ON Semiconductor

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MPS6521 (NPN)
MPS6523 (PNP)

MPS6521 is a Preferred Device

Amplifier Transistors

Features

- Voltage and Current are Negative for PNP Transistors
- Pb−Free Packages are Available*

MAXIMUM RATINGS

Rating	Symbol	NPN	PNP	Unit
Collector−Emitter Voltage MPS6521 MPS6523	V_{CEO}	 25 −	 − 25	Vdc
Collector−Base Voltage MPS6521 MPS6523	V_{CBO}	 40 −	 − 25	Vdc
Emitter−Base Voltage	V_{EBO}	4.0		Vdc
Collector Current − Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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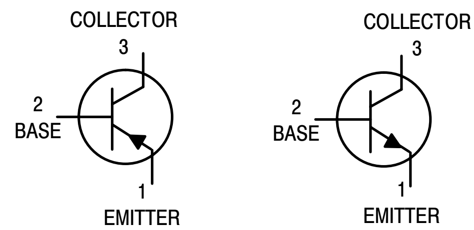
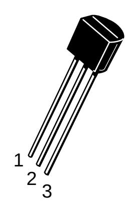
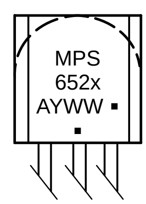


MARKING DIAGRAM



TO−92
CASE 29−11
STYLE 1



MPS652x	= Device Code	
	x = 1 or 3	
A	= Assembly Location	
Y	= Year	
WW	= Work Week	
▪	= Pb−Free Package	

(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
MPS6521	TO−92	5000 Units/Box
MPS6521G	TO−92 (Pb−Free)	5000 Units/Box
MPS6521RLRA	TO−92	2000/Tape & Reel
MPS6521RLRAG	TO−92 (Pb−Free)	2000/Tape & Reel
MPS6523	TO−92	5000 Units/Box
MPS6523G	TO−92 (Pb−Free)	5000 Units/Box

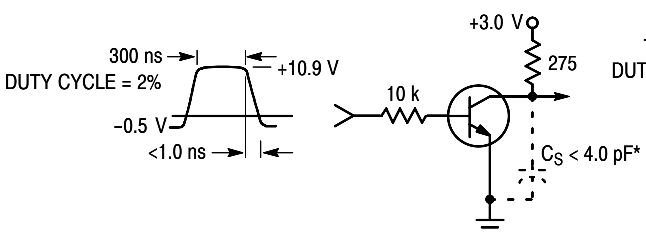
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

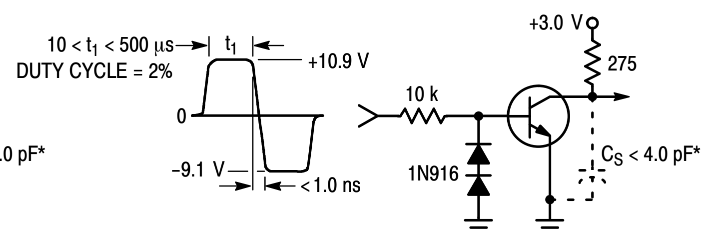
Preferred devices are recommended choices for future use and best overall value.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (I_C = 0.5 mAdc, I_B = 0)		$V_{(BR)CEO}$	25	−	Vdc
Emitter−Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	−	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 30 Vdc, I_E = 0)	MPS6521		−	0.05	
(V_{CB} = 20 Vdc, I_E = 0)	MPS6523		−	0.05	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			−
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MPS6521		150	−	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6521		300	600	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MPS6523		150	−	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6523		300	600	
Collector−Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	−	0.5	Vdc
SMALL−SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	−	3.5	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 k Ω, Power Bandwidth = 15.7 kHz, 3.0 dB points @ 10 Hz and 10 kHz)		NF	−	3.0	dB

NPN
MPS6521
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)

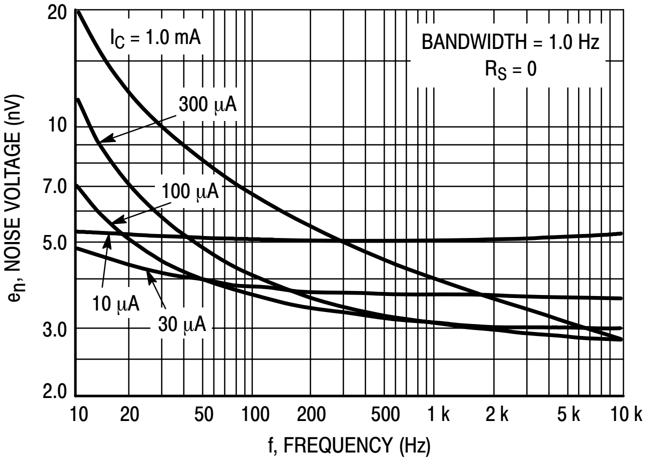


Figure 3. Noise Voltage

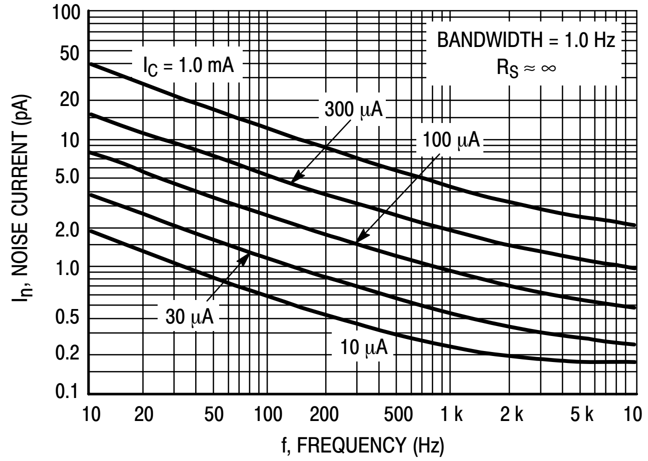


Figure 4. Noise Current

NPN
MPS6521
NOISE FIGURE CONTOURS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

