General Purpose Amplifier

NPN Silicon

MMBTA20LT1

3 COLLECTOR

1 BASE
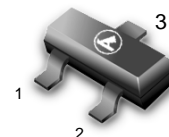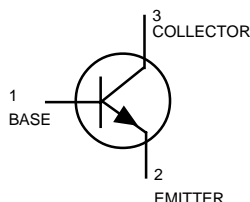
2 EMITTER

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	4.0	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

MMBTA20LT1 = 1C

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 ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Emitter–Base Breakdown Voltage ($I_E = 100$ µAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$Vdc , $I_E = 0$)	I_{CBO}	—	100	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.

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	40	400	—
Collector–Emitter Saturation Voltage(3) ($I_C = 10$mAdc, $I_B = 1.0$mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current – Gain–Bandwidth Product ($V_{CE} = 10$Vdc, $I_C = 5.0$ mAdc, f = 100MHz)	f_T	125	—	MHz
Output Capacitance ($V_{CB} = 10$Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	4.0	pF

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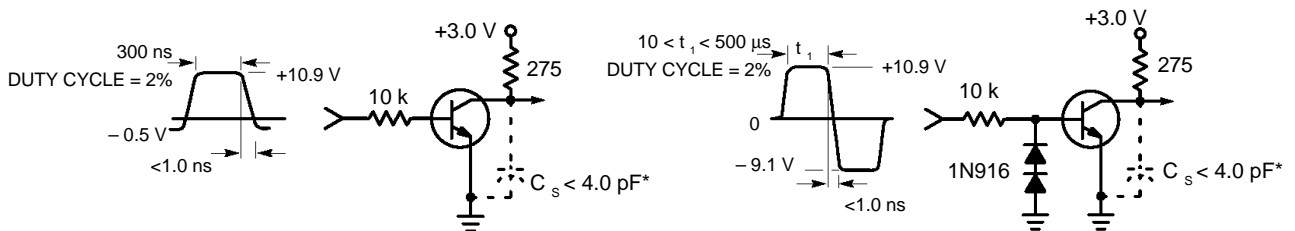
*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time

Figure 2. Turn–Off Time

TYPICAL NOISE CHARACTERISTICS

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

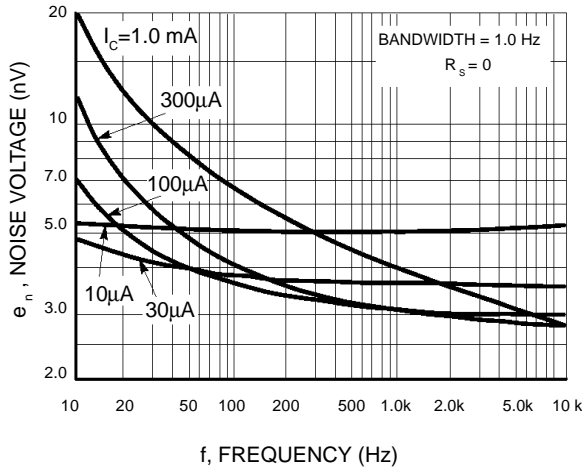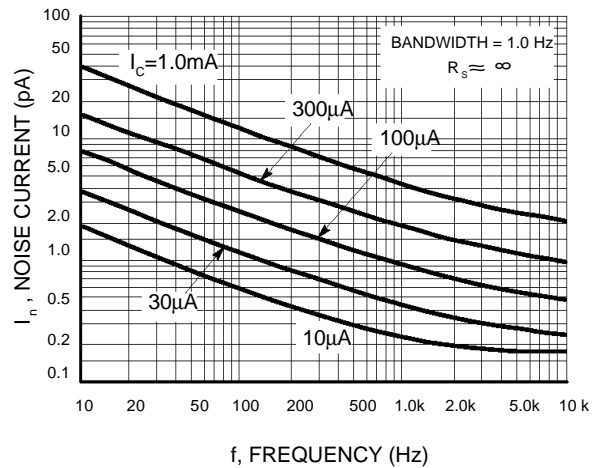**Figure 3. Noise Voltage**

