General Purpose Transistors

NPN Silicon

3
COLLECTOR

1
BASE

2
EMITTER
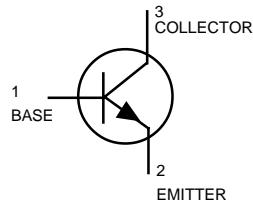
BCW33LT1
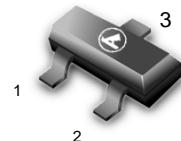
**CASE 318–08, STYLE 6
SOT–23 (TO–236AB)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	20	Vdc
Collector–Base Voltage	V_{CBO}	30	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) $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	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

BCW33LT1 = D3

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

Characteristic	Symbol	Min	Max	Unit

OFF CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage ($I_C = 2.0mAdc$, $I_B = 0$)	$V_{(BR)CEO}$	32	—	Vdc
Collector–Base Breakdown Voltage ($I_C = 10 \mu Adc$, $I_B = 0$)	$V_{(BR)CBO}$	32	—	Vdc
Emitter–Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current	I_{CBO}			
($V_{CB} = 32$ Vdc, $I_E = 0$)		—	100	nAdc
($V_{CB} = 32$ Vdc, $I_E = 0$, $T_A = 100°C$)		—	10	μAdc

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.

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	420	800	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base–Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.55	0.70	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	10	dB

EQUIVALENT SWITCHING TIME TEST CIRCUITS
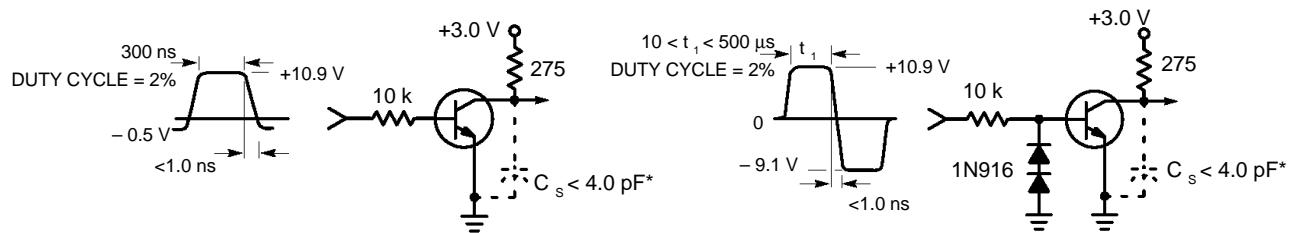
*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time

Figure 2. Turn–Off Time

BCW33LT1

TYPICAL NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)
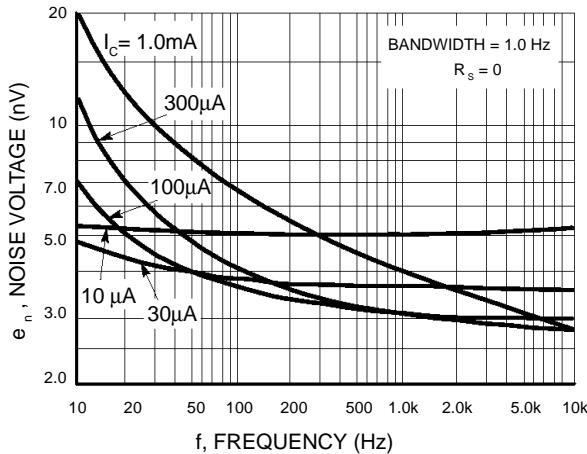
**Figure 3. Noise Voltage**
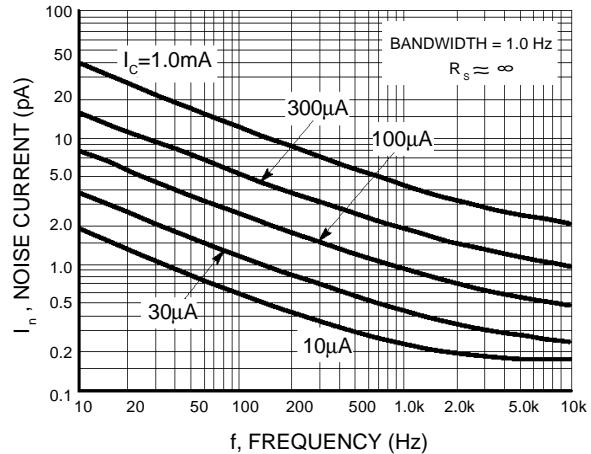
**Figure 4. Noise Current**

