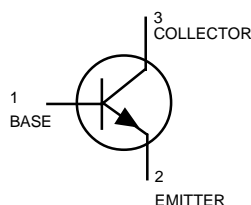
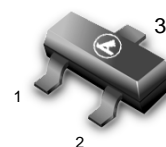


# General Purpose Transistors

## NPN Silicon


**BCW72LT1**

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

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO}$	45	Vdc
Collector-Base Voltage	$V_{CBO}$	50	Vdc
Emitter-Base Voltage	$V_{EBO}$	5.0	Vdc
Collector Current — Continuous	$I_C$	100	mAdc

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board, (1) $T_A = 25^\circ\text{C}$	$P_D$	225	mW
Derate above $25^\circ\text{C}$		1.8	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	$^\circ\text{C}/\text{W}$
Total Device Dissipation Alumina Substrate, (2) $T_A = 25^\circ\text{C}$	$P_D$	300	mW
Derate above $25^\circ\text{C}$		2.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

### DEVICE MARKING

BCW72LT1 = K2

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ( $I_C = 2.0\text{mAdc}, V_{EB} = 0$ )	$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage ( $I_C = 2.0\text{mAdc}, V_{EB} = 0$ )	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ( $I_C = 10\ \mu\text{Adc}, I_E = 0$ )	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ( $I_E = 10\ \mu\text{Adc}, I_C = 0$ )	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ( $V_{CB} = 20\text{Vdc}, I_E = 0$ )	$I_{CBO}$	—	—	100	nAdc
( $V_{CB} = 20\text{Vdc}, I_E = 0, T_A = 100^\circ\text{C}$ )		—	—	10	$\mu\text{Adc}$

1. FR-5 = 1.0 x 0.75 x 0.062 in.

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

**BCW72LT1**

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

Characteristic	Symbol	Min	Typ	Max	Unit
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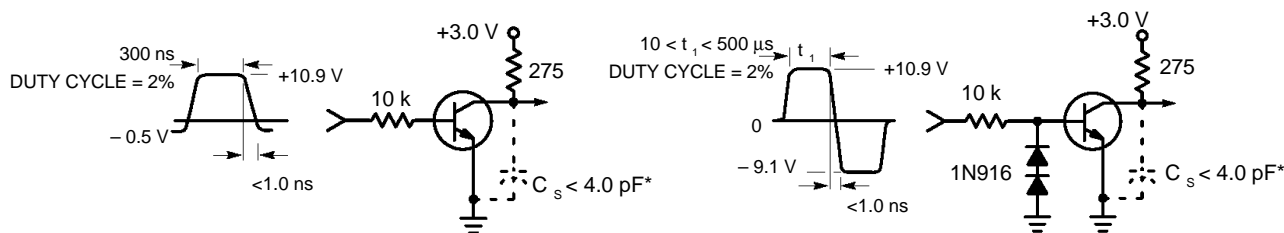
**ON CHARACTERISTICS**

DC Current Gain ( $I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}$ )	$h_{FE}$	200	—	450	—
Collector–Emitter Saturation Voltage ( $I_C = 10 \text{ mAdc}, I_B = 0.5 \text{ mAdc}$ ) ( $I_C = 50 \text{ mAdc}, I_B = 2.5 \text{ mAdc}$ )	$V_{CE(sat)}$	—	— 0.21	0.25	Vdc
Base–Saturation Voltage ( $I_C = 50 \text{ mAdc}, I_B = 2.5 \text{ mAdc}$ )	$V_{BE(on)}$	—	0.85	—	Vdc
Base–Emitter On Voltage ( $I_C = 2.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}$ )	$V_{BE(on)}$	0.6	—	0.75	Vdc

**SMALL–SIGNAL CHARACTERISTICS**

Current–Gain — Bandwidth Product ( $I_C = 10 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, f = 100 \text{ MHz}$ )	$f_T$	—	300	—	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$ )	$C_{obo}$	—	—	4.0	pF
Input Capacitance ( $I_E = 0, V_{CB} = 10 \text{ Vdc}, f = 1.0 \text{ MHz}$ )	$C_{ibo}$	—	9.0	—	pF
Noise Figure ( $I_C = 0.2 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, R_S = 2.0 \text{ k}\Omega, f = 1.0 \text{ kHz}, BW = 200 \text{ Hz}$ )	NF	—	—	10	dB

