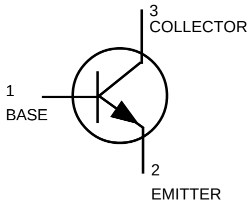
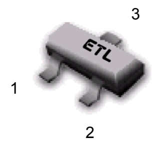
General Purpose Transistors

NPN Silicon



BCW60ALT1
BCW60BLT1
BCW60DLT1



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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	32	Vdc
Collector–Base Voltage	V_{CBO}	32	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°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J , T_{stg}	–55 to +150	°C

DEVICE MARKING

BCW60ALT1 = AA, BCW60BLT1 = AB, BCW60DLT1 = AD

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 2.0mAdc, I_E = 0)	$V_{(BR)CEO}$	32	—	Vdc
Emitter–Base Breakdown Voltage (I_E= 1.0 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 32 Vdc,) (V_{CE} = 32 Vdc, T_A = 150°C)	I_{CES}	 — —	 20 20	 nAdc µAdc
Emitter Cutoff Current (I_{EB}= 4.0 Vdc, I_C = 0)	I_{EBO}	—	20	nAdc

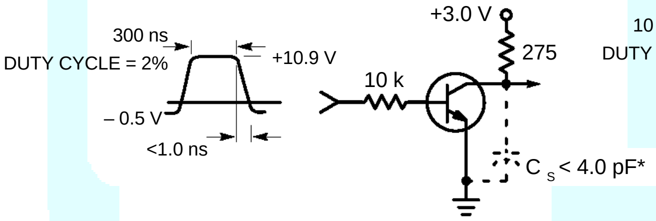
1. FR– 5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

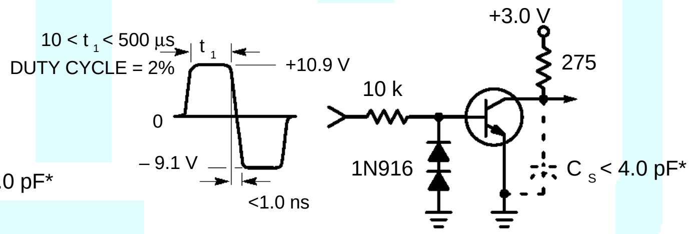
BCW60ALT1 BCW60BLT1 BCW60DLT1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C= 10 µAdc, V_{CE} = 5.0 Vdc)	BCW60A		20	—	
	BCW60B		30	—	
	BCW60D		100	—	
(I_C= 2.0 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}			—
	BCW60A		120	220	
	BCW60B		175	310	
	BCW60D		380	630	
(I_C= 50 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}			—
	BCW60A		60	—	
	BCW60B		70	—	
	BCW60D		100	—	
AC Current Gain		h_{FE}			—
(V_{CE} = 5.0Vdc, I_C= 2.0 mAdc,	BCW60A		125	250	
f= 1.0 kHz)	BCW60B		175	350	
	BCW60D		350	700	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)			—	0.55	
(I_C = 10 mAdc, I_B = 0.25 mAdc)			—	0.35	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)			0.7	1.05	
(I_C = 50 mAdc, I_B = 0.25 mAdc)			0.6	0.85	
Base–Emitter On Voltage		$V_{BE(on)}$			Vdc
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)			0.6	0.75	
SMSMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)		C_{obo}	—	4.5	pF
Noise Figure (V_{CE} = 5.0 Vdc, I_C = 0.2 mAdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	6.0	dB
SWITCHING CHARACTERISTICS					
Turn–On Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_{on}	—	150	ns
Turn–Off Time (I_{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R_1 = R_2 = 5.0 kΩ, R_L = 990 Ω)		t_{off}	—	800	ns

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 Vdc, T_A = 25°C)

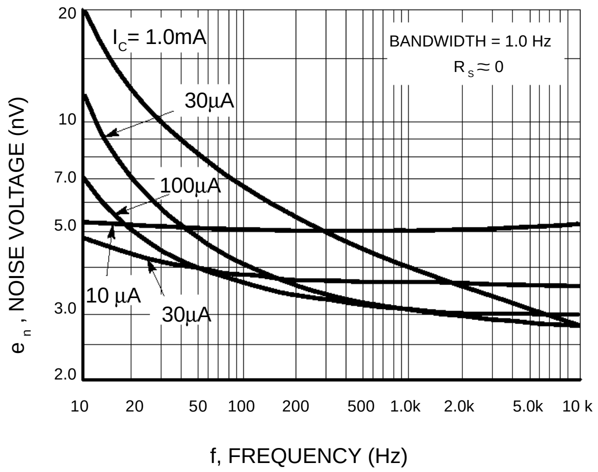


Figure 3. Noise Voltage

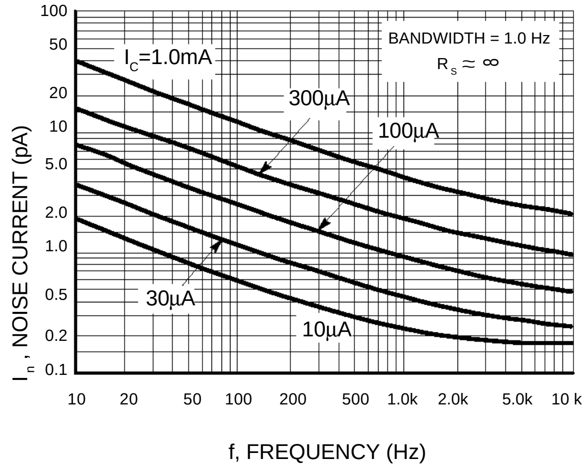


Figure 4. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

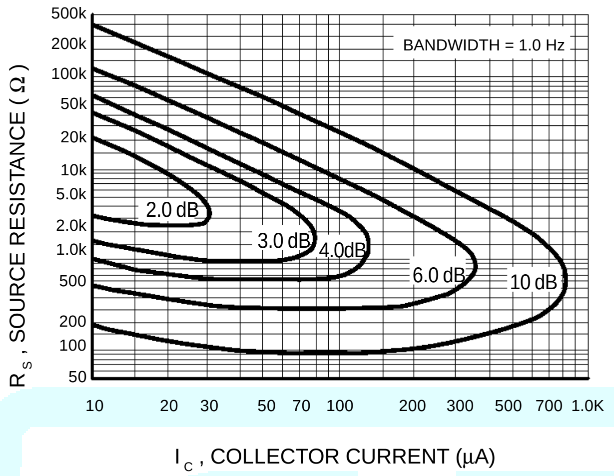


Figure 5. Narrow Band, 100 Hz

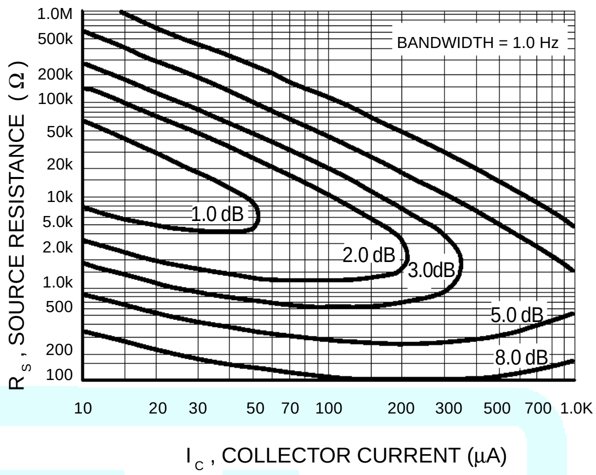


Figure 6. Narrow Band, 1.0 kHz

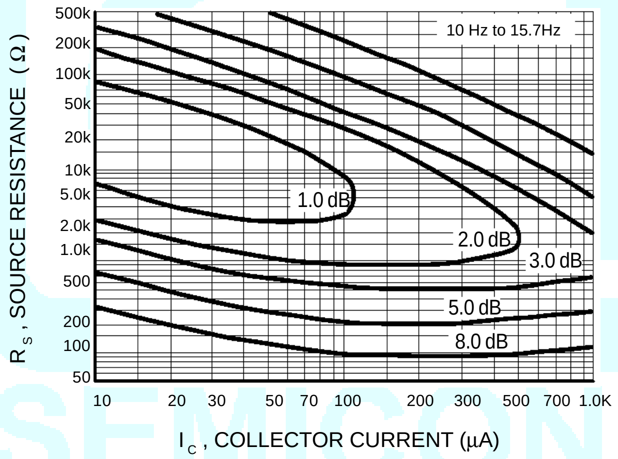


Figure 7. Wideband

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 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_s = Source Resistance (Ω)