NOISE FIGURE CONTOURS

(V_{CE} = 5.0 Vdc, T_A = 25°C)
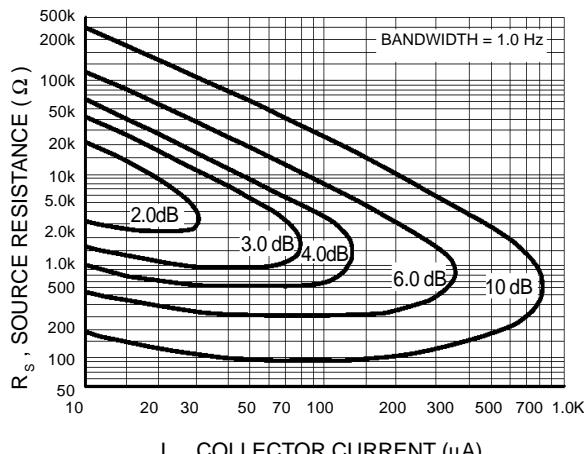
**Figure 5. Narrow Band, 100 Hz**
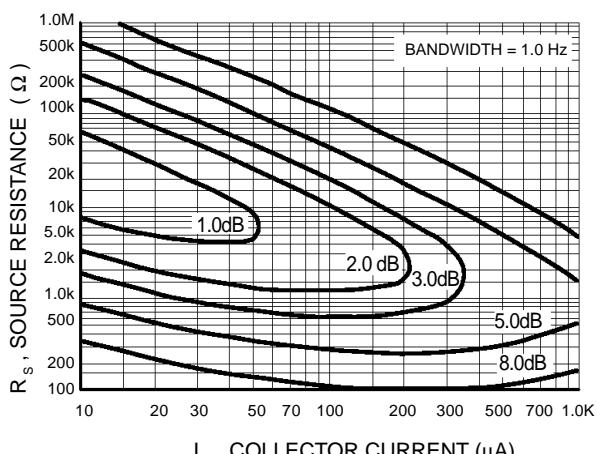
**Figure 6. Narrow Band, 1.0 kHz**
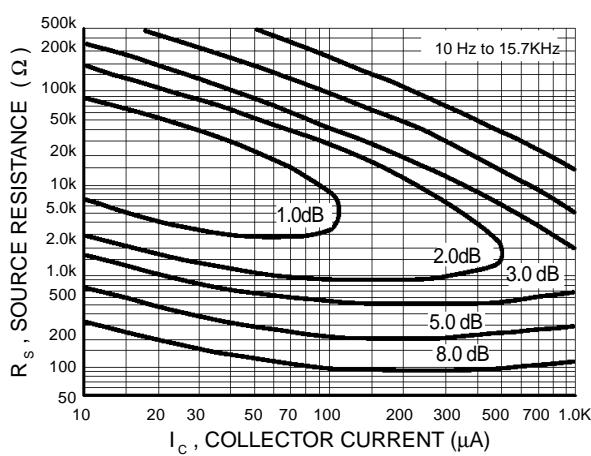
Figure 7. Wideband

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)