**EQUIVALENT SWITCHING TIME TEST CIRCUITS**



\*Total shunt capacitance of test jig and connectors

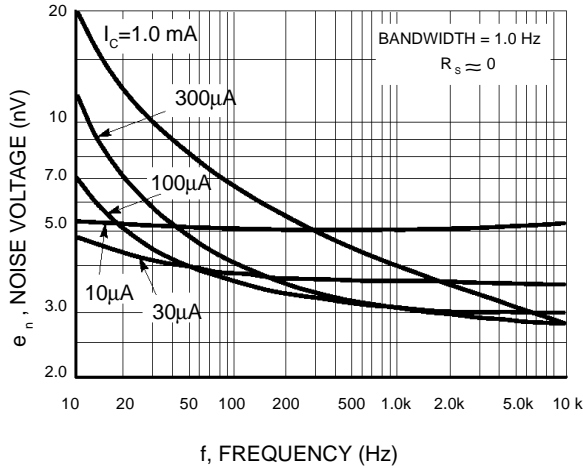
**Figure 1. Turn–On Time**

**Figure 2. Turn–Off Time**

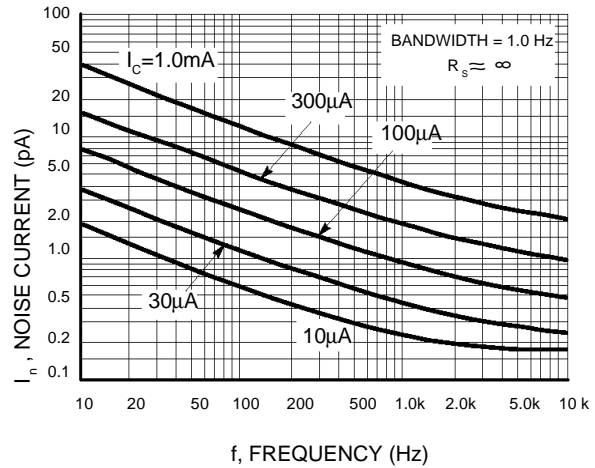
**BCW72LT1**

**TYPICAL NOISE CHARACTERISTICS**

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



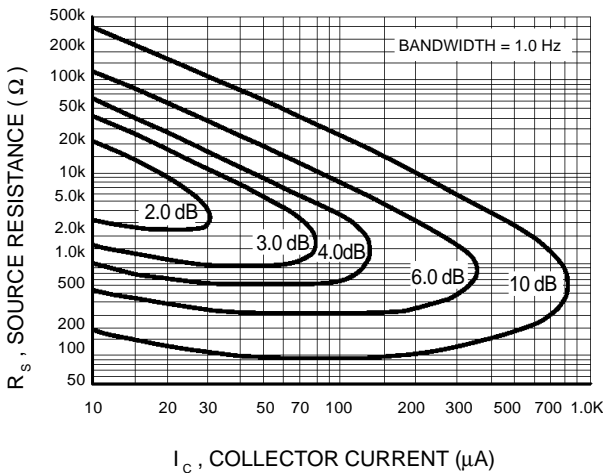
**Figure 3. Noise Voltage**



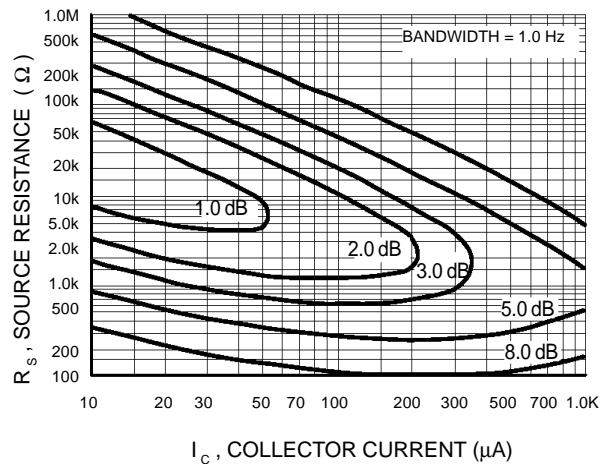
**Figure 4. Noise Current**

**NOISE FIGURE CONTOURS**

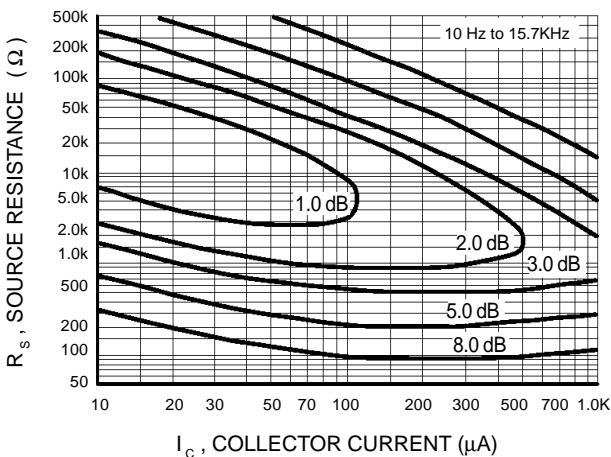
( $V_{CE} = 5.0 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$ )



