

**40V NPN SMALL SIGNAL SURFACE MOUNT TRANSISTOR**
**Features**

- Epitaxial Planar Die Construction
- Complementary PNP Type Available (MMBT3906)
- Ideal for Medium Power Amplification and Switching
- **Totally Lead-Free & Fully RoHS compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **Qualified to AEC-Q101 Standards for High Reliability**
- **PPAP capable (Note 4)**

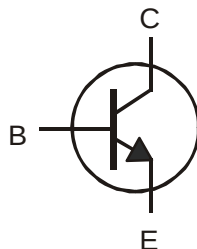
**Mechanical Data**

- Case: SOT23
- Case Material: molded plastic, "Green" molding compound
- UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 
- Weight: 0.008 grams (approximate)

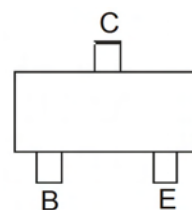
SOT23



Top View



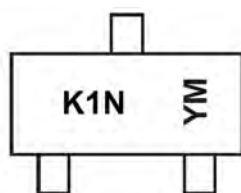
Device Symbol


 Top View  
Pin-Out

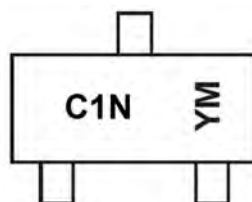
**Ordering Information** (Notes 4 & 5)

| Product       | Compliance | Marking   | Reel size (inches) | Tape width (mm) | Quantity per reel |
|---------------|------------|-----------|--------------------|-----------------|-------------------|
| MMBT3904-7-F  | AEC-Q101   | K1N / C1N | 7                  | 8               | 3,000             |
| MMBT3904Q-7-F | Automotive | K1N       | 7                  | 8               | 3,000             |
| MMBT3904-13-F | AEC-Q101   | K1N / C1N | 13                 | 8               | 10,000            |

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See <http://www.diodes.com> for more information about Diodes Incorporated's definitions of Halogen and Antimony free, "Green" and Lead-Free.
  3. Halogen and Antimony free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
  4. Automotive products are AEC-Q101 qualified and are PPAP capable. Automotive, AEC-Q101 and standard products are electrically and thermally the same, except where specified.
  5. For packaging details, go to our website at <http://www.diodes.com>

**Marking Information**


K = SAT (Shanghai Assembly / Test site)  
 1N = Product Type Marking Code  
 YM = Date Code Marking  
 Y = Year (ex: Y = 2011)  
 M = Month (ex: 9 = September)



C = CAT (Chengdu Assembly / Test site)  
 1N = Product Type Marking Code  
 YM = Date Code Marking  
 Y = Year (ex: Y = 2011)  
 M = Month (ex: 9 = September)

**Date Code Key**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|
| Code | X    | Y    | Z    | A    | B    | C    | D    | E    |

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Code  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | O   | N   | D   |

**Maximum Ratings** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

| Characteristic               | Symbol           | Value | Unit |
|------------------------------|------------------|-------|------|
| Collector-Base Voltage       | V <sub>CBO</sub> | 60    | V    |
| Collector-Emitter Voltage    | V <sub>CEO</sub> | 40    | V    |
| Emitter-Base Voltage         | V <sub>EB0</sub> | 6.0   | V    |
| Continuous Collector Current | I <sub>C</sub>   | 200   | mA   |

**Thermal Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

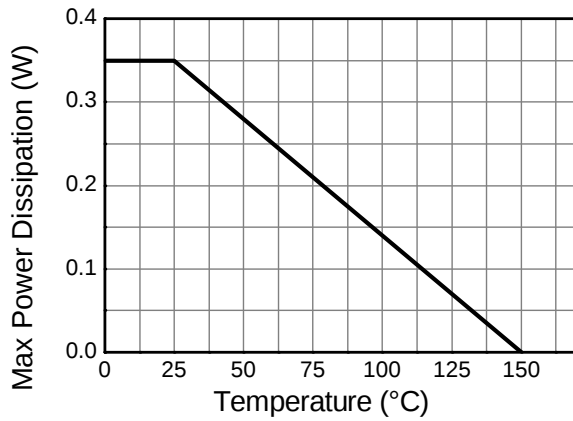
| Characteristic                          | Symbol                            | Value       | Unit |
|-----------------------------------------|-----------------------------------|-------------|------|
| Power Dissipation                       | P <sub>D</sub>                    | 310         | mW   |
|                                         |                                   | 350         |      |
| Thermal Resistance, Junction to Ambient | R <sub>θJA</sub>                  | 403         | °C/W |
|                                         |                                   | 357         |      |
| Thermal Resistance, Junction to Leads   | R <sub>θJL</sub>                  | 350         | °C/W |
| Operating and Storage Temperature Range | T <sub>J</sub> , T <sub>STG</sub> | -55 to +150 | °C   |