## TYPICAL STATIC CHARACTERISTICS
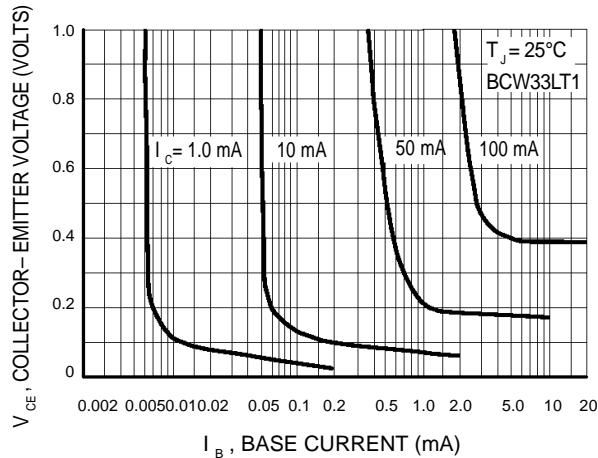
**Figure 8. Collector Saturation Region**
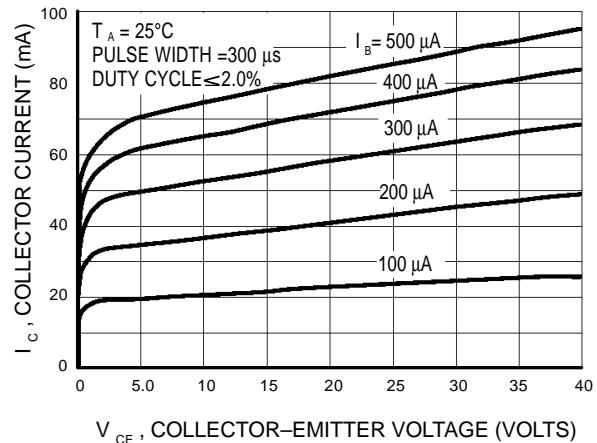
Figure 9. Collector Characteristics
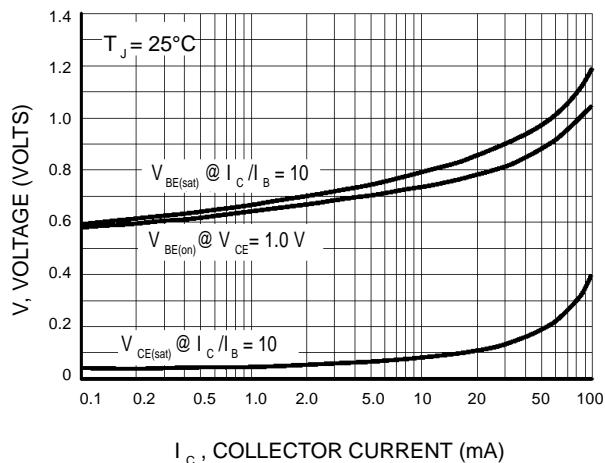
Figure 10. "On" Voltages
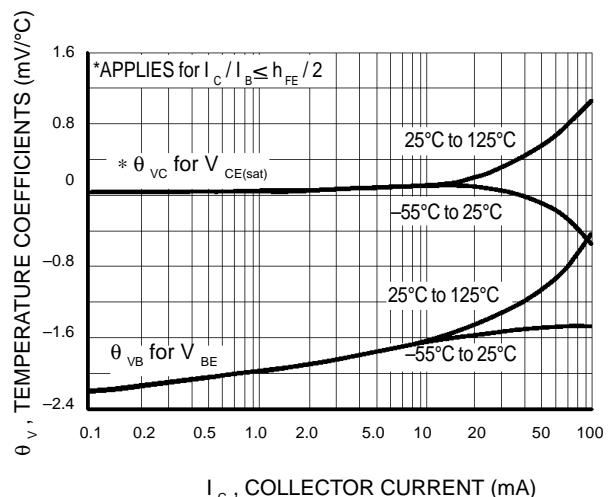
Figure 11. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS
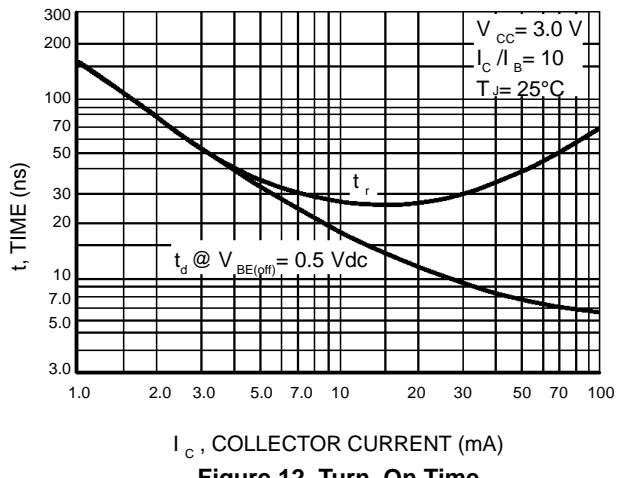

