TYPES 2N3789, 2N3790, 2N3791, 2N3792
P-N-P SINGLE-DIFFUSED SILICON POWER TRANSISTORS

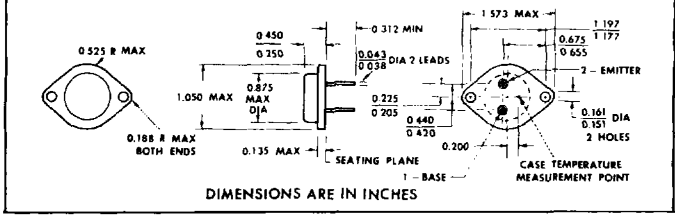
TYPES 2N3789, 2N3790, 2N3791, 2N3792
BULLETIN NO. DL-S 6810050, NOVEMBER 1968

FOR POWER-AMPLIFIER AND HIGH-SPEED-SWITCHING APPLICATIONS
DESIGNED FOR COMPLEMENTARY USE WITH 2N3713 THRU 2N3716

- **150 Watts at 25°C Case Temperature**
- **10 A Rated Collector Current**
- **Min f_T of 4 MHz at 10 V, 500 mA**
- **Min f_{hfe} of 30 kHz at 10 V, 500 mA**

*mechanical data

ALL JEDEC TO-3 DIMENSIONS AND NOTES ARE APPLICABLE
THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE



DIMENSIONS ARE IN INCHES

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

	2N3789 2N3791	2N3790 2N3792
*Collector-Base Voltage	-60 V	-80 V
*Collector-Emitter Voltage (See Note 1)	-60 V	-80 V
*Emitter-Base Voltage	←— -7 V —→	
*Continuous Collector Current	←— -10 A —→	
Peak Collector Current (See Note 2)	←— -15 A —→	
*Continuous Base Current	←— -4 A —→	
*Safe Operating Region at (or below) 25°C Case Temperature	See Figures 6 and 7	
*Continuous Device Dissipation at (or below) 25°C Case Temperature (See Note 3)	←— 150 W —→	
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 4)	←— 4 W —→	
*Operating Collector Junction Temperature Range	-65°C to 200°C	
*Storage Temperature Range	-65°C to 200°C	
Lead Temperature 1/16 Inch from Case for 10 Seconds	←— 235°C —→	

NOTES:
1. This value applies when the base-emitter diode is open-circuited.
2. This value applies for $t_p = 0.3$ ms, duty cycle $\leq 10\%$.
3. Derate linearly to 200°C case temperature at the rate of 0.855 W/deg.
4. Derate linearly to 200°C free-air temperature at the rate of 22.9 mW/deg.

*Indicates JEDEC registered data

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

PARAMETER		TEST CONDITIONS	2N3789		2N3790		2N3791		2N3792		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -200$ mA, $I_B = 0$, See Note 5	-60		-80		-60		-80		V
I_{CEO}	Collector Cutoff Current	$V_{CE} = -30$ V, $I_B = 0$		-10				-10			mA
		$V_{CE} = -40$ V, $I_B = 0$				-10				-10	
I_{CEV}	Collector Cutoff Current	$V_{CE} = -60$ V, