# Low Noise Transistor

## **PNP Silicon**

## Features

- NSV 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 <sub>CEO</sub> | -50   | Vdc  |
| Collector-Base Voltage         | V <sub>CBO</sub> | -50   | Vdc  |
| Emitter-Base Voltage           | V <sub>EBO</sub> | -3.0  | Vdc  |
| Collector Current – Continuous | Ι <sub>C</sub>   | -50   | mAdc |

#### THERMAL CHARACTERISTICS

| Characteristic   | Symbol                            | Max         | Unit        |
|--|-----------------------------------|-------------|-------------|
| Total Device Dissipation FR–5 Board,<br>(Note 1) T <sub>A</sub> = 25°C<br>Derate above 25°C        | PD                                | 225<br>1.8  | mW<br>mW/°C |
| Thermal Resistance, Junction-to-Ambient  | $R_{\theta JA}$                   | 556         | °C/W        |
| Total Device Dissipation Alumina<br>Substrate, (Note 2) T <sub>A</sub> = 25°C<br>Derate above 25°C | P <sub>D</sub>                    | 300<br>2.4  | mW<br>mW/°C |
| Thermal Resistance, Junction-to-Ambient  | $R_{\thetaJA}$                    | 417         | °C/W        |
| Junction and Storage Temperature   | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °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.

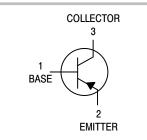
1.  $FR-5 = 1.0 \times 0.75 \times 0.062$  in.

2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



## **ON Semiconductor®**

#### www.onsemi.com





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

#### MARKING DIAGRAM



2Q = Device Code M = Date Code\*

• = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation and/or overbar may vary depending upon manufacturing location.

#### **ORDERING INFORMATION**

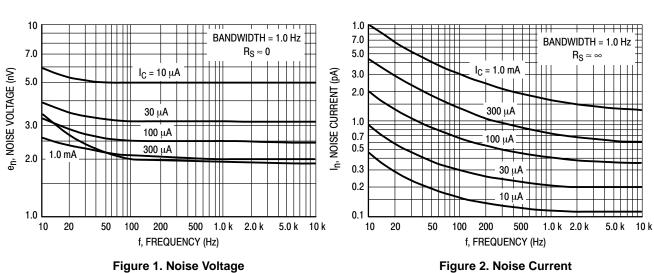
| Device          | Package   | Shipping <sup>†</sup> |
|-----------------|-----------|-----------------------|
| MMBT5087LT1G,   | SOT–23    | 3,000 / Tape &        |
| NSVMMBT5087LT1G | (Pb–Free) | Reel                  |
| MMBT5087LT3G,   | SOT-23    | 10,000 / Tape &       |
| NSVMMBT5087LT3G | (Pb-Free) | 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.

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

| Characteristic   | Symbol               | Min               | Мах           | Unit |
|--|----------------------|-------------------|---------------|------|
| OFF CHARACTERISTICS  |                      |                   |               |      |
| Collector–Emitter Breakdown Voltage<br>( $I_C = -1.0 \text{ mAdc}, I_B = 0$ )  | V <sub>(BR)CEO</sub> | -50               | _             | Vdc  |
| Collector–Base Breakdown Voltage<br>( $I_C = -100 \ \mu Adc, I_E = 0$ )  | V <sub>(BR)CBO</sub> | -50               | -             | Vdc  |
| Collector Cutoff Current<br>$(V_{CB} = -10 \text{ Vdc}, I_E = 0)$<br>$(V_{CB} = -35 \text{ Vdc}, I_E = 0)$   | I <sub>CBO</sub>     |                   | -10<br>-50    | nAdc |
| ON CHARACTERISTICS   | ·                    |                   |               | •    |
| DC Current Gain<br>$(I_C = -100 \ \mu Adc, \ V_{CE} = -5.0 \ Vdc)$<br>$(I_C = -1.0 \ m Adc, \ V_{CE} = -5.0 \ Vdc)$<br>$(I_C = -10 \ m Adc, \ V_{CE} = -5.0 \ Vdc)$  | h <sub>FE</sub>      | 250<br>250<br>250 | 800<br>-<br>- | -    |
| Collector–Emitter Saturation Voltage<br>( $I_c = -10$ mAdc, $I_B = -1.0$ mAdc)   | V <sub>CE(sat)</sub> | -                 | -0.3          | Vdc  |
| Base–Emitter Saturation Voltage<br>( $I_c = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}$ )   | V <sub>BE(sat)</sub> | -                 | 0.85          | Vdc  |
| SMALL-SIGNAL CHARACTERISTICS   |                      |                   |               |      |
| Current–Gain — Bandwidth Product ( $I_C = -500 \ \mu Adc$ , $V_{CE} = -5.0 \ Vdc$ , f = 20 MHz)  | f <sub>T</sub>       | 40                | _             | MHz  |
| Output Capacitance<br>( $V_{CB} = -5.0 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$ )  | C <sub>obo</sub>     | -                 | 4.0           | pF   |
| Small–Signal Current Gain<br>(I <sub>C</sub> = –1.0 mAdc, V <sub>CE</sub> = –5.0 Vdc, f = 1.0 kHz)   | h <sub>fe</sub>      | 250               | 900           | -    |
| Noise Figure<br>( $I_C = -20 \text{ mAdc}$ , $V_{CE} = -5.0 \text{ Vdc}$ , $R_S = 10 \text{ k}\Omega$ , f = 1.0 kHz)<br>( $I_C = -100 \mu \text{Adc}$ , $V_{CE} = -5.0 \text{ Vdc}$ , $R_S = 3.0 \text{ k}\Omega$ , f = 1.0 kHz) | NF                   |                   | 2.0<br>2.0    | dB   |