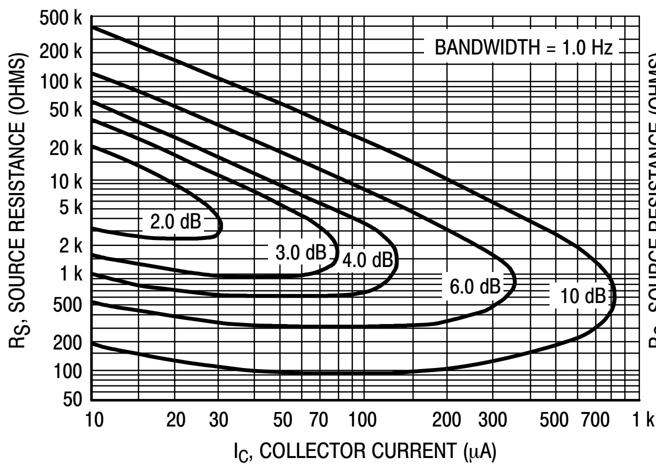


Figure 5. Narrow Band, 100 Hz

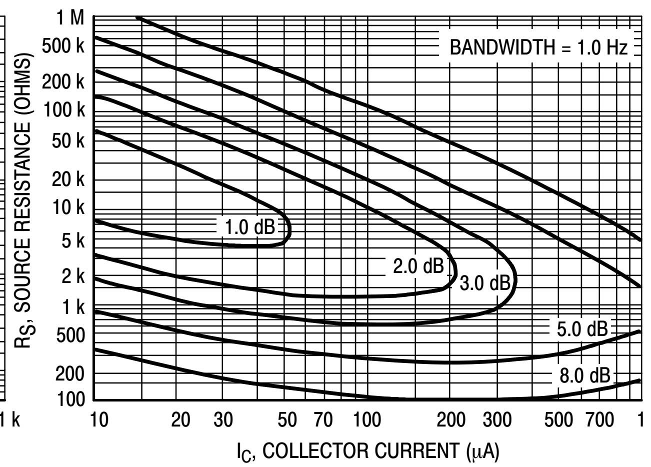


Figure 6. Narrow Band, 1.0 kHz

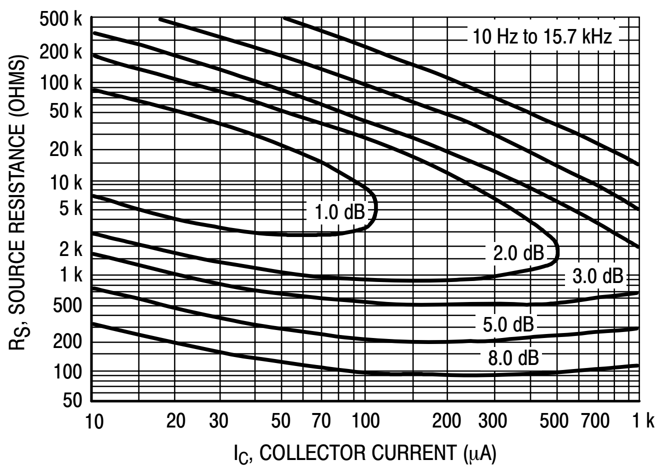


Figure 7. Wideband

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 (Ohms)