Figure 4. Noise Current

NOISE FIGURE CONTOURS

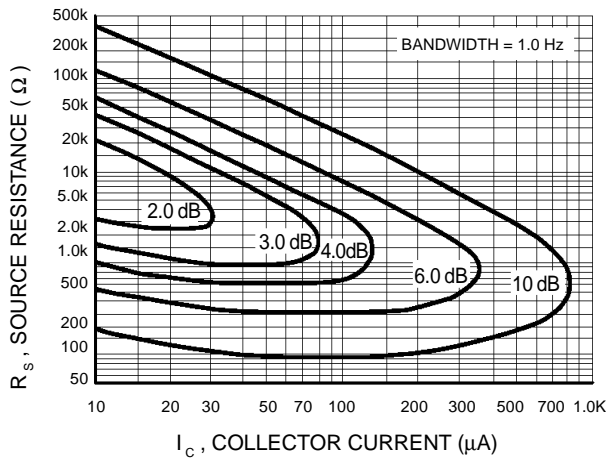$(V_{CE} = 5.0 \text{ Vdc}, T_A = 25°C)$
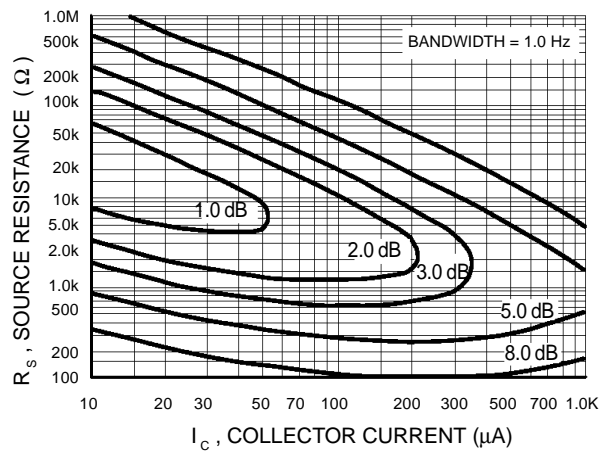

Figure 5. Narrow Band, 100 Hz
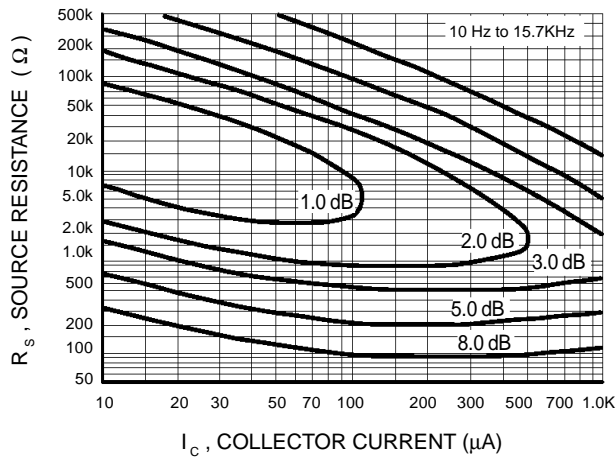

Figure 6. Narrow Band, 1.0 kHz

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 $(1.38 \times 10^{-23} \text{ j}/ °K)$

T = Temperature of the Source Resistance (°K)

R_s = Source Resistance (Ω)

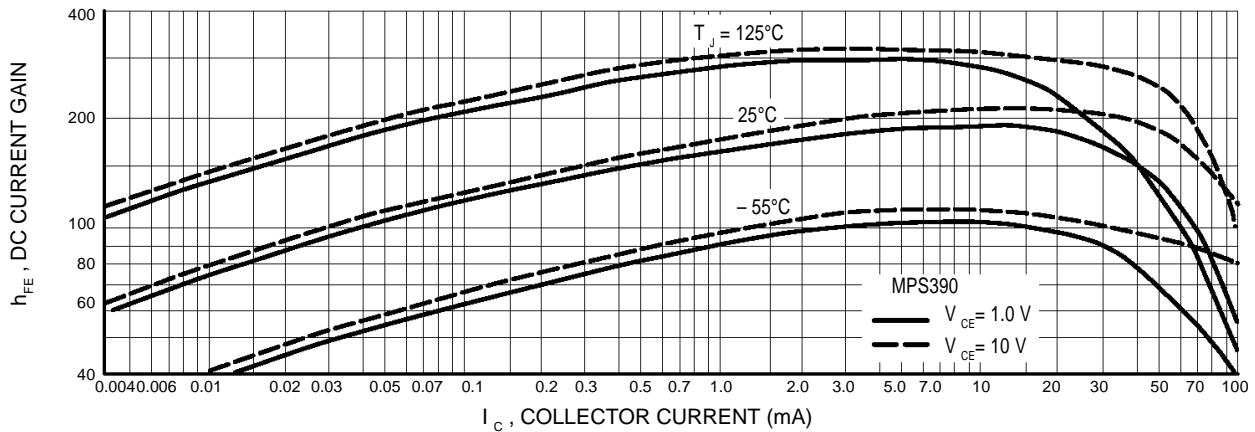## TYPICAL STATIC CHARACTERISTICS

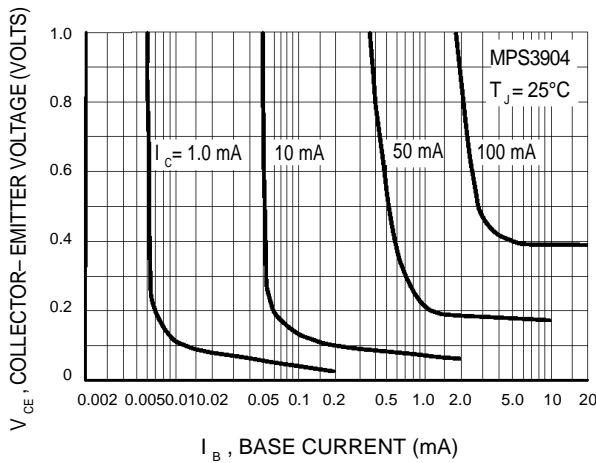**Figure 8. DC Current Gain**

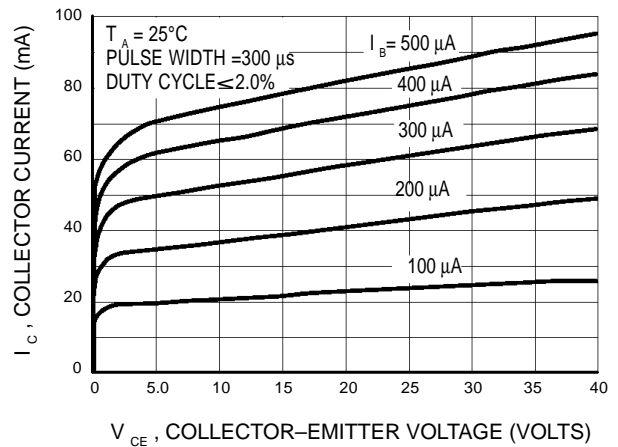**Figure 9. Collector Saturation Region**