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.



**TYPICAL NOISE CHARACTERISTICS** 

 $(V_{CE}=-5.0 \text{ Vdc}, \text{ } \text{T}_{\text{A}}=25^{\circ}\text{C})$ 

### **NOISE FIGURE CONTOURS**

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

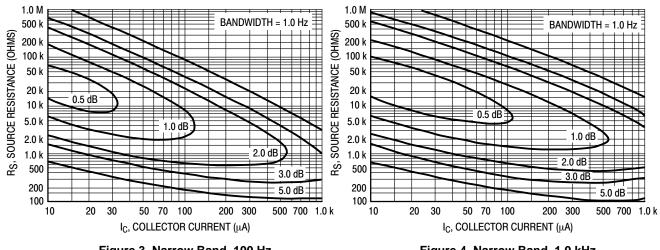
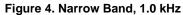


Figure 3. Narrow Band, 100 Hz



Noise Figure is Defined as:

$$NF = 20 \log_{10} \left[ \frac{e_{n}^{2} + 4KTR_{S} + I_{n}^{2}R_{S}^{2}}{4KTR_{S}} \right]^{1/2}$$

e<sub>n</sub> = Noise Voltage of the Transistor referred to the input. (Figure 3)

= Noise Current of the Transistor referred to the input. (Figure 4)  $I_n$ 

K = Boltzman's Constant (1.38 x 10<sup>-23</sup> j/°K)

T = Temperature of the Source Resistance (°K)

R<sub>S</sub> = Source Resistance (Ohms)