NPN
MPS6521
TYPICAL STATIC CHARACTERISTICS

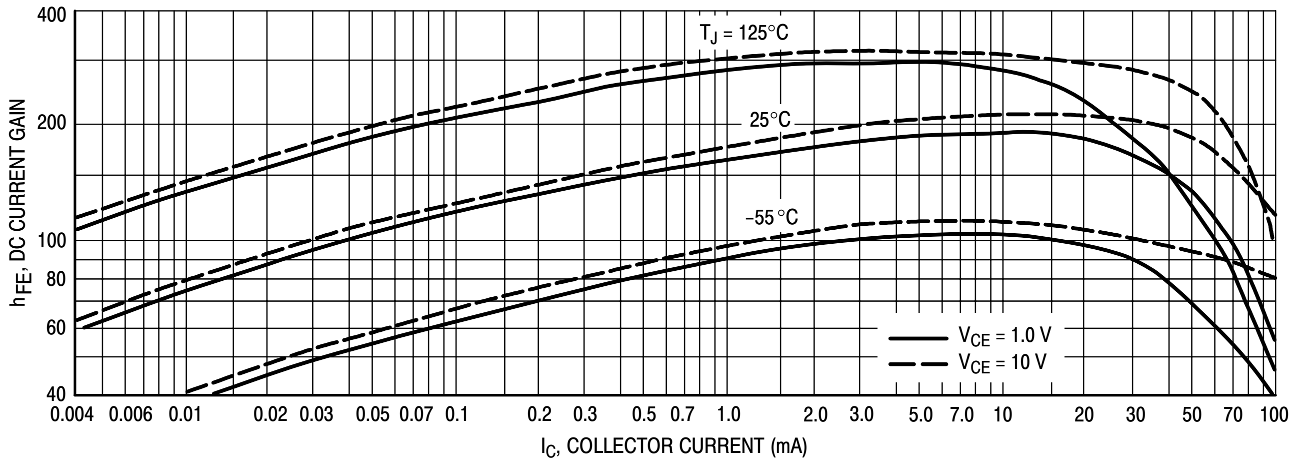


Figure 8. DC Current Gain

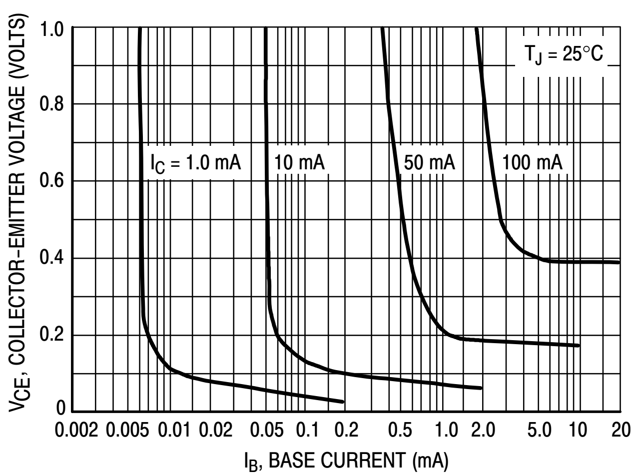


Figure 9. Collector Saturation Region

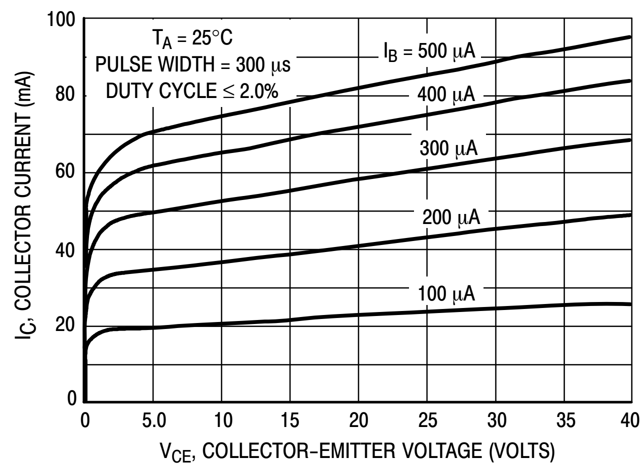


Figure 10. Collector Characteristics

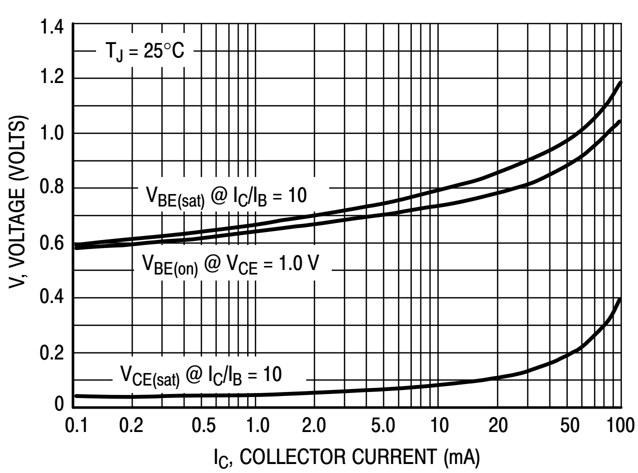


Figure 11. “On” Voltages

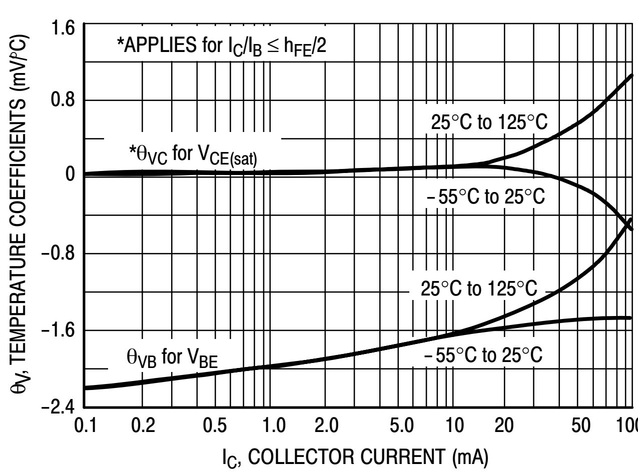


Figure 12. Temperature Coefficients

NPN
MPS6521
TYPICAL DYNAMIC CHARACTERISTICS

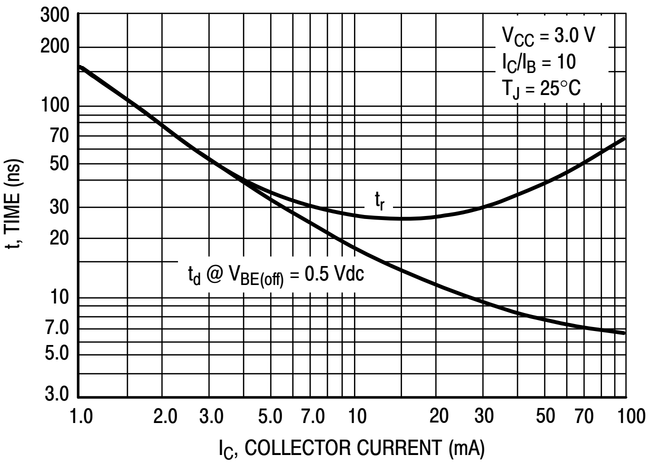