Figure 12. Turn–On Time
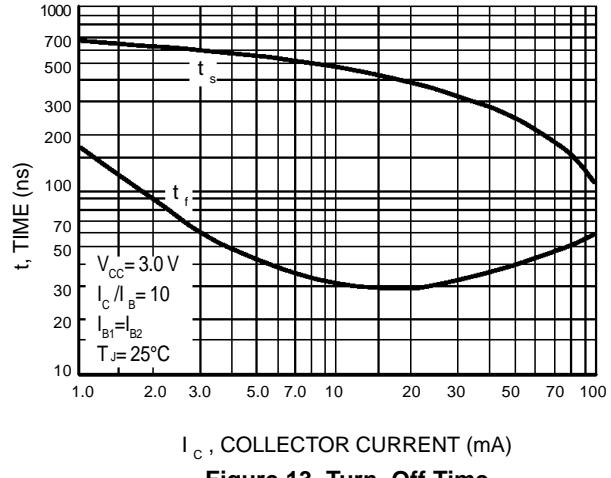
Figure 13. Turn–Off Time
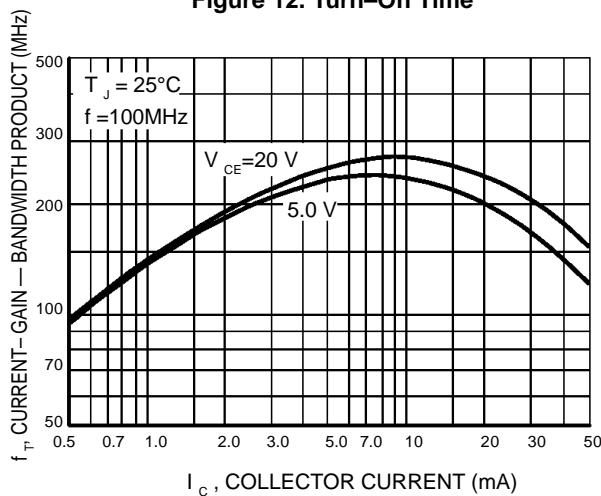
Figure 14. Current–Gain — Bandwidth Product
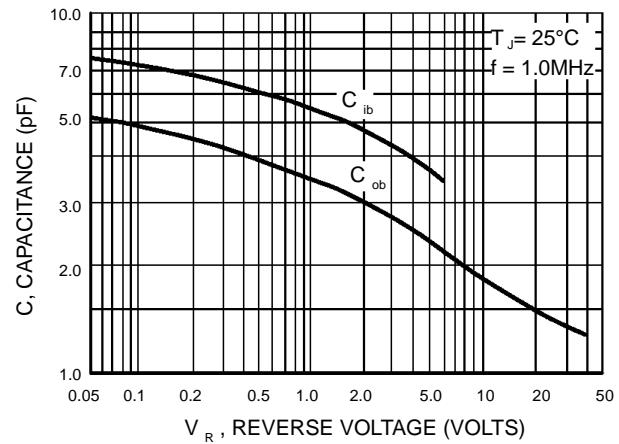
Figure 15. Capacitance
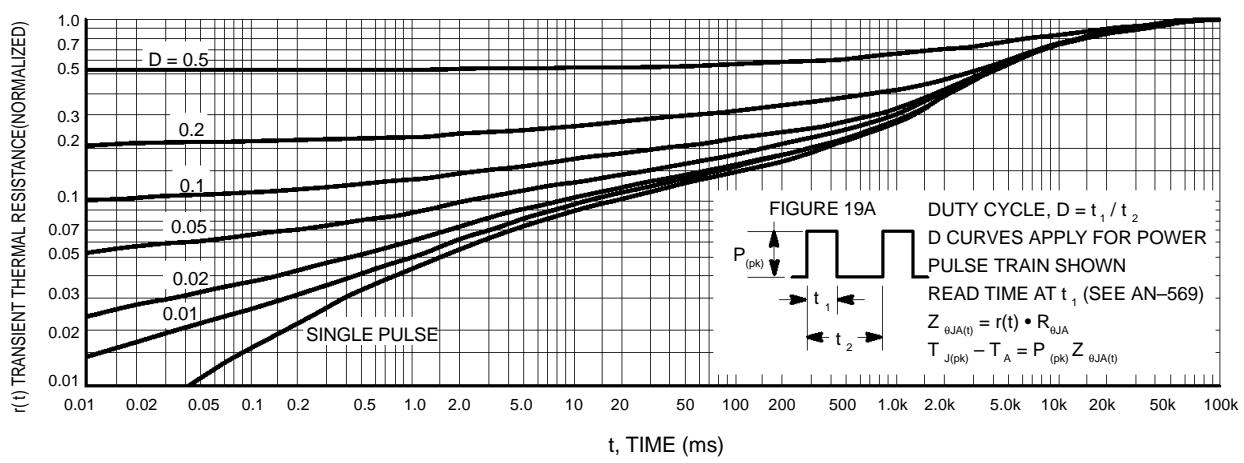
Figure 16. Thermal Response

I_C, COLLECTOR CURRENT (nA)

$V_{CC} = 30$ Vdc

I_{CEO}

I_{CBO}
AND

I_{CEX} @ $V_{BE(off)} = 3.0$ Vdc

T_J, JUNCTION TEMPERATURE (°C)
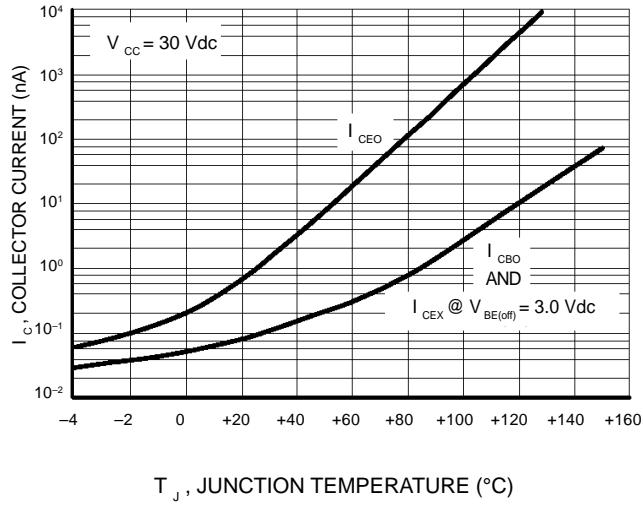
Figure 16A.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

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

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 16 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 16 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.