**Figure 5. Narrow Band, 100 Hz**



**Figure 6. Narrow Band, 1.0 kHz**



**Figure 7. Wideband**

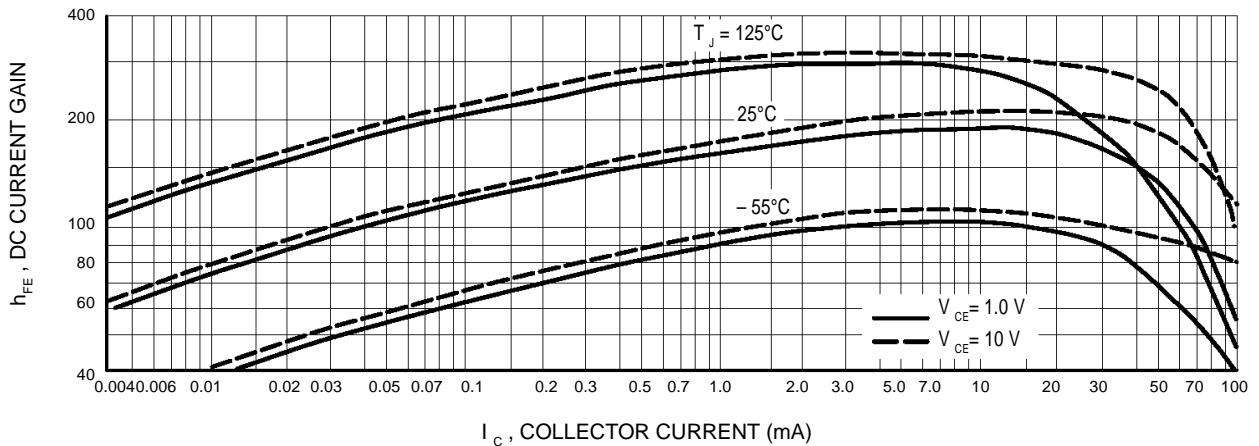
Noise Figure is Defined as:

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

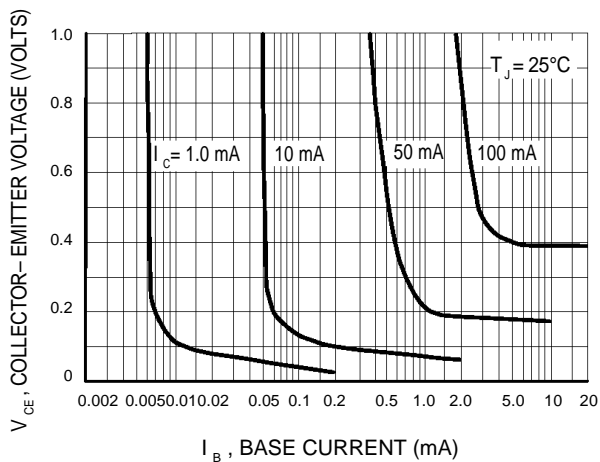
- $e_n$  = Noise Voltage of the Transistor referred to the input. (Figure 3)
- $I_n$  = Noise Current of the Transistor referred to the input. (Figure 4)
- $K$  = Boltzman's Constant ( $1.38 \times 10^{-23} \text{ J/}^\circ\text{K}$ )
- $T$  = Temperature of the Source Resistance ( $^\circ\text{K}$ )
- $R_s$  = Source Resistance ( $\Omega$ )