Figure 13. Turn−On Time

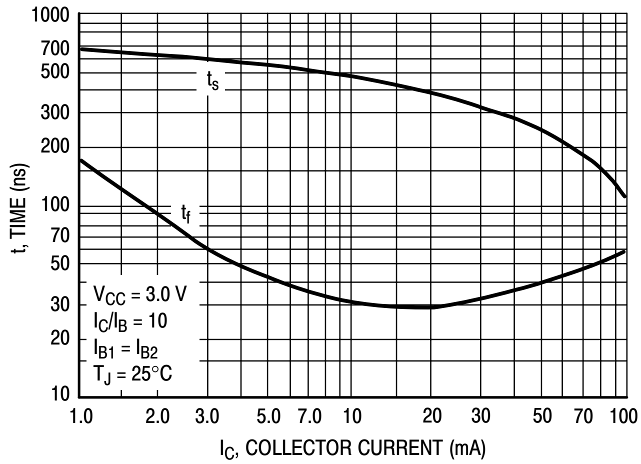


Figure 14. Turn−Off Time

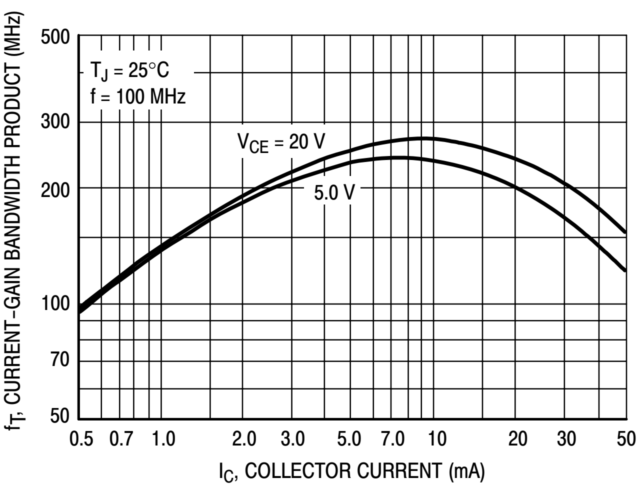


Figure 15. Current−Gain — Bandwidth Product

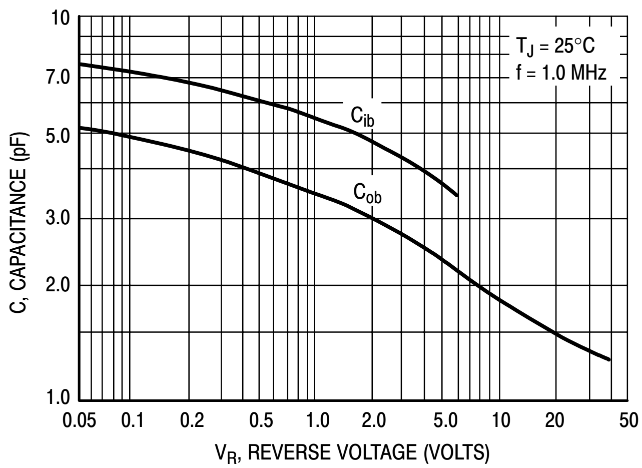


Figure 16. Capacitance

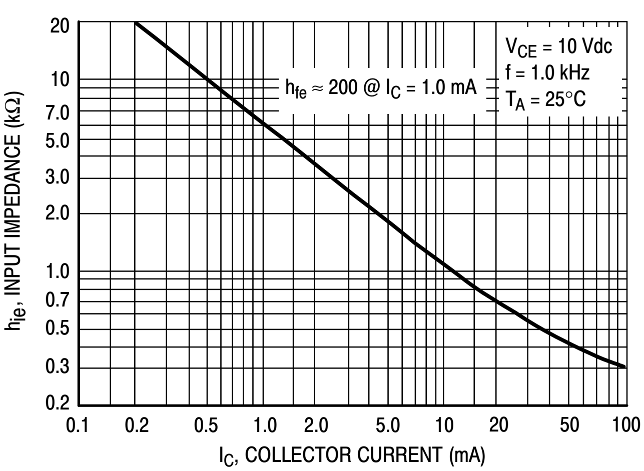


Figure 17. Input Impedance

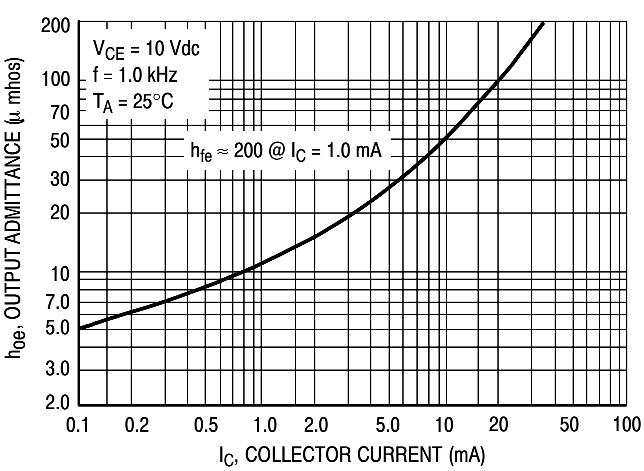


Figure 18. Output Admittance

NPN
MPS6521

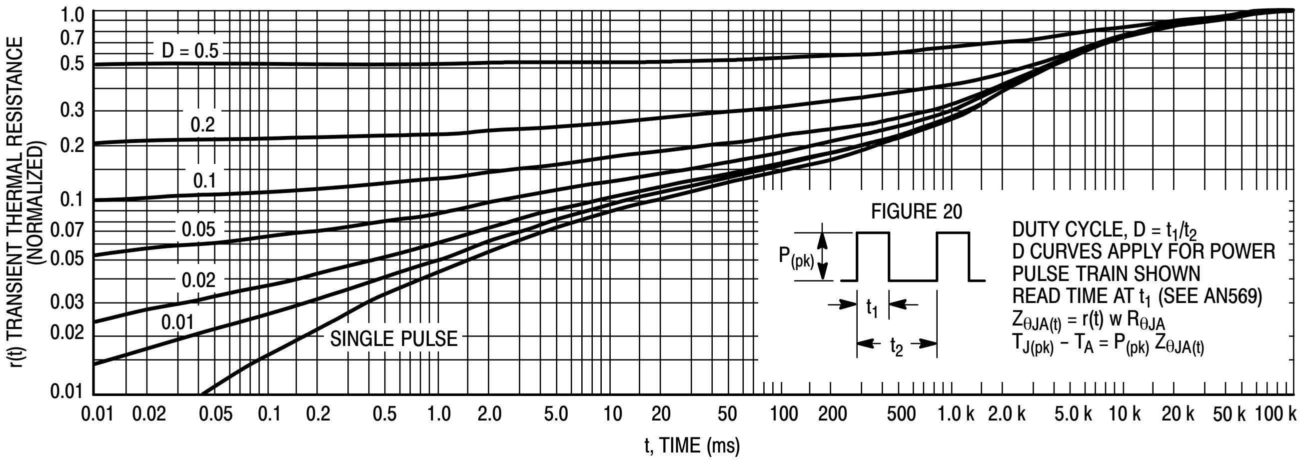


Figure 19. Thermal Response

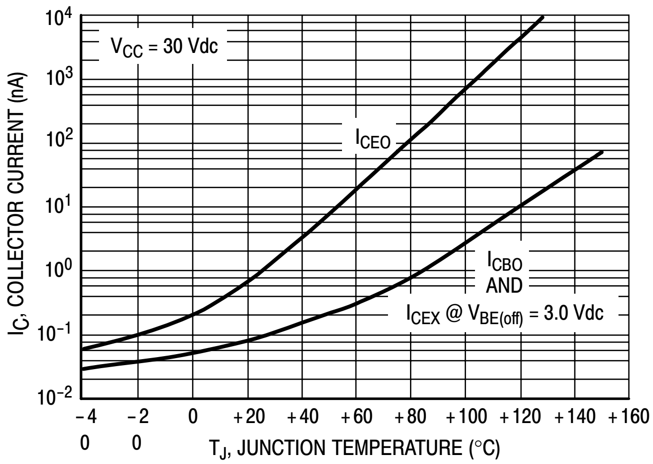


Figure 21.