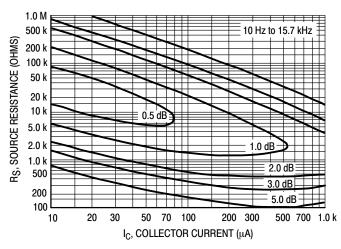


Figure 5. Wideband

#### TYPICAL STATIC CHARACTERISTICS

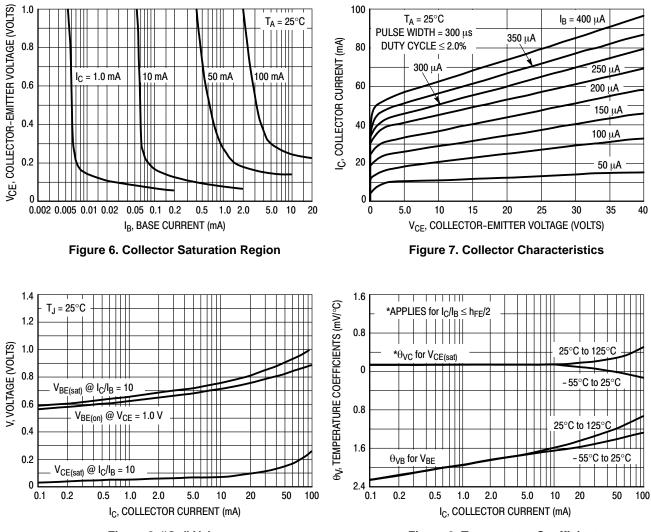


Figure 8. "On" Voltages

Figure 9. Temperature Coefficients

## **TYPICAL DYNAMIC CHARACTERISTICS**

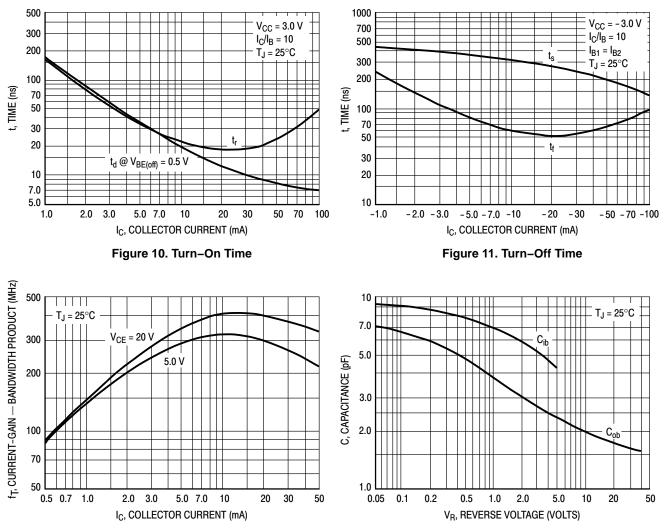


Figure 12. Current–Gain — Bandwidth Product

Figure 13. Capacitance

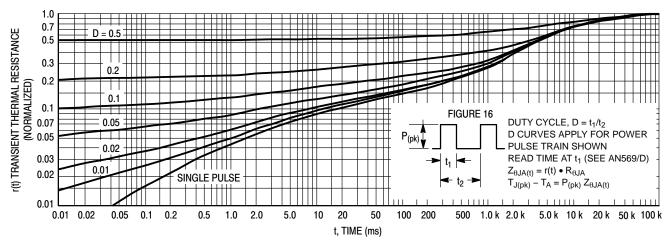


Figure 14. Thermal Response

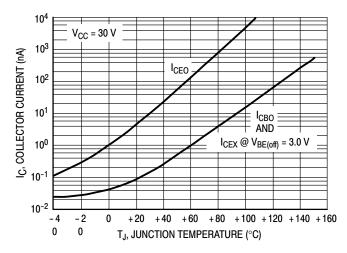


Figure 15. Typical Collector Leakage Current

#### DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 16. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 14 was calculated for various duty cycles.

To find  $Z_{\theta JA(t)}$ , multiply the value obtained from Figure 14 by the steady state value  $R_{\theta JA}$ .

Example:

Dissipating 2.0 watts peak under the following conditions:  $t_1 = 1.0 \text{ ms}, t_2 = 5.0 \text{ ms} (D = 0.2)$ 

Using Figure 14 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

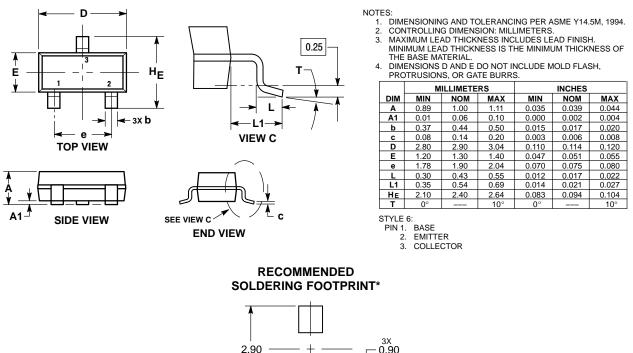
The peak rise in junction temperature is therefore

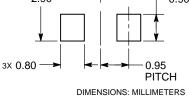
 $\Delta T = r(t) \ge P_{(pk)} \ge R_{\theta JA} = 0.22 \ge 2.0 \ge 200 = 88^{\circ}C.$ 

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

#### PACKAGE DIMENSIONS

SOT-23 (TO-236) CASE 318-08 ISSUE AR





\*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns me rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at <u>www.onsemi.com/site/pdf/Patent\_Marking.pdf</u>. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor asy products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application. Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufac

#### PUBLICATION ORDERING INFORMATION

#### LITERATURE FULFILLMENT

Literature Distribution Center for ON Semiconductor 19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA Phone: 303–675–2175 or 800–344–3860 Toll Free USA/Canada Fax: 303–675–2176 or 800–344–3867 Toll Free USA/Canada Email: orderlit@onsemi.com N. American Technical Support: 800–282–9855 Toll Free USA/Canada Europe, Middle East and Africa Technical Support:

Phone: 421 33 790 2910 Japan Customer Focus Center Phone: 81–3–5817–1050 ON Semiconductor Website: www.onsemi.com

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative