</td>
<td>(t_d)</td>
<td>–</td>
<td>35</td>
<td>ns</td>
</tr>
<tr>
<td>Rise Time ((V_{CC} = 3.0\ Vdc, I_C = 10\ mAdc, I_{B1} = 1.0\ mAdc))</td>
<td>(t_r)</td>
<td>–</td>
<td>35</td>
<td>ns</td>
</tr>
<tr>
<td>Storage Time ((V_{CC} = 3.0\ Vdc, I_C = 10\ mAdc, I_{B1} = I_{B2} = 1.0\ mAdc))</td>
<td>(t_s)</td>
<td>–</td>
<td>200</td>
<td>ns</td>
</tr>
<tr>
<td>Fall Time ((V_{CC} = 3.0\ Vdc, I_C = 10\ mAdc, I_{B1} = I_{B2} = 1.0\ mAdc))</td>
<td>(t_f)</td>
<td>–</td>
<td>50</td>
<td>ns</td>
</tr>
</tbody>
</table>

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.

4. Pulse Test: Pulse Width \(\leq 300\ \mu s\), Duty Cycle \(\leq 2.0\%\).

![Figure 1. Delay and Rise Time Equivalent Test Circuit](image1)

![Figure 2. Storage and Fall Time Equivalent Test Circuit](image2)

* Total shunt capacitance of test jig and connectors

www.onsemi.com
TYPICAL TRANSIENT CHARACTERISTICS

Figure 3. Capacitance

Figure 4. Charge Data

Figure 5. Turn-On Time

Figure 6. Rise Time

Figure 7. Storage Time

Figure 8. Fall Time
MMBT3904L, SMMBT3904L

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS
(V<sub>CE</sub> = 5.0 Vdc, T<sub>A</sub> = 25°C, Bandwidth = 1.0 Hz)

![Figure 9: Noise Figure vs Frequency](image1)

![Figure 10: Noise Figure vs Source Resistance](image2)

h PARAMETERS
(V<sub>CE</sub> = 10 Vdc, f = 1.0 kHz, T<sub>A</sub> = 25°C)

![Figure 11: Current Gain](image3)

![Figure 12: Output Admittance](image4)

![Figure 13: Input Impedance](image5)

![Figure 14: Voltage Feedback Ratio](image6)
TYPICAL STATIC CHARACTERISTICS

Figure 15. DC Current Gain

Figure 16. Collector Saturation Region
Figure 17. Collector Emitter Saturation Voltage vs. Collector Current

Figure 18. Base Emitter Saturation Voltage vs. Collector Current

Figure 19. Base Emitter Voltage vs. Collector Current

Figure 20. Temperature Coefficients

Figure 21. Current Gain Bandwidth vs. Collector Current

Figure 22. Safe Operating Area
**MECHANICAL CASE OUTLINE**

**PACKAGE DIMENSIONS**

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**SOT-23 (TO-236)**

**CASE 318-08**

**ISSUE AS**

**DATE 30 JAN 2018**

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**NOTES:**

2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

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**RECOMMENDED SOLDERING FOOTPRINT**

**SIDE VIEW**

**TOP VIEW**

**END VIEW**

**VIEW C**

**GENERAL MARKING DIAGRAM**

**SPECIFIC DEVICE CODE**

**STYLE 6:**

- **PIN 1.** BASE
- **PIN 2.** EMITTER
- **PIN 3.** COLLECTOR

**STYLE 7:**

- **PIN 1.** EMITTER
- **PIN 2.** BASE
- **PIN 3.** COLLECTOR

**STYLE 8:**

- **PIN 1.** ANODE
- **PIN 2.** NO CONNECTION
- **PIN 3.** CATHODE

**STYLE 9:**

- **PIN 1.** ANODE
- **PIN 2.** DRAIN
- **PIN 3.** GATE

**STYLE 10:**

- **PIN 1.** CATHODE
- **PIN 2.** DRIVING
- **PIN 3.** SOURCE

**STYLE 11:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** CATHODE

**STYLE 12:**

- **PIN 1.** CATHODE
- **PIN 2.** CATHODE
- **PIN 3.** ANODE

**STYLE 13:**

- **PIN 1.** SOURCE
- **PIN 2.** CATHODE
- **PIN 3.** GATE

**STYLE 14:**

- **PIN 1.** CATHODE
- **PIN 2.** CATHODE
- **PIN 3.** ANODE

**STYLE 15:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** CATHODE

**STYLE 16:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** GATE

**STYLE 17:**

- **PIN 1.** NO CONNECTION
- **PIN 2.** CATHODE
- **PIN 3.** ANODE

**STYLE 18:**

- **PIN 1.** NO CONNECTION
- **PIN 2.** CATHODE
- **PIN 3.** ANODE

**STYLE 19:**

- **PIN 1.** NO CONNECTION
- **PIN 2.** CATHODE
- **PIN 3.** ANODE

**STYLE 20:**

- **PIN 1.** CATHODE
- **PIN 2.** CATHODE
- **PIN 3.** NO CONNECTION

**STYLE 21:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** CATHODE

**STYLE 22:**

- **PIN 1.** RETURN
- **PIN 2.** OUTPUT
- **PIN 3.** INPUT

**STYLE 23:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** SOURCE

**STYLE 24:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** GATE

**STYLE 25:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** NO CONNECTION

**STYLE 26:**

- **PIN 1.** ANODE
- **PIN 2.** CATHODE
- **PIN 3.** NO CONNECTION

---

**DIMENSIONS: MILLIMETERS**

<table>
<thead>
<tr>
<th>DIM</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>0.89</td>
<td>1.00</td>
<td>1.11</td>
<td>0.035</td>
<td>0.039</td>
<td>0.044</td>
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<tr>
<td>A1</td>
<td>0.01</td>
<td>0.06</td>
<td>0.10</td>
<td>0.000</td>
<td>0.002</td>
<td>0.004</td>
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<tr>
<td>B</td>
<td>0.37</td>
<td>0.44</td>
<td>0.50</td>
<td>0.015</td>
<td>0.017</td>
<td>0.020</td>
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<tr>
<td>c</td>
<td>0.08</td>
<td>0.14</td>
<td>0.20</td>
<td>0.003</td>
<td>0.006</td>
<td>0.008</td>
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<tr>
<td>D</td>
<td>2.80</td>
<td>2.90</td>
<td>3.04</td>
<td>0.110</td>
<td>0.114</td>
<td>0.120</td>
</tr>
<tr>
<td>E</td>
<td>1.20</td>
<td>1.30</td>
<td>1.40</td>
<td>0.047</td>
<td>0.051</td>
<td>0.055</td>
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<tr>
<td>L</td>
<td>0.30</td>
<td>0.43</td>
<td>0.55</td>
<td>0.012</td>
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<td>L1</td>
<td>0.35</td>
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<td>T</td>
<td>90°</td>
<td>90°</td>
<td>90°</td>
<td>0°</td>
<td>10°</td>
<td>10°</td>
</tr>
</tbody>
</table>

**RECOMMENDED**

**SOLDERING FOOTPRINT**

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**ISSUES AS**

**DATE 30 JAN 2018**

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**SCALE 4:1**

**DOCUMENT NUMBER:** 98ASB42226B

**DESCRIPTION:** SOT-23 (TO-236)

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