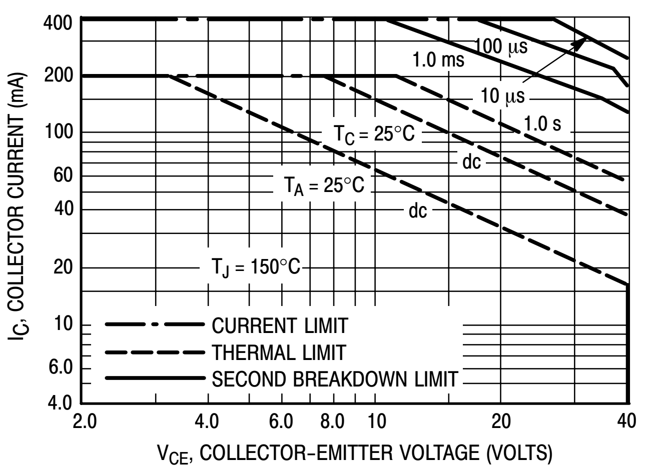


Figure 22.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 20. 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 MPS6521 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 ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

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 22 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 $T_{J(pk)} \le$ 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.

PNP
MPS6523
TYPICAL NOISE CHARACTERISTICS

(V_{CE} = −5.0 Vdc, T_A = 25°C)

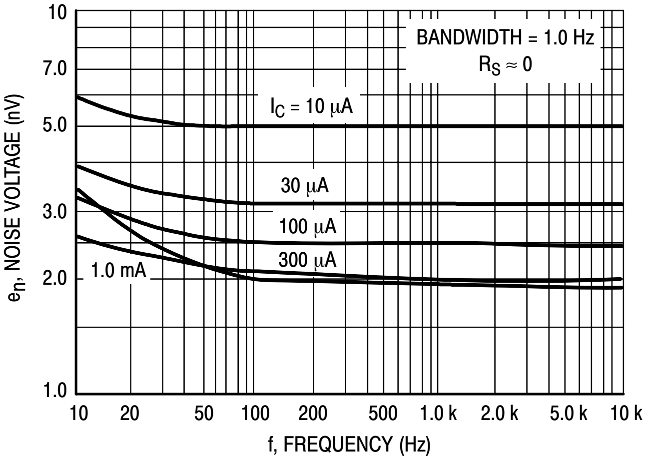


Figure 23. Noise Voltage

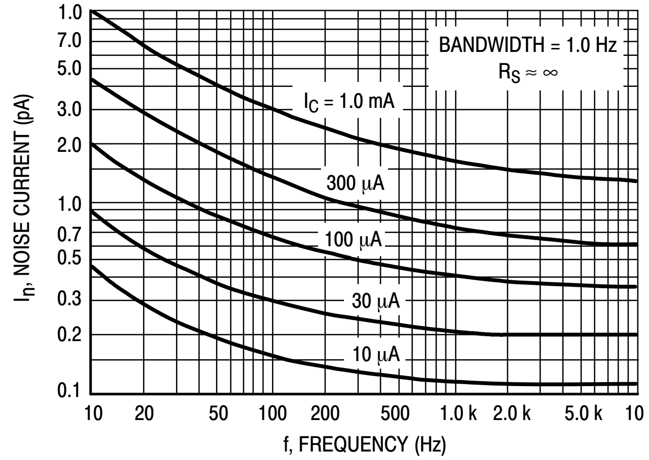


Figure 24. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = −5.0 Vdc, T_A = 25°C)

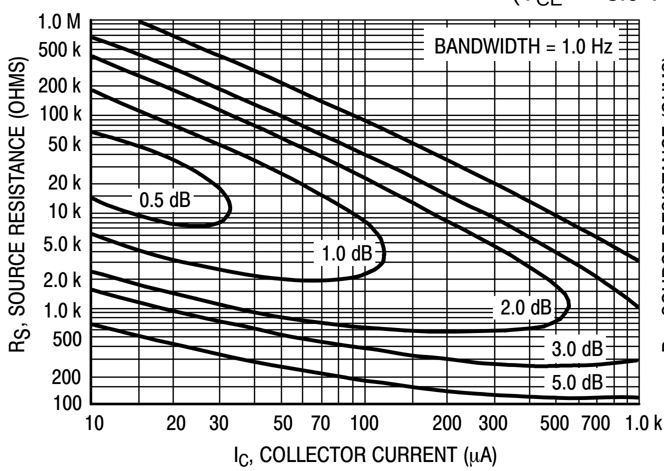


Figure 25. Narrow Band, 100 Hz

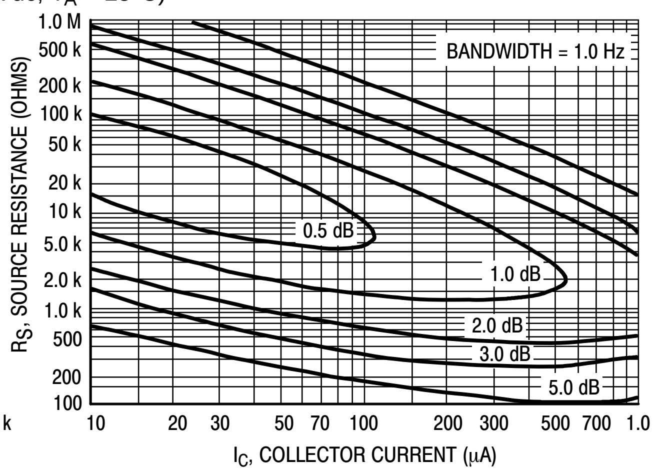


Figure 26. Narrow Band, 1.0 kHz

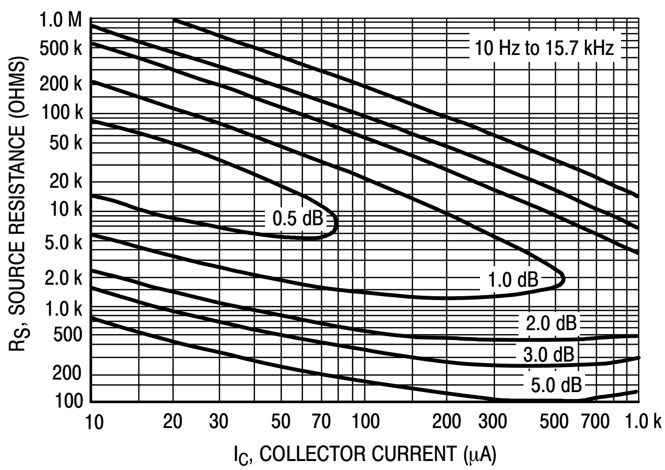


Figure 27. Wideband

Noise Figure is Defined as:

