# **General Purpose Transistor**

## **NPN 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

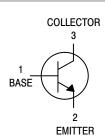


## **ON Semiconductor®**

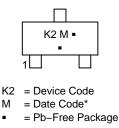
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SOT-23 (TO-236) CASE 318-08 STYLE 6



#### MARKING DIAGRAM



(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>
BCW72LT1G	SOT-23 (Pb-Free)	3,000 / Tape & Reel
SBCW72LT1G	SOT-23 (Pb-Free)	3,000 / Tape & Reel

<sup>+</sup>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.

#### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V <sub>CEO</sub>	45	Vdc
Collector-Base Voltage	V <sub>CBO</sub> 50		Vdc
Emitter-Base Voltage	V <sub>EBO</sub>	5.0	Vdc
Collector Current – Continuous	Ι <sub>C</sub>	100	mAdc

#### THERMAL CHARACTERISTICS

Characteristic	Symbol	Мах	Unit
Total Device Dissipation FR–5 Board, (Note 1) T <sub>A</sub> = 25°C Derate above 25°C	PD	225 1.8	mW mW/°C
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (Note 2) T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub>	300 2.4	mW 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.

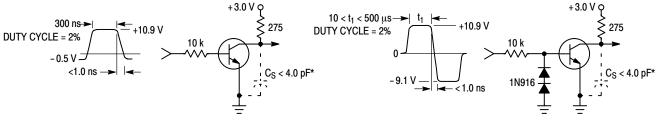
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

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

Characteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS					
Collector – Emitter Breakdown Voltage $(I_C = 2.0 \text{ mAdc}, V_{EB} = 0)$	V <sub>(BR)CEO</sub>	45	-	_	Vdc
Collector – Emitter Breakdown Voltage $(I_C = 2.0 \text{ mAdc}, V_{EB} = 0)$	V <sub>(BR)CES</sub>	45	_	_	Vdc
Collector – Base Breakdown Voltage $(I_C = 10 \ \mu Adc, I_E = 0)$	V <sub>(BR)CBO</sub>	50	-	-	Vdc
Emitter – Base Breakdown Voltage $(I_E = 10 \ \mu Adc, I_C = 0)$	V <sub>(BR)EBO</sub>	5.0	-	_	Vdc
Collector Cutoff Current $(V_{CB} = 20 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 20 \text{ Vdc}, I_E = 0, T_A = 100^{\circ}\text{C})$	I <sub>CBO</sub>			100 10	nAdc μAdc
ON CHARACTERISTICS		•	•	•	•
DC Current Gain ( $I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}$ )	h <sub>FE</sub>	200	-	450	-
Collector – Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}, I_B = 0.5 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}, I_B = 2.5 \text{ mAdc}$ )	V <sub>CE(sat)</sub>		_ 0.21	0.25 -	Vdc
Base – Emitter Saturation Voltage $(I_C = 50 \text{ mAdc}, I_B = 2.5 \text{ mAdc})$	V <sub>BE(sat)</sub>	-	0.85	_	Vdc
Base – Emitter On Voltage $(I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$	V <sub>BE(on)</sub>	0.6	_	0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product ( $I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f = 100 \text{ MHz}$ )	fT	-	300	_	MHz
Output Capacitance ( $I_E = 0$ , $V_{CB} = 10$ Vdc, f = 1.0 MHz)	C <sub>obo</sub>	-	_	4.0	pF
Input Capacitance ( $I_E = 0$ , $V_{CB} = 10$ Vdc, f = 1.0 MHz)	C <sub>ibo</sub>	-	9.0	_	pF
Noise Figure (I <sub>C</sub> = 0.2 mAdc, V <sub>CE</sub> = 5.0 Vdc, R <sub>S</sub> = 2.0 k $\Omega$ , f = 1.0 kHz, BW = 200 Hz)	NF	-	-	10	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.