**BCW72LT1**

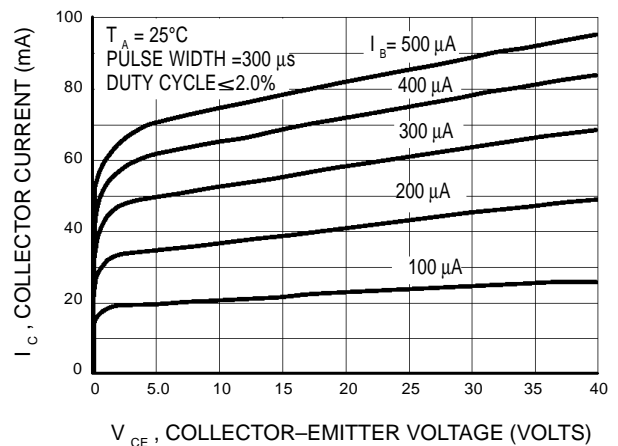
**TYPICAL STATIC CHARACTERISTICS**



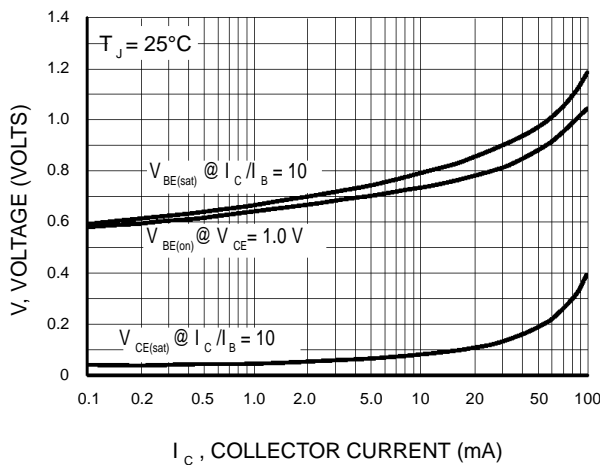
**Figure 8. DC Current Gain**



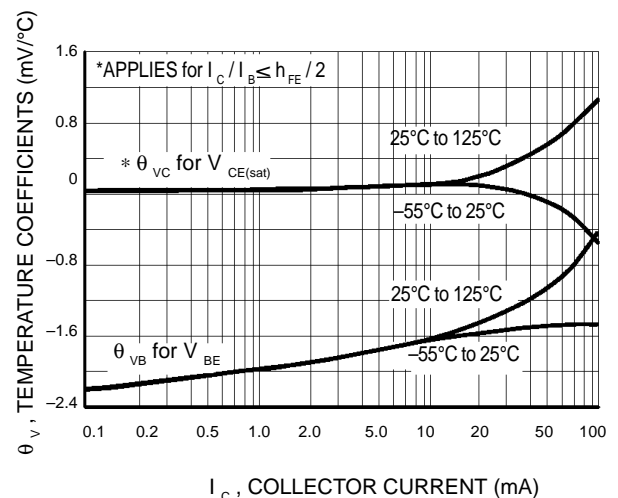
**Figure 9. Collector Saturation Region**



**Figure 10. Collector Characteristics**



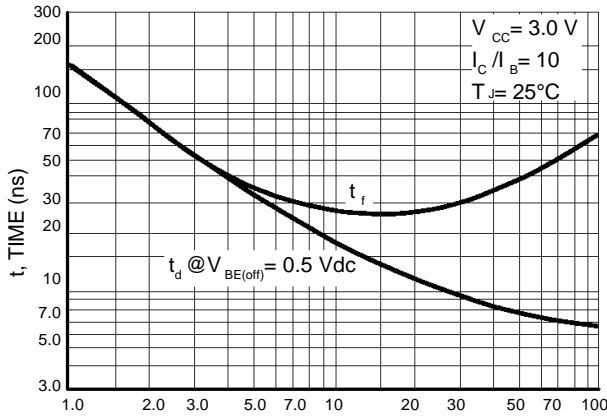
**Figure 11. "On" Voltages**



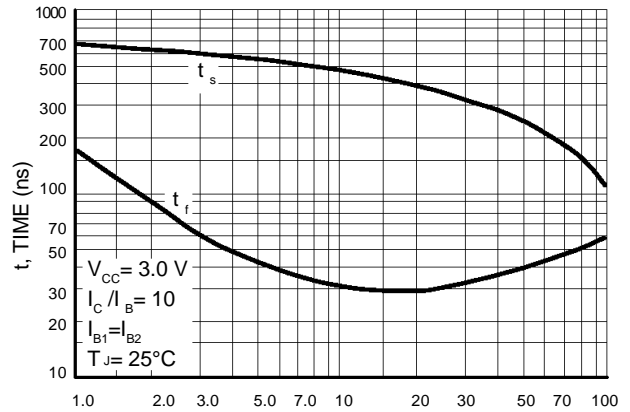
**Figure 12. Temperature Coefficients**

**BCW72LT1**

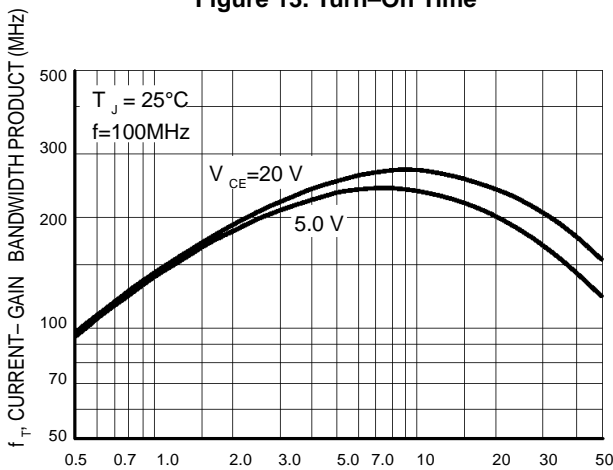
**TYPICAL DYNAMIC CHARACTERISTICS**



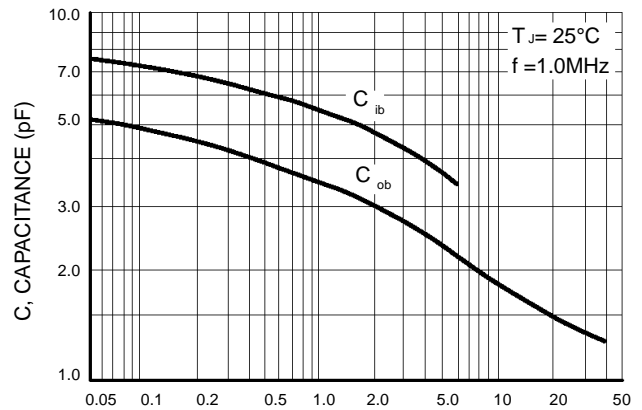
**Figure 13. Turn-On Time**



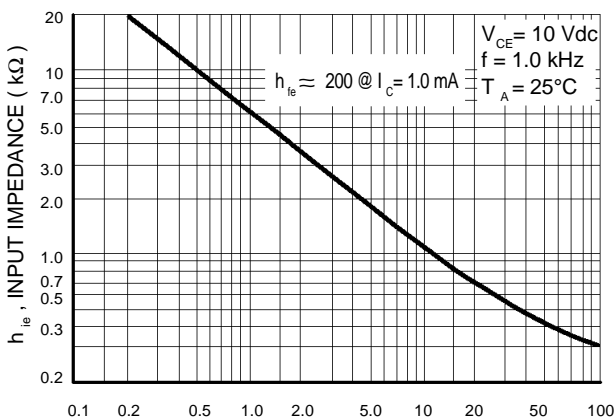
**Figure 14. Turn-Off Time**



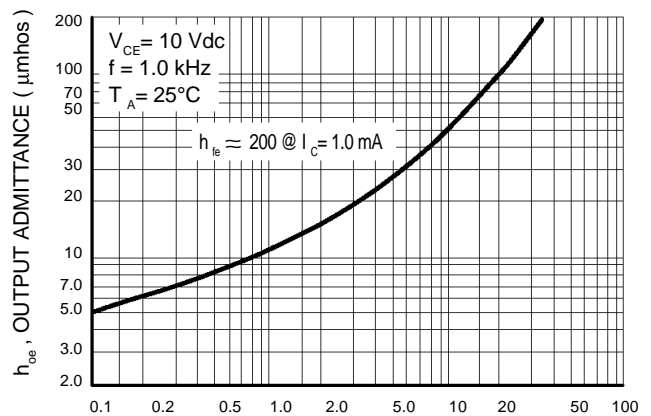
**Figure 15. Current-Gain — Bandwidth Product**



**Figure 16. Capacitance**



**Figure 17. Input Impedance**



**Figure 18. Output Admittance**

BCW72LT1

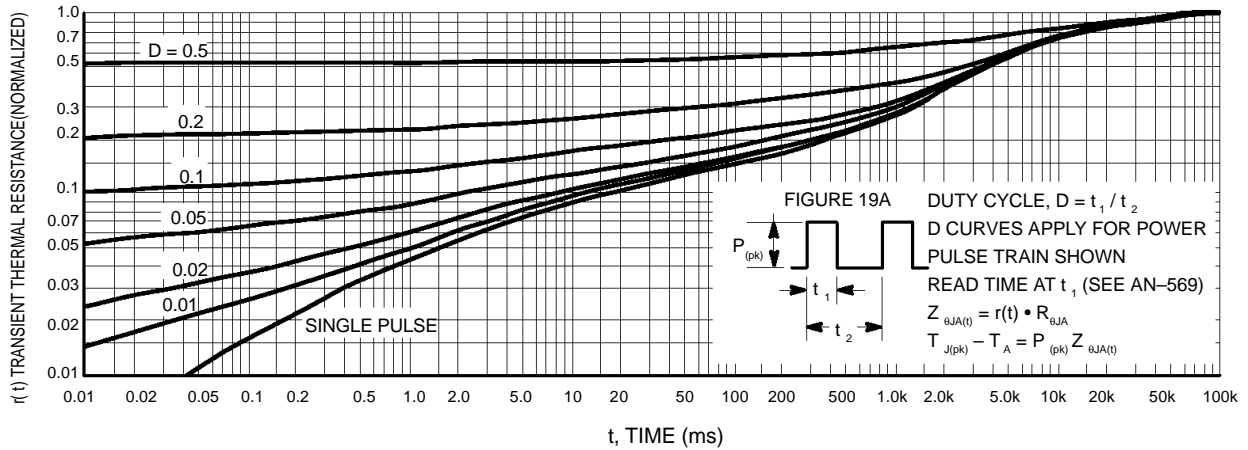


Figure 19. Thermal Response

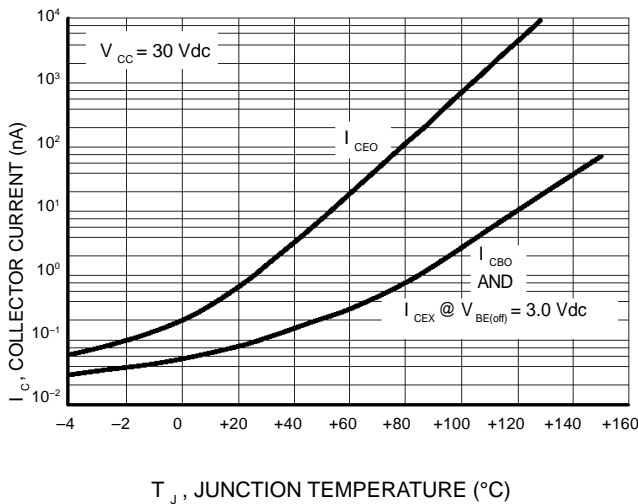


Figure 19A.

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

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

For more information, see AN-569.

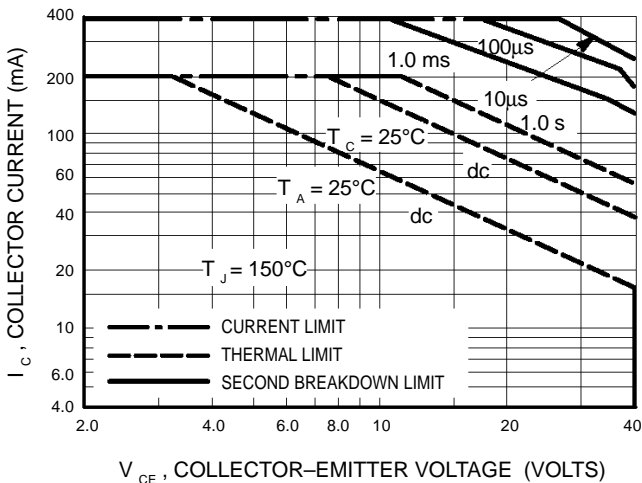


Figure 20.

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  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  or  $T_A$  is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 150^\circ\text{C}$ .  $T_{J(pk)}$  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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