Figure 10. Collector Characteristics
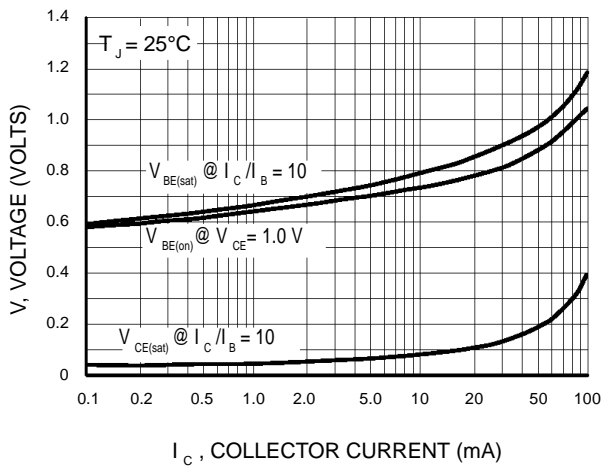
Figure 11. "On" Voltages
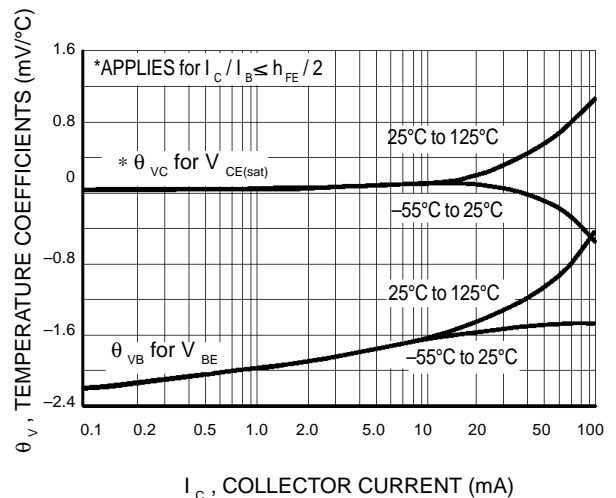
Figure 12. Temperature Coefficients
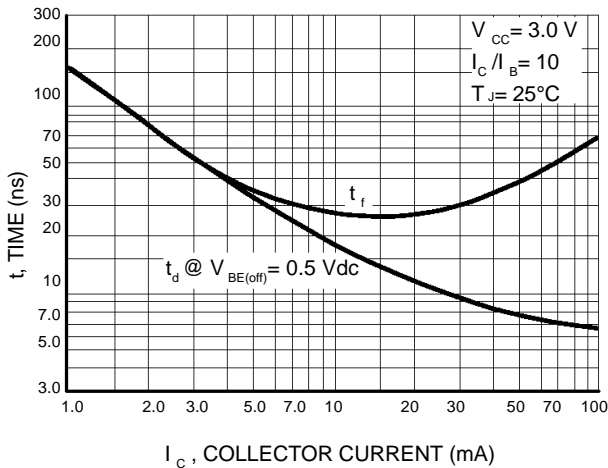
TYPICAL DYNAMIC CHARACTERISTICS

$V_{CC} = 3.0$ V
$I_C/I_B = 10$
$T_J = 25°C$

t_f

$t_d @ V_{BE(off)} = 0.5$ Vdc

I_C, COLLECTOR CURRENT (mA)

Figure 13. Turn–On Time

t_s

t_f

$V_{CC} = 3.0$ V
$I_C/I_B = 10$
$I_{B1} = I_{B2}$
$T_J = 25°C$

I_C, COLLECTOR CURRENT (mA)

Figure 14. Turn–Off Time

$T_J = 25°C$
$f = 100$MHz

$V_{CE} = 20$ V

5.0 V

I_C, COLLECTOR CURRENT (mA)
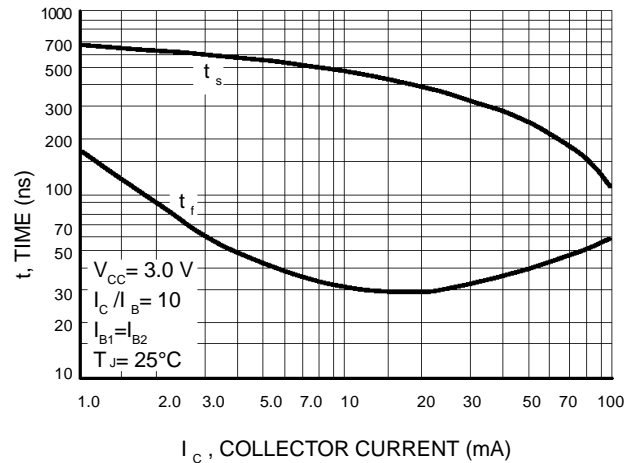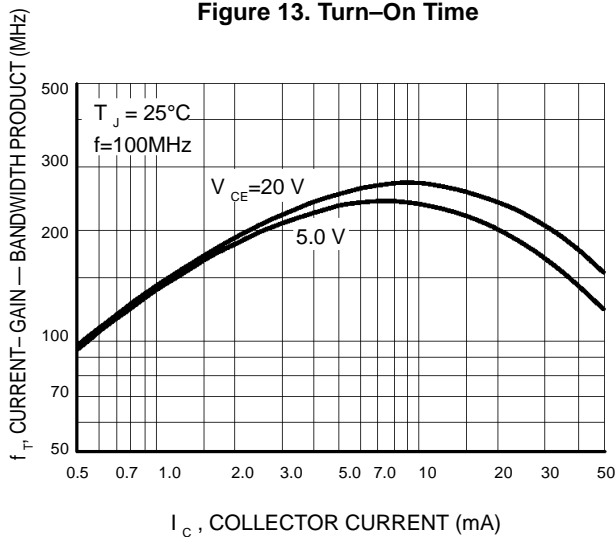
Figure 15. Current–Gain — Bandwidth Product