#### **EQUIVALENT SWITCHING TIME TEST CIRCUITS**



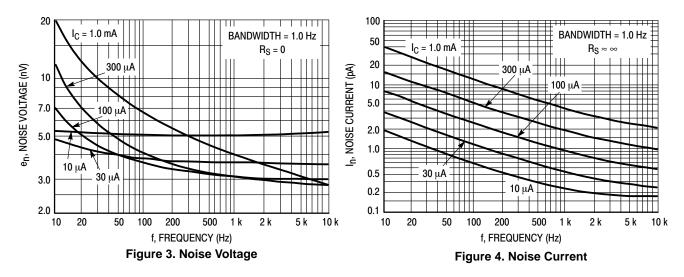
\*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time

Figure 2. Turn-Off Time

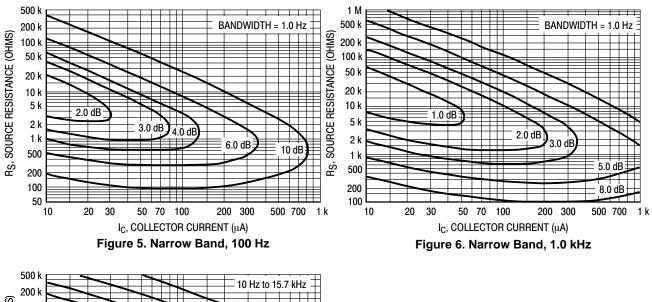
#### **TYPICAL NOISE CHARACTERISTICS**

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



NOISE FIGURE CONTOURS

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



Noise Figure is defined as:

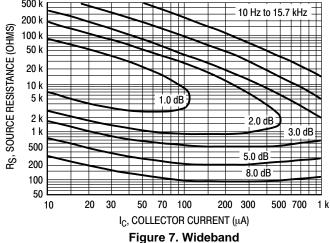
$$NF = 20 \log_{10} \left( \frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S} \right)^{1/2}$$

 $e_n$  = Noise Voltage of the Transistor referred to the input. (Figure 3)

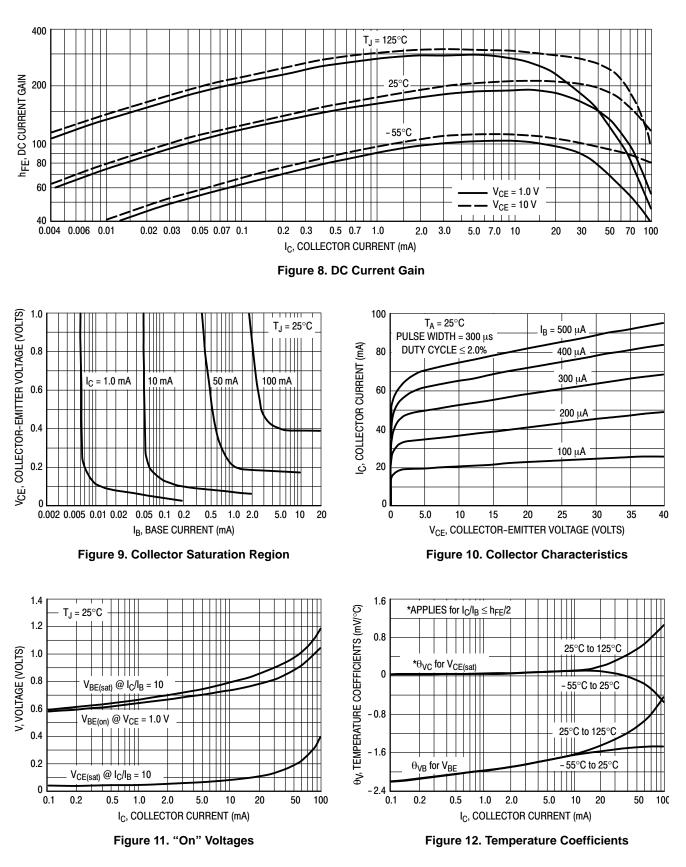
 $I_n$  = Noise Current of the Transistor referred to the input. (Figure 4)

K = Boltzman's Constant (1.38 x  $10^{-23}$  j/°K)

