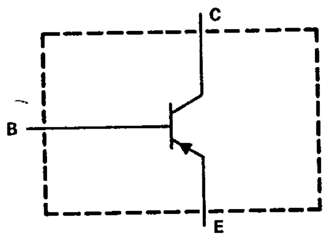
2N3791
P-N-P SILICON POWER TRANSISTOR

NOVEMBER 1968 – REVISED OCTOBER 1984

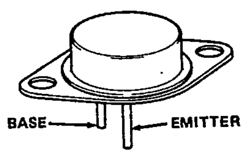
T-33-13

- Designed for Complementary Use With 2N3713
- 150 W at 25°C Case Temperature
- 10 A Continuous Collector Current
- 15 A Peak Collector Current
- Min f_T of 4 MHz at 10 V, 0.5 A
- Min f_{hfe} of 30 kHz at 10 V, 0.5 A
- Designed for Use in Power Amplifier and Switching Applications

device schematic



TO-3 PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	2N3791
*Colletor-base voltage	– 60 V
*Collector-emitter voltage (I_B = 0)	– 60 V
*Emitter-base voltage	7 V
*Continuous collector current	10 A
Peak collector current (see Note 1)	15 A
*Continuous base current	4 A
*Continuous device dissipation at (or below) 25°C case temperature (see Note 2)	150 W
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	4 W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	235°C
*Safe operating areas at (or below) 25°C case temperature	See Figures 8 and 9
*Operating junction and storage temperature range	– 65°C to 200°C

NOTES: 1. This value applies for t_w = 0.3 ms, duty cycle ≤ 10 %.
2. Derate linearly to 200°C case temperature at the rate of 0.855 W/°C.
3. Derate linearly to 200°C free-air temperature at the rate of 22.9 mW/°C.

*JEDEC registered data.

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electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS			2N3791 MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	$I_C = -0.2$ A,	$I_B = 0$,	See Note 4	−60			V
I_{CEO}	$V_{CE} = -30$ V,	$I_B = 0$				−10	mA
I_{CEV}	$V_{CE} = -60$ V,	$V_{BE} = 1.5$ V				−1	mA
	$V_{CE} = -80$ V,	$V_{BE} = 1.5$ V				−1	
I_{EBO}	$V_{EB} = -7$ V,	$I_C = 0$				−5	mA
h_{FE}	$V_{CE} = -2$ V,	$I_C = -1$ A,	See Notes 4 and 5	50		180	
	$V_{CE} = -2$ V,	$I_C = -3$ A,	See Notes 4 and 5	30			
	$V_{CE} = -4$ V,	$I_C = -10$ A,	See Notes 4 and 5	4			
V_{BE}	$V_{CE} = -2$ V,	$I_C = -5$ A,	See Notes 4 and 5			−1.8	V
	$V_{CE} = -4$ V,	$I_C = -10$ A,	See Notes 4 and 5			−4	
$V_{CE(sat)}$	$I_B = -0.5$ A,	$I_C = -5$ A,	See Notes 4 and 5			−1	V
	$I_B = -2$ A,	$I_C = -10$ A,	See Notes 4 and 5			−4	
h_{fe}	$V_{CE} = -10$ V,	$I_C = -0.5$ A,	f = 1 kHz	25		250	
$\|h_{fe}\|$	$V_{CE} = -10$ V,	$I_C = -0.5$ A,	f = 1 MHz	4			
f_{hfe}	$V_{CE} = -10$ V,	$I_C = -0.5$ A,	See Note 6	30			kHz
C_{obo}	$V_{CB} = -10$ V,	$I_E = 0$,	f = 100 kHz			500	pF

NOTES: 4. These parameters must be measured using pulse techniques, $t_w = 300\ \mu s$, duty cycle $\leq 2\%$.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 1,6 mm (0.0625 inch) from the device body.
6. f_{hfe} is the frequency at which the magnitude of the small-signal forward current transfer is 0.707 of its low-frequency value. For these devices, the reference measurement is made at 1 kHz.