BCW60ALT1 BCW60BLT1 BCW60DLT1

TYPICAL NOISE CHARACTERISTICS

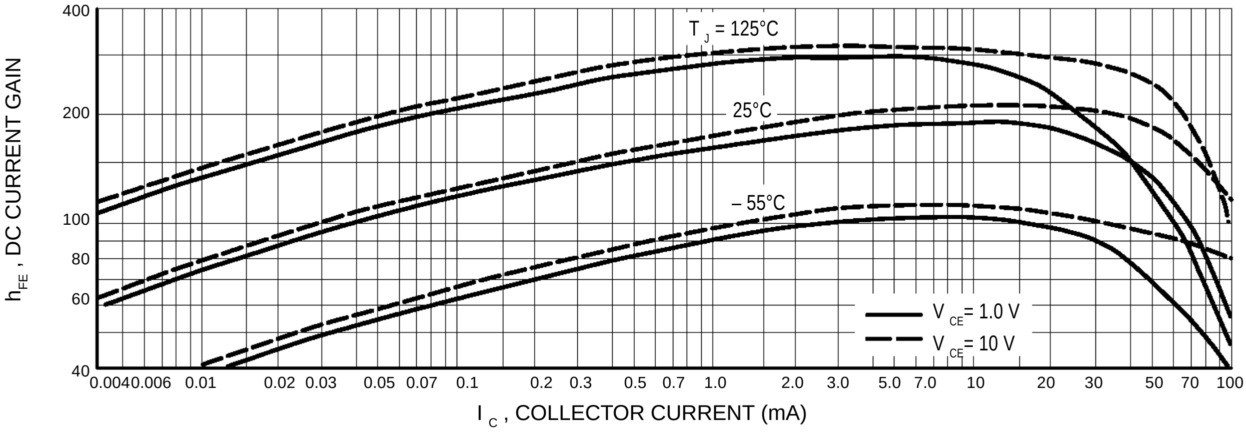


Figure 8. DC Current Gain

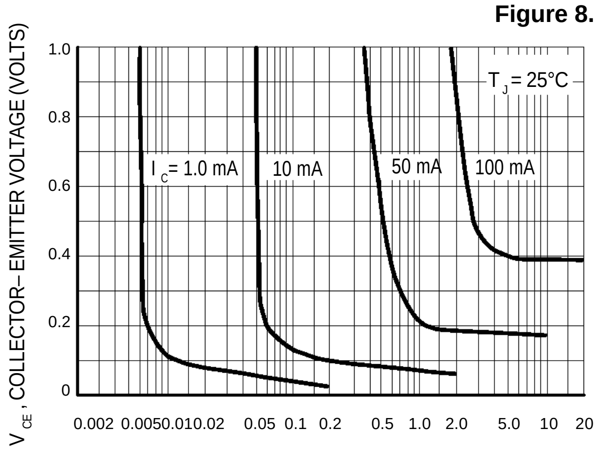


Figure 9. Collector Saturation Region

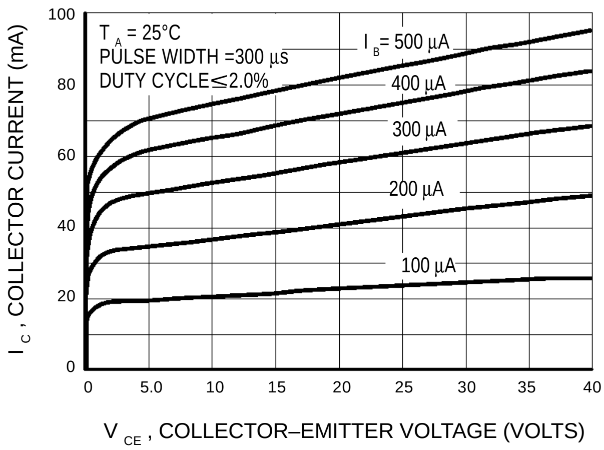


Figure 10. Collector Characteristics

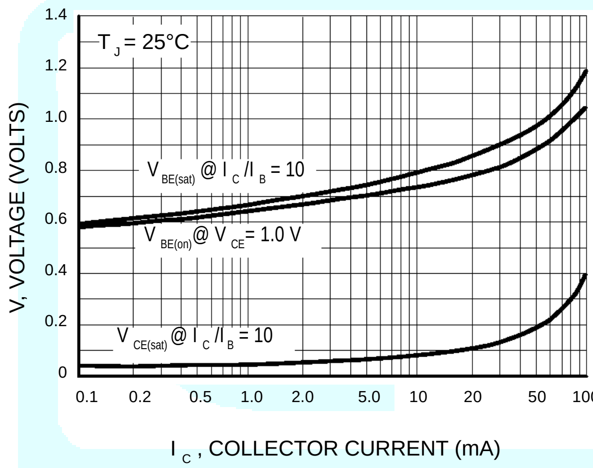


Figure 11. "On" Voltages

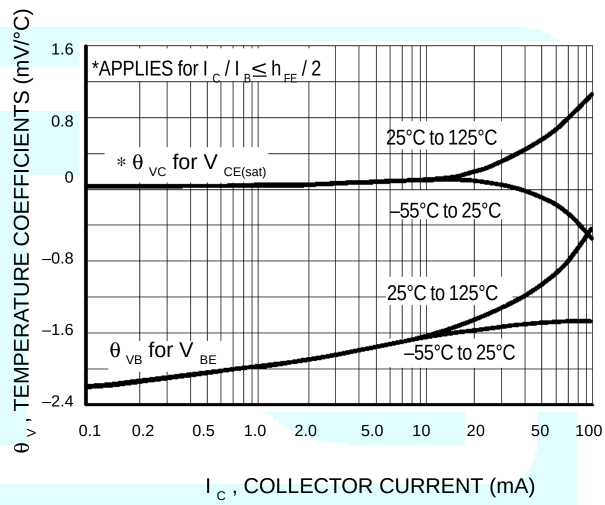


Figure 12. Temperature Coefficients

BCW60ALT1 BCW60BLT1 BCW60DLT1

TYPICAL DYNAMIC CHARACTERISTICS

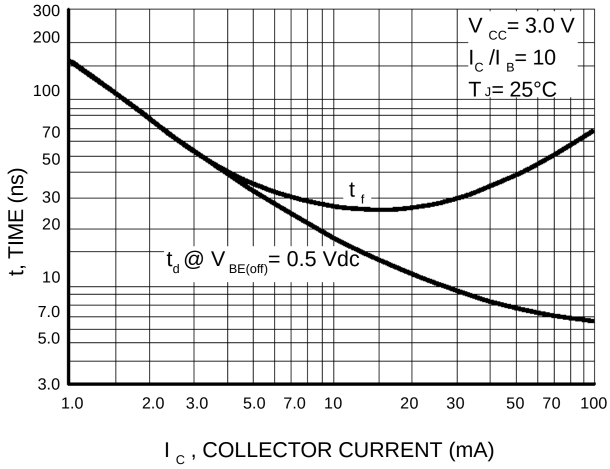


Figure 13. Turn–On Time

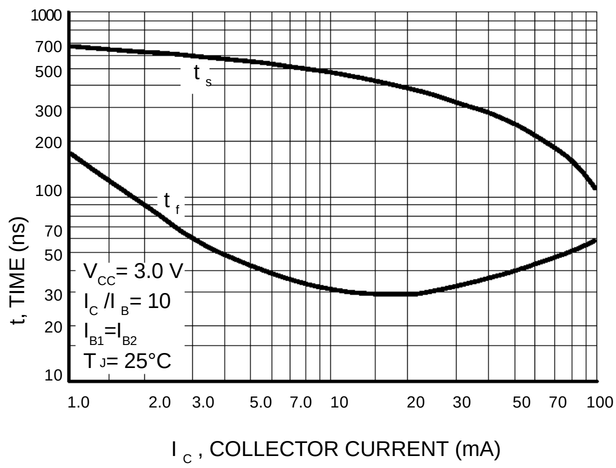


Figure 14. Turn–Off Time

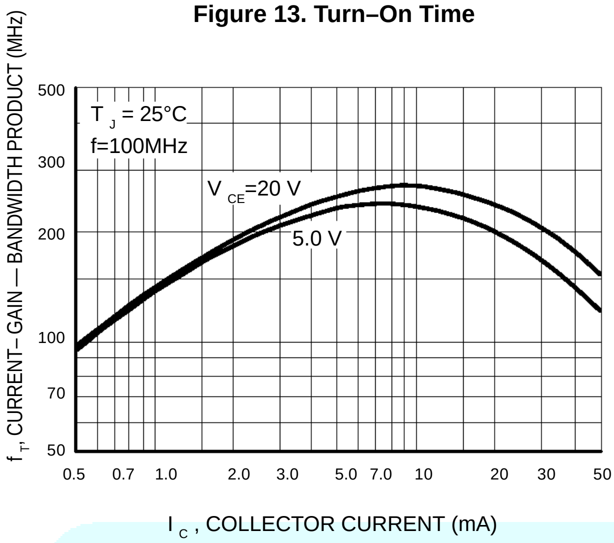


Figure 15. Current–Gain — Bandwidth Product

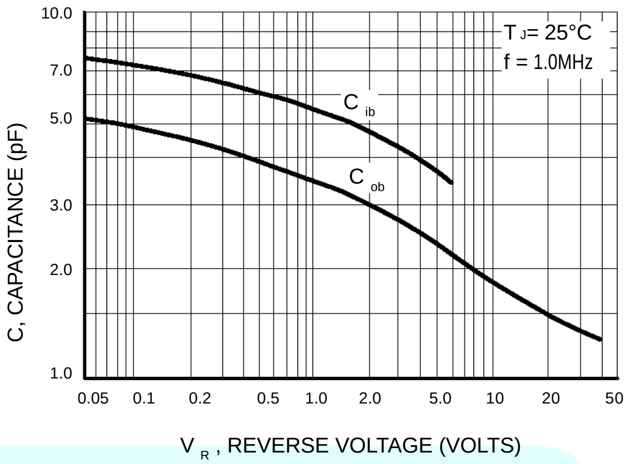


Figure 16. Capacitance

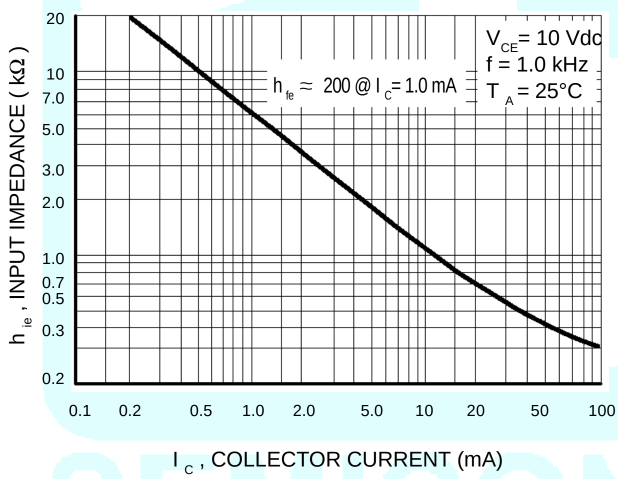


Figure 17. Input Impedance

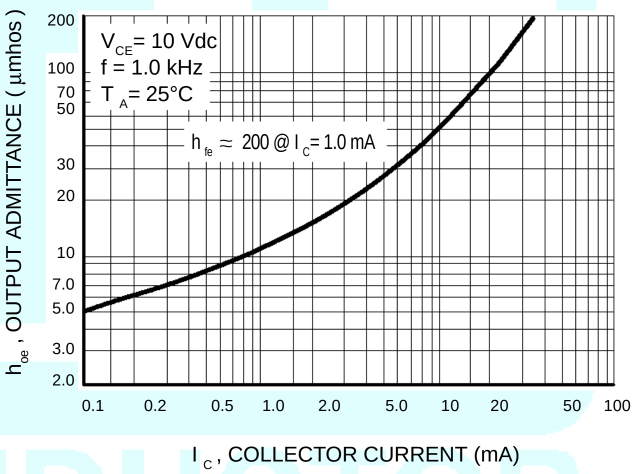


Figure 18. Output Admittance

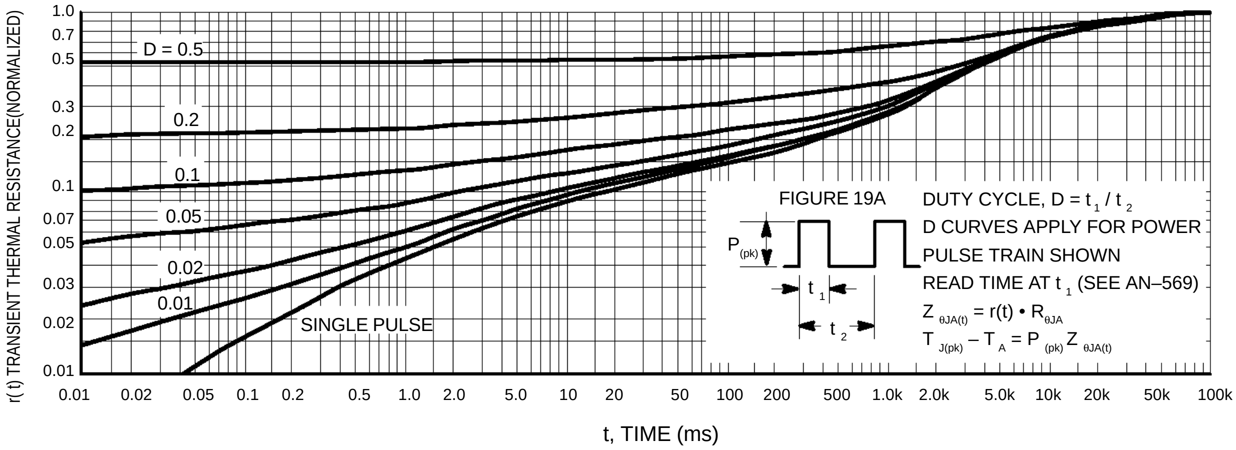


Figure 19. Thermal Response

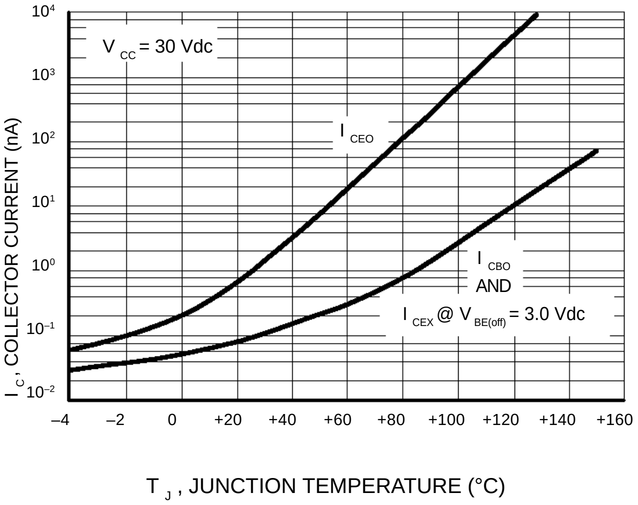


Figure 19A.

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 ms, t_2 = 5.0 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

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

For more information, see AN–569.

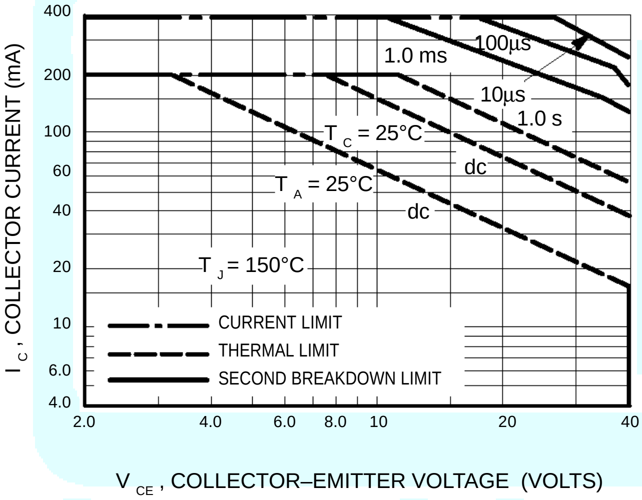


Figure 20.

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