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

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 (1.38×10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

PNP
MPS6523
TYPICAL STATIC CHARACTERISTICS

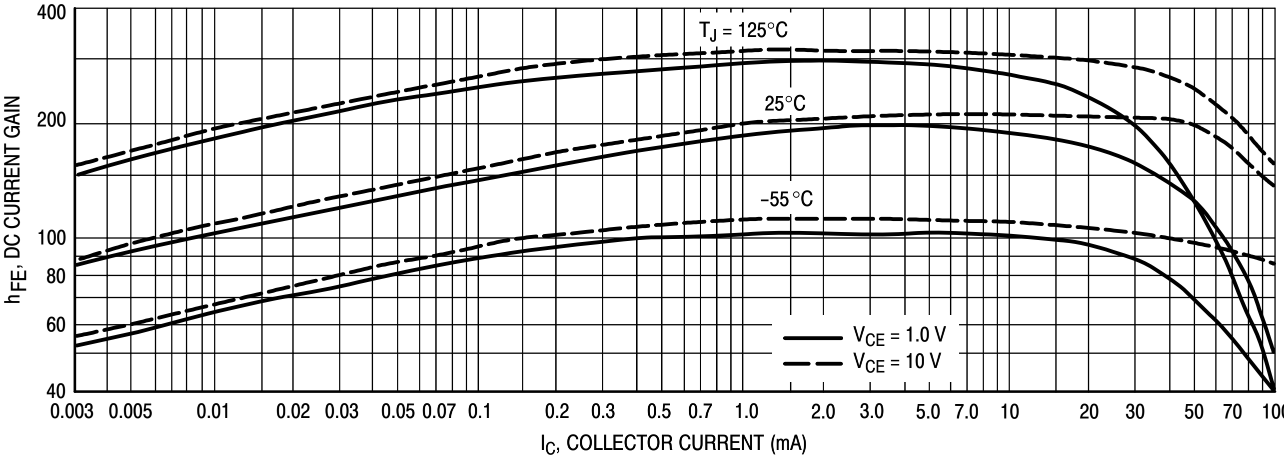


Figure 28. DC Current Gain

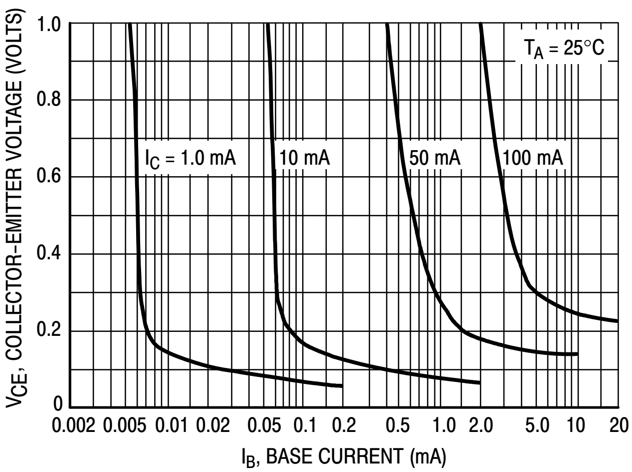


Figure 29. Collector Saturation Region

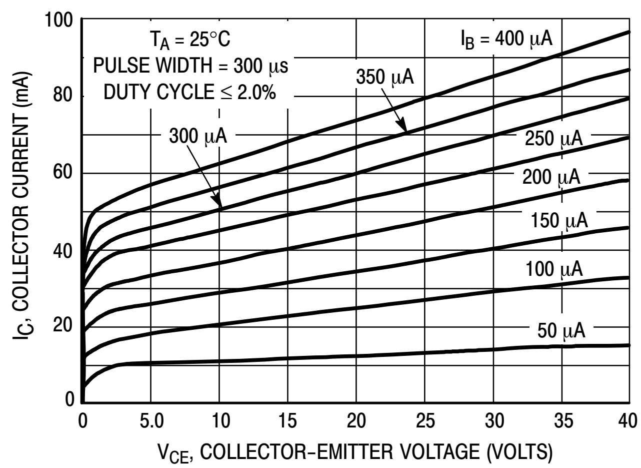


Figure 30. Collector Characteristics

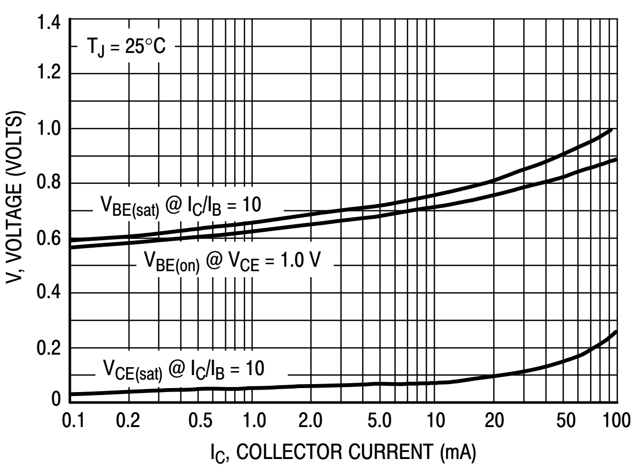


Figure 31. “On” Voltages

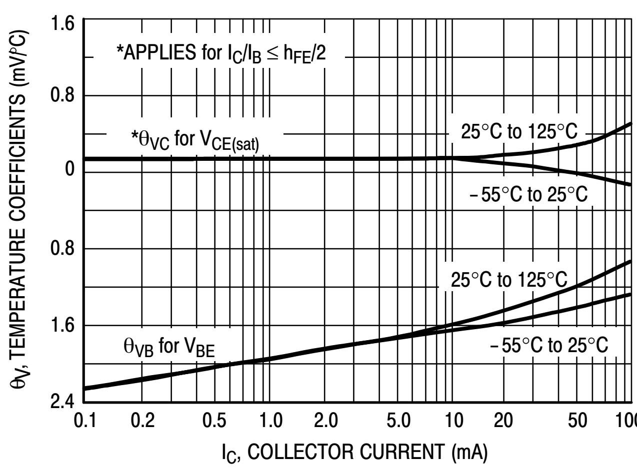


Figure 32. Temperature Coefficients

PNP
MPS6523
TYPICAL DYNAMIC CHARACTERISTICS

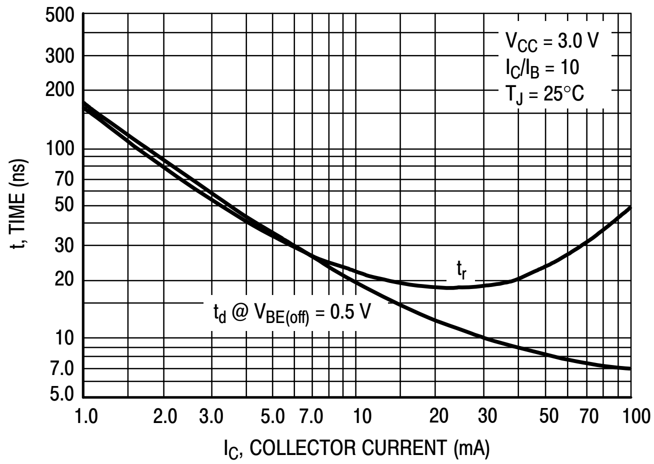


Figure 33. Turn−On Time

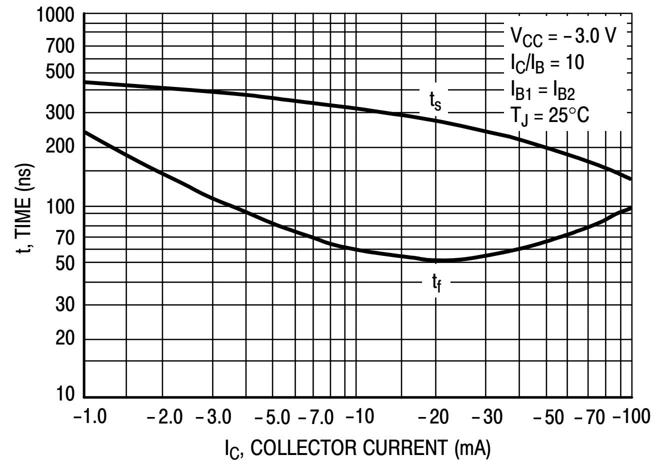


Figure 34. Turn−Off Time

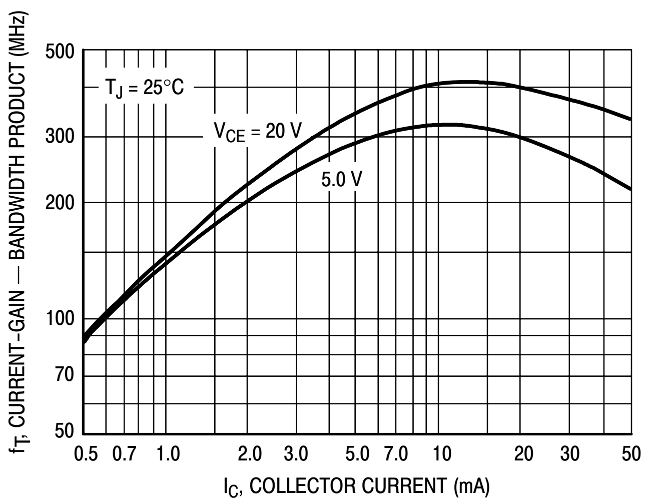


Figure 35. Current−Gain — Bandwidth Product

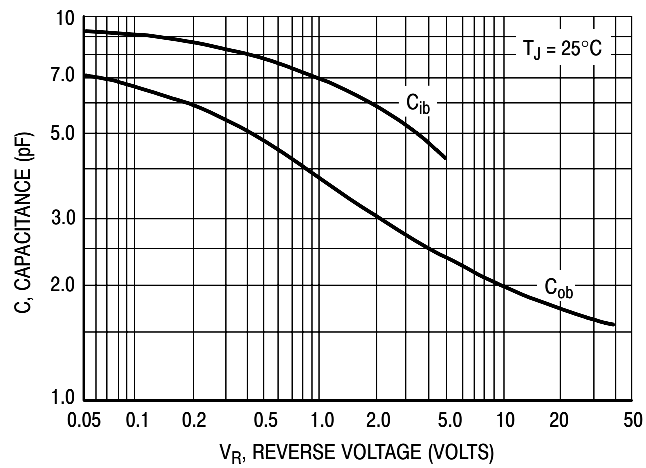


Figure 36. Capacitance

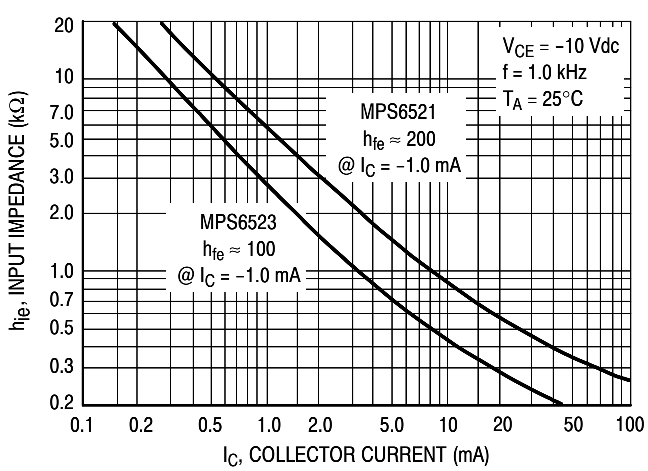


Figure 37. Input Impedance

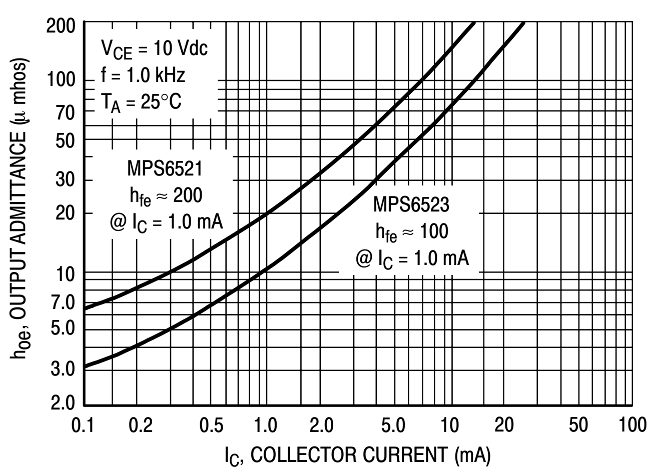


Figure 38. Output Admittance

PNP
MPS6523

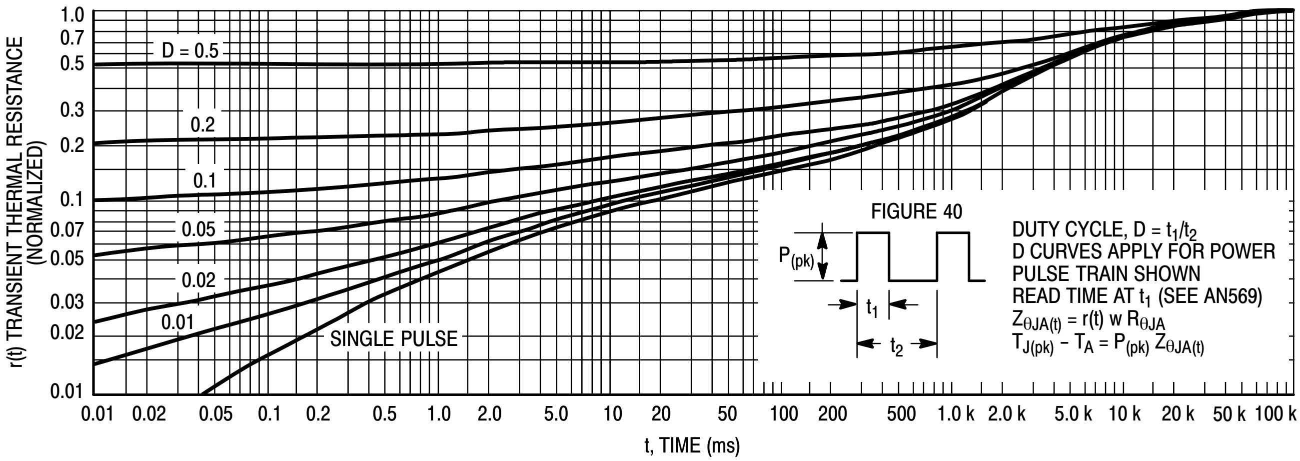


Figure 39. Thermal Response

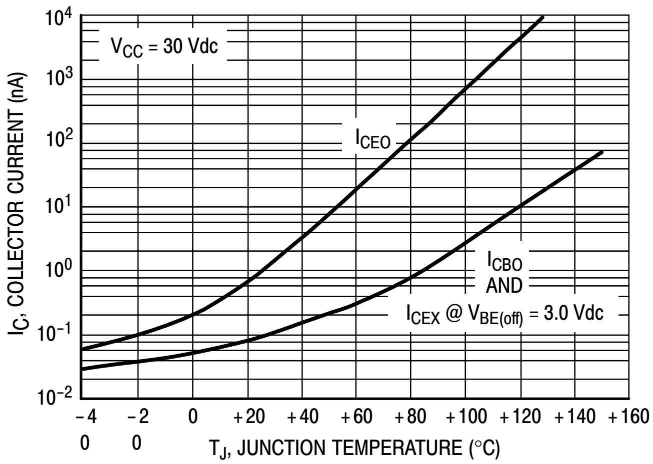


Figure 41.

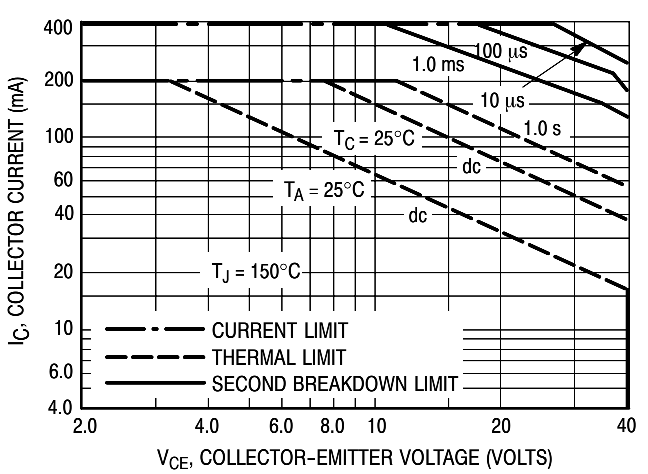


Figure 42.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 40. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 39 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 39 by the steady state value $R_{\theta JA}$.

Example:

The MPS6523 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 39 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

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

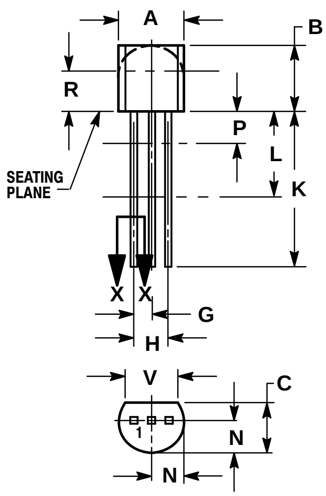
For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

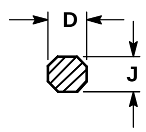
The safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 42 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 $T_{J(pk)} \le 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 39. 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.

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AL





SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---

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