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$			1.17	°C/W
$R_{\theta JA}$			43.7	°C/W

resistive-load switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	$I_C = -1$ A,	$I_{B1} = -0.1$ A,	$I_{B2} = 0.1$ A,		0.35		μs
t_{off}	$V_{BE(off)} = 3.7$ V,	$R_L = 20\ \Omega$,	See Figure 1		0.8		μs

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

2 2N Devices

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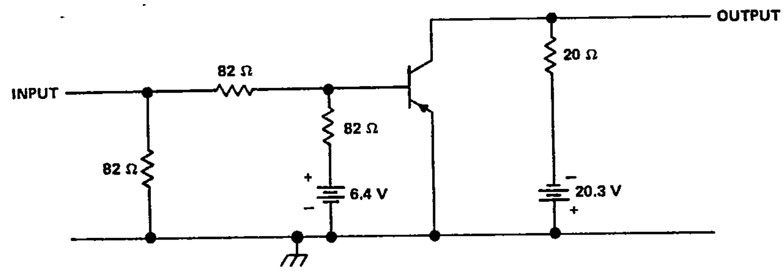
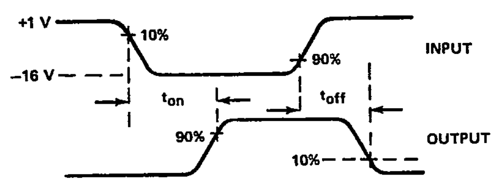
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\,\Omega$, $t_w = 10\,\mu s$, duty cycle $\leq 2\%$.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10\,M\Omega$, $C_{in} \leq 11.5$ pF.
C. Resistors must be noninductive types.
D. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

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TYPICAL CHARACTERISTICS

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STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

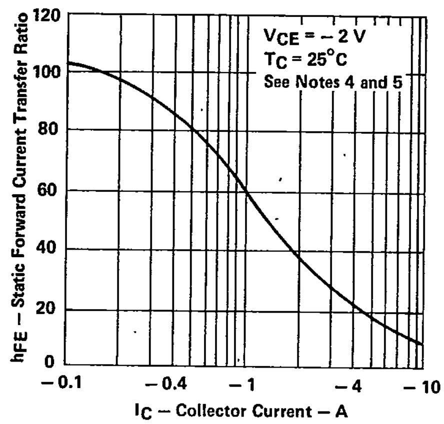

FIGURE 2

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

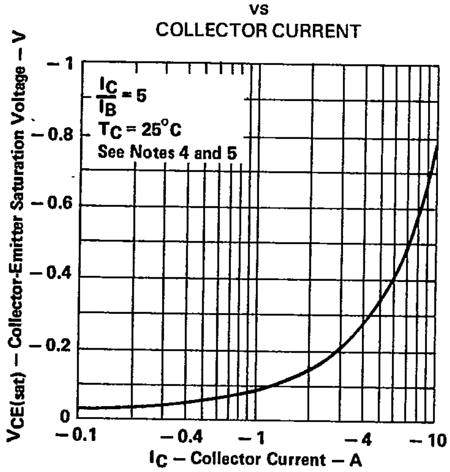

FIGURE 3

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

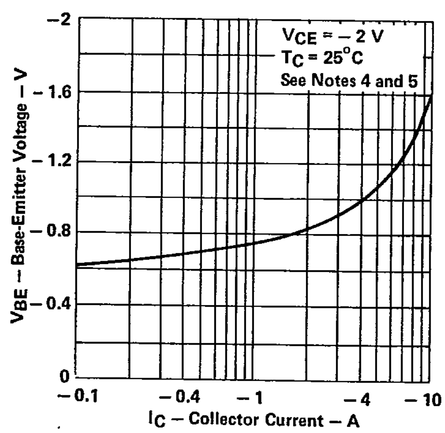

FIGURE 4

NOTES: 4. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

2
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MAXIMUM SAFE OPERATING AREAS

2N3791

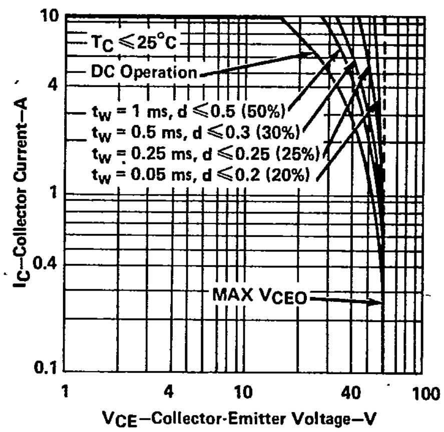

FIGURE 5

THERMAL INFORMATION

DISSIPATION DERATING CURVE

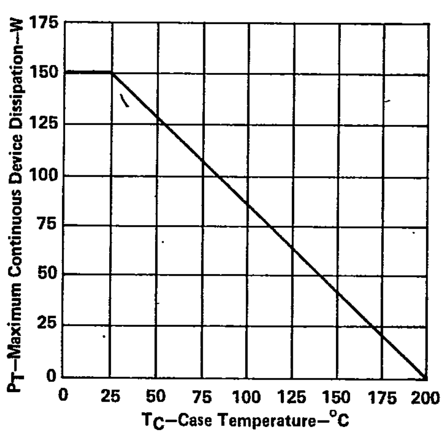

FIGURE 6

PEAK-POWER COEFFICIENT CURVE

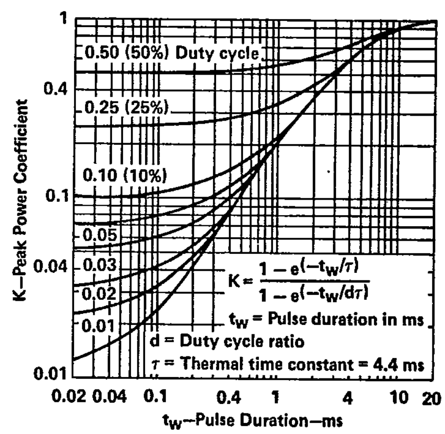

FIGURE 7

2N Devices

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THERMAL INFORMATION

SYMBOL DEFINITION

SYMBOL	DEFINITION	VALUE	UNIT
$P_{T(av)}$	Average Power Dissipation		W
$P_{T(max)}$	Peak Power Dissipation		W
$R_{\theta JA}$	Junction-to-Free-Air Thermal Resistance	43.7	°C/W
$R_{\theta JC}$	Junction-to-Case Thermal Resistance	1.17	°C/W
$R_{\theta CA}$	Case-to-Free-Air Thermal Resistance	42.5	°C/W
$R_{\theta CHS}$	Case-to-Heat-Sink Thermal Resistance		°C/W
$R_{\theta HSA}$	Heat-Sink-to-Free-Air Thermal Resistance		°C/W
T_A	Free-Air Temperature		°C
T_C	Case Temperature		°C
$T_{J(av)}$	Average Junction Temperature	≤ 200	°C
$T_{J(max)}$	Peak Junction Temperature	≤ 200	°C
K	Peak Power Coefficient	See Figure 7	
t_w	Pulse Duration		ms
t_x	Pulse Period		ms
d	Duty Cycle Ratio (t_w/t_x)		

Equation No. 1 —Application: dc power dissipation, heat sink used.

$$P_{T(av)} = \frac{T_{J(av)} - T_A}{R_{\theta JC} + R_{\theta CHS} + R_{\theta HSA}}$$

for 25°C ≤ T_C ≤ 200°C, as in Figure 6.

Equation No. 2 —Application: dc power dissipation, no heat sink used.

$$P_{T(av)} = \frac{T_{J(av)} - T_A}{R_{\theta JA}} \quad \text{for } 25°C \leq T_A \leq 200°C$$

Equation No. 3 —Application: peak power dissipation, heat sink used.

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(R_{\theta CHS} + R_{\theta HSA}) + K\,R_{\theta JC}}$$

for 25°C ≤ T_C ≤ 200°C

Equation No. 4 — Application: peak power dissipation, no heat sink used.

$$P_{T(max)} = \frac{T_{J(max)} - T_{MA}}{d\,R_{\theta CA} + K\,R_{\theta JC}} \quad \text{for } 25°C \leq T_A \leq 200°C$$

Example — Find $P_{T(max)}$ (design limit)

OPERATING CONDITIONS:

$R_{\theta CHS} + R_{\theta HSA}$ = 2.25°C/W (from information supplied with heat sink)

$T_{J(av)}$ (design limit) = 200°C

T_A = 50°C

d = 10% (0.1)

t_w = 0.1 ms

Solution:

From Figure 7, Peak-Power Coefficient K = 0.11 and by use of equation No. 3

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(R_{\theta CHS} + R_{\theta HSA}) + K\,R_{\theta JC}}$$

$$P_{T(max)} = \frac{200 - 50}{0.1\,(2.25) + 0.11\,(1.17)} = 424\,W$$