$T_J = 25°C$
$f = 1.0$MHz

C_{ib}

C_{ob}

V_R, REVERSE VOLTAGE (VOLTS)

Figure 16. Capacitance

$V_{CE} = 10$ Vdc
$f = 1.0$ kHz
$T_A = 25°C$

MPS3904
$h_{fe} \simeq 200 @ I_C = 1.0$ mA

I_C, COLLECTOR CURRENT (mA)
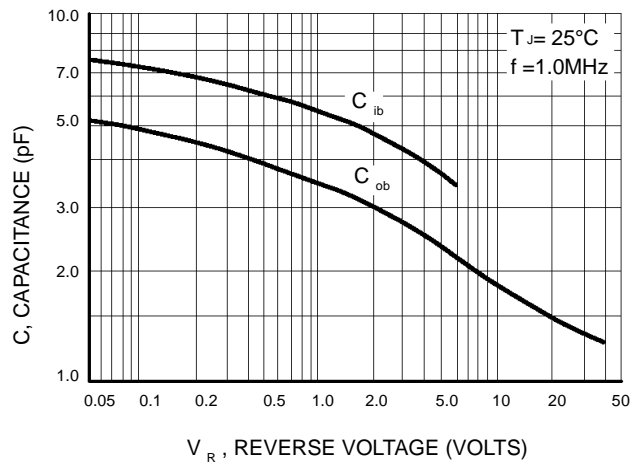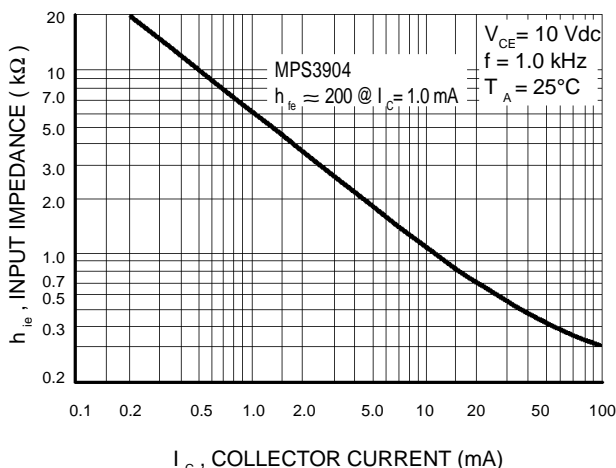
Figure 17. Input Impedance