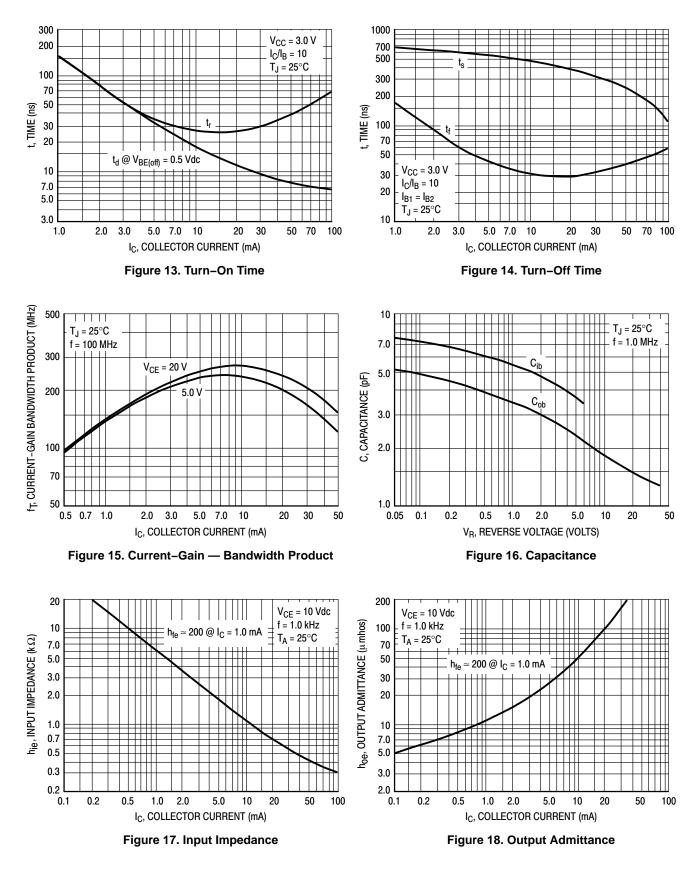
- T = Temperature of the Source Resistance ( $^{\circ}$ K)
- R<sub>S</sub> = Source Resistance (Ohms)

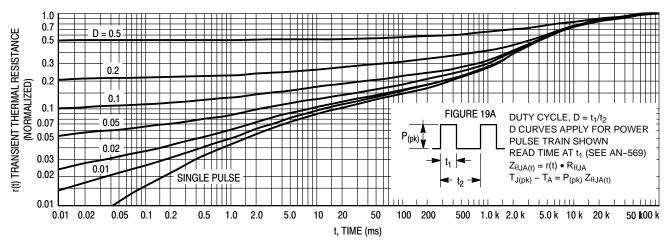


### **TYPICAL STATIC CHARACTERISTICS**



### **TYPICAL DYNAMIC CHARACTERISTICS**







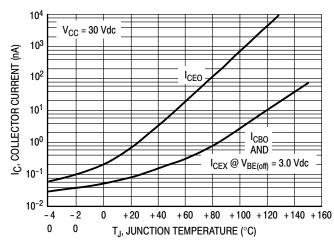


Figure 19A.

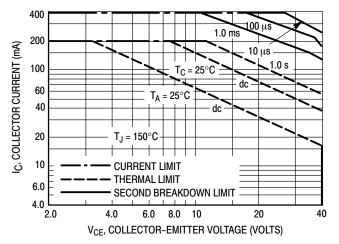


Figure 20.

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

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find  $Z_{\theta JA(t)}$ , multiply the value obtained from Figure 19 by the steady state value  $R_{\theta JA}$ .

Example:

The MPS3904 is 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 19 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

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

For more information, see AN-569.

The safe operating area curves indicate  $I_C-V_{CE}$  limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon  $T_{J(pk)} = 150^{\circ}C$ ;  $T_C$  or  $T_A$  is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided  $T_{J(pk)} \le 150^{\circ}C$ .  $T_{J(pk)}$  may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

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