**ESD Ratings** (Note 9)

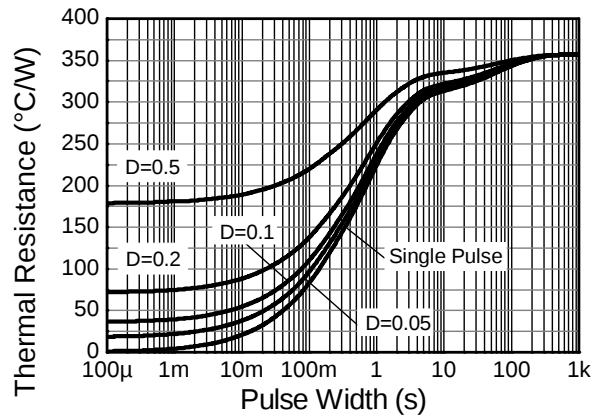
| Characteristic                             | Symbol  | Value   | Unit | JEDEC Class |
|--------------------------------------------|---------|---------|------|-------------|
| Electrostatic Discharge - Human Body Model | ESD HBM | ≥ 8,000 | V    | 3B          |
| Electrostatic Discharge - Machine Model    | ESD MM  | ≥ 400   | V    | C           |

- Notes:
6. For the device mounted on minimum recommended pad layout FR4 PCB with high coverage of single sided 1oz copper, in still air conditions.
  7. For the device mounted on 15mm x 15mm x 1.6mm FR4 PCB with high coverage of single sided 1oz copper, in still air conditions.
  8. Thermal resistance from junction to solder-point (at the end of the collector lead).
  9. Refer to JEDEC specification JESD22-A114 and JESD22-A115.

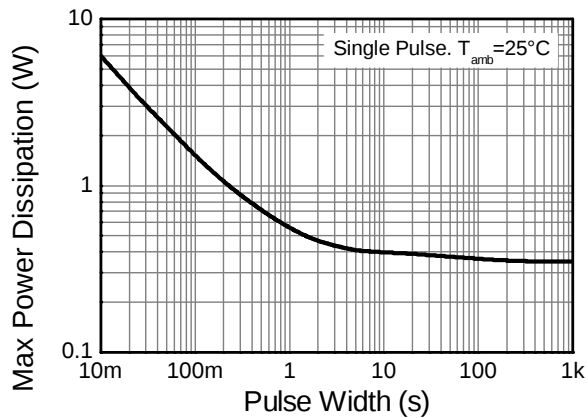
## Thermal Characteristics



**Derating Curve**



**Transient Thermal Impedance**



**Pulse Power Dissipation**

**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

| Characteristic                                | Symbol               | Min                         | Max                     | Unit               | Test Condition                                                                                                                                                                                                                                       |
|-----------------------------------------------|----------------------|-----------------------------|-------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>OFF CHARACTERISTICS</b>                    |                      |                             |                         |                    |                                                                                                                                                                                                                                                      |
| Collector-Base Breakdown Voltage              | BV <sub>CBO</sub>    | 60                          | —                       | V                  | I <sub>C</sub> = 10μA, I <sub>E</sub> = 0                                                                                                                                                                                                            |
| Collector-Emitter Breakdown Voltage (Note 10) | BV <sub>CEO</sub>    | 40                          | —                       | V                  | I <sub>C</sub> = 10mA, I <sub>B</sub> = 0                                                                                                                                                                                                            |
| Emitter-Base Breakdown Voltage                | BV <sub>EBO</sub>    | 6.0                         | —                       | V                  | I <sub>E</sub> = 10μA, I <sub>C</sub> = 0                                                                                                                                                                                                            |
| Collector Cutoff Current                      | I <sub>CEX</sub>     | —                           | 50                      | nA                 | V <sub>CE</sub> = 30V, V <sub>EB(OFF)</sub> = 3.0V                                                                                                                                                                                                   |
| Base Cutoff Current                           | I <sub>BL</sub>      | —                           | 50                      | nA                 | V <sub>CE</sub> = 30V, V <sub>EB(OFF)</sub> = 3.0V                                                                                                                                                                                                   |
| <b>ON CHARACTERISTICS (Note 10)</b>           |                      |                             |                         |                    |                                                                                                                                                                                                                                                      |
| DC Current Gain                               | h <sub>FE</sub>      | 40<br>70<br>100<br>60<br>30 | —<br>—<br>300<br>—<br>— | —                  | I <sub>C</sub> = 100μA, V <sub>CE</sub> = 1.0V<br>I <sub>C</sub> = 1.0mA, V <sub>CE</sub> = 1.0V<br>I <sub>C</sub> = 10mA, V <sub>CE</sub> = 1.0V<br>I <sub>C</sub> = 50mA, V <sub>CE</sub> = 1.0V<br>I <sub>C</sub> = 100mA, V <sub>CE</sub> = 1.0V |
| Collector-Emitter Saturation Voltage          | V <sub>CE(sat)</sub> | —                           | 0.20<br>0.30            | V                  | I <sub>C</sub> = 10mA, I <sub>B</sub> = 1.0mA<br>I <sub>C</sub> = 50mA, I <sub>B</sub> = 5.0mA                                                                                                                                                       |
| Base-Emitter Saturation Voltage               | V <sub>BE(sat)</sub> | 0.65<br>—                   | 0.85<br>0.95            | V                  | I <sub>C</sub> = 10mA, I <sub>B</sub> = 1.0mA<br>I <sub>C</sub> = 50mA, I <sub>B</sub> = 5.0mA                                                                                                                                                       |
| <b>SMALL SIGNAL CHARACTERISTICS</b>           |                      |                             |                         |                    |                                                                                                                                                                                                                                                      |
| Output Capacitance                            | C <sub>obo</sub>     | —                           | 4.0                     | pF                 | V <sub>CB</sub> = 5.0V, f = 1.0MHz, I <sub>E</sub> = 0                                                                                                                                                                                               |
| Input Capacitance                             | C <sub>ibo</sub>     | —                           | 8.0                     | pF                 | V <sub>EB</sub> = 0.5V, f = 1.0MHz, I <sub>C</sub> = 0                                                                                                                                                                                               |
| Input Impedance                               | h <sub>ie</sub>      | 1.0                         | 10                      | kΩ                 | V <sub>CE</sub> = 10V, I <sub>C</sub> = 1.0mA,<br>f = 1.0kHz                                                                                                                                                                                         |
| Voltage Feedback Ratio                        | h <sub>re</sub>      | 0.5                         | 8.0                     | × 10 <sup>-4</sup> |                                                                                                                                                                                                                                                      |
| Small Signal Current Gain                     | h <sub>fe</sub>      | 100                         | 400                     | —                  |                                                                                                                                                                                                                                                      |
| Output Admittance                             | h <sub>oe</sub>      | 1.0                         | 40                      | μS                 |                                                                                                                                                                                                                                                      |
| Current Gain-Bandwidth Product                | f <sub>T</sub>       | 300                         | —                       | MHz                | V <sub>CE</sub> = 20V, I <sub>C</sub> = 10mA,<br>f = 100MHz                                                                                                                                                                                          |
| Noise Figure                                  | NF                   | —                           | 5.0                     | dB                 | V <sub>CE</sub> = 5.0V, I <sub>C</sub> = 100μA,<br>R <sub>S</sub> = 1.0kΩ, f = 1.0kHz                                                                                                                                                                |
| <b>SWITCHING CHARACTERISTICS</b>              |                      |                             |                         |                    |                                                                                                                                                                                                                                                      |
| Delay Time                                    | t <sub>d</sub>       | —                           | 35                      | ns                 | V <sub>CC</sub> = 3.0V, I <sub>C</sub> = 10mA,<br>V <sub>BE(off)</sub> = -0.5V, I <sub>B1</sub> = 1.0mA                                                                                                                                              |
| Rise Time                                     | t <sub>r</sub>       | —                           | 35                      | ns                 |                                                                                                                                                                                                                                                      |
| Storage Time                                  | t <sub>s</sub>       | —                           | 200                     | ns                 | V <sub>CC</sub> = 3.0V, I <sub>C</sub> = 10mA,<br>I <sub>B1</sub> = I <sub>B2</sub> = 1.0mA                                                                                                                                                          |
| Fall Time                                     | t <sub>f</sub>       | —                           | 50                      | ns                 |                                                                                                                                                                                                                                                      |

Notes: 9. Measured under pulsed conditions. Pulse width ≤ 300μs. Duty cycle ≤ 2%.

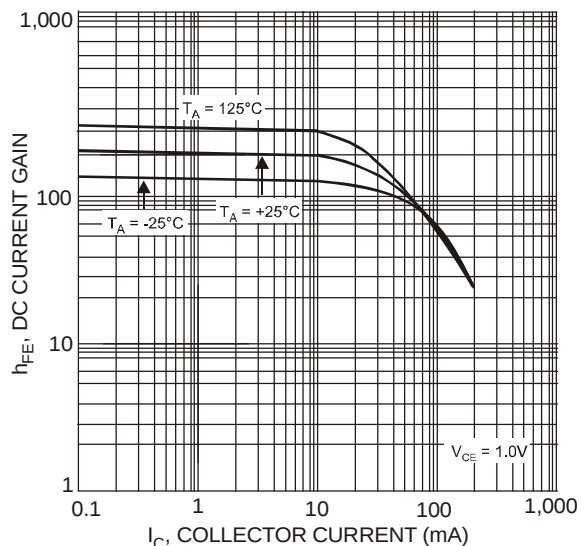


Fig. 1 Typical DC Current Gain vs. Collector Current

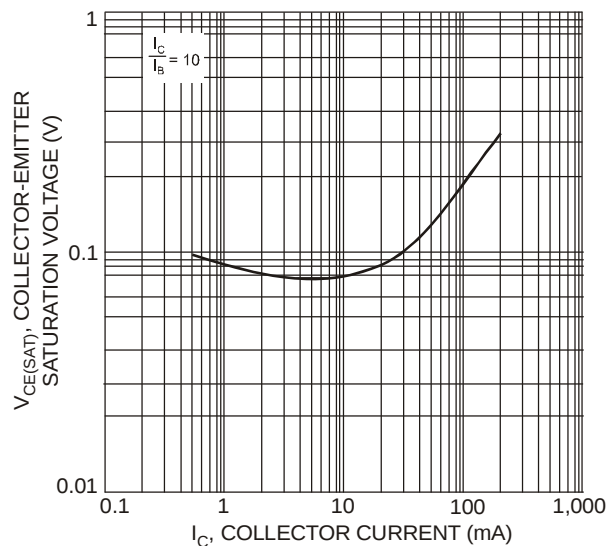


Fig. 2 Typical Collector-Emitter Saturation Voltage vs. Collector Current

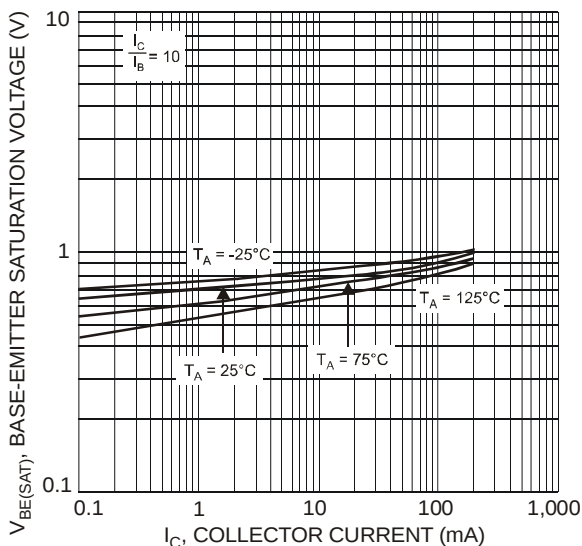


Fig. 3 Typical Base-Emitter Saturation Voltage vs. Collector Current

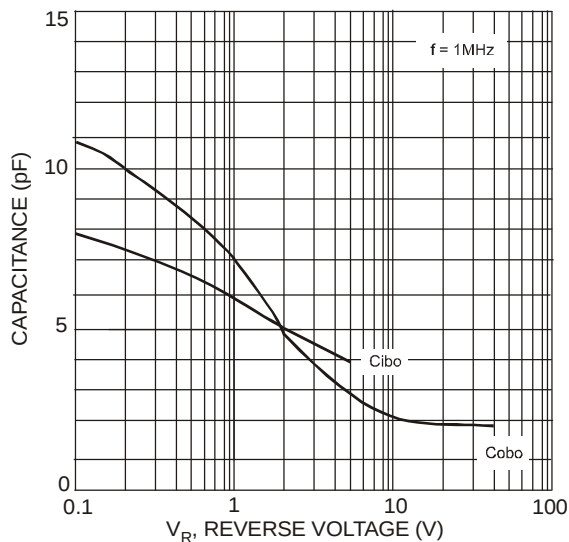


Fig. 4 Typical Capacitance Characteristics

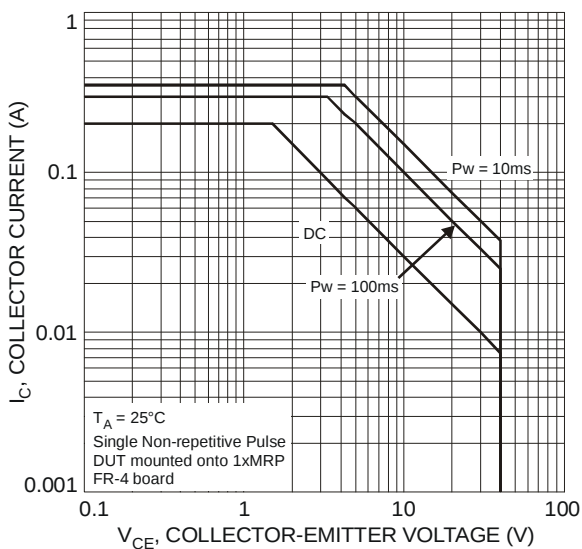
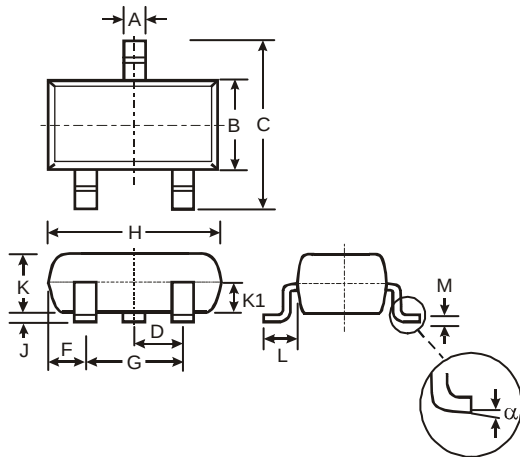


Fig. 5 Typical Collector Current vs. Collector-Emitter Voltage

## Package Outline Dimensions

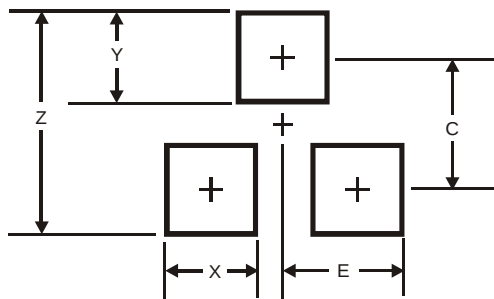
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.



| SOT23                |       |      |       |
|----------------------|-------|------|-------|
| Dim                  | Min   | Max  | Typ   |
| A                    | 0.37  | 0.51 | 0.40  |
| B                    | 1.20  | 1.40 | 1.30  |
| C                    | 2.30  | 2.50 | 2.40  |
| D                    | 0.89  | 1.03 | 0.915 |
| F                    | 0.45  | 0.60 | 0.535 |
| G                    | 1.78  | 2.05 | 1.83  |
| H                    | 2.80  | 3.00 | 2.90  |
| J                    | 0.013 | 0.10 | 0.05  |
| K                    | 0.903 | 1.10 | 1.00  |
| K1                   | -     | -    | 0.400 |
| L                    | 0.45  | 0.61 | 0.55  |
| M                    | 0.085 | 0.18 | 0.11  |
| $\alpha$             | 0°    | 8°   | -     |
| All Dimensions in mm |       |      |       |

## Suggested Pad Layout

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.



| Dimensions | Value (in mm) |
|------------|---------------|
| Z          | 2.9           |
| X          | 0.8           |
| Y          | 0.9           |
| C          | 2.0           |
| E          | 1.35          |

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