$V_{CE} = 10$ Vdc
$f = 1.0$ kHz
$T_A = 25°C$

MPS3904
$h_{fe} \simeq 200 @ I_C = 1.0$ mA

I_C, COLLECTOR CURRENT (mA)
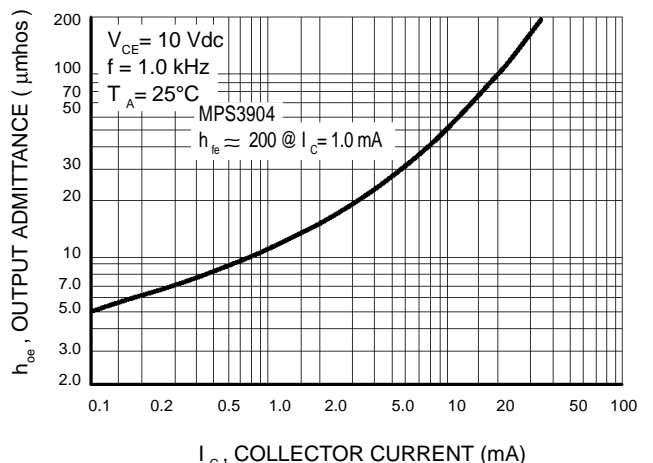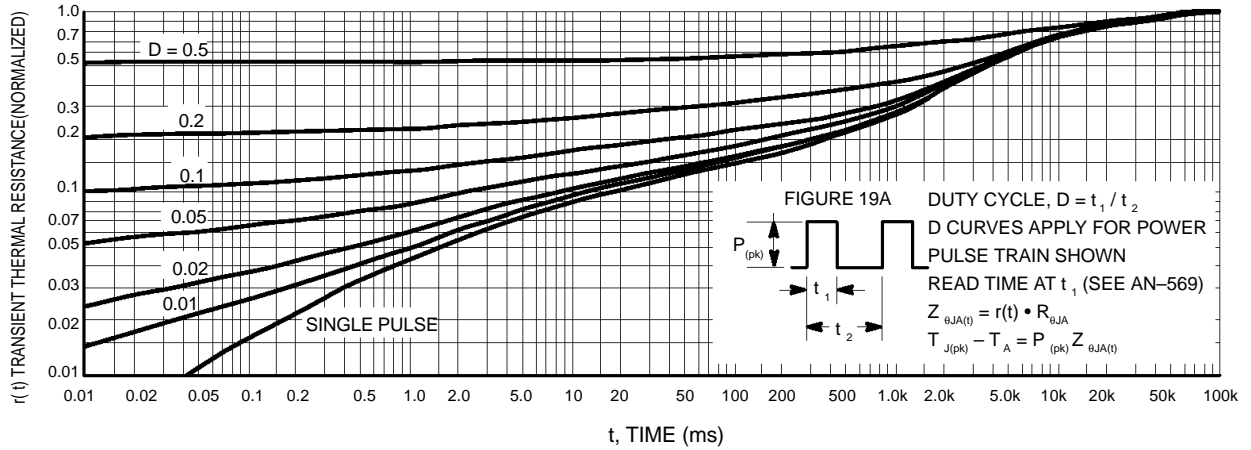
Figure 18. Output Admittance
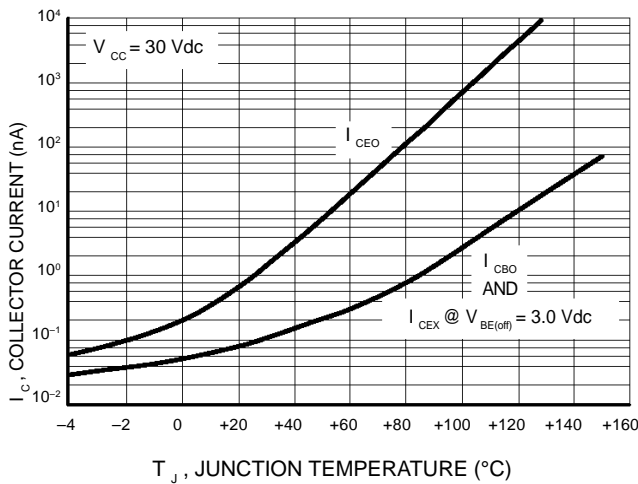
Figure 19. Thermal Response

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

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$
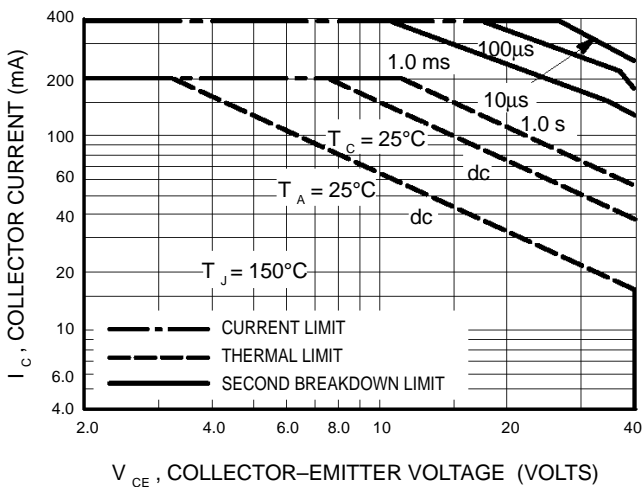
For more information, see AN–569.

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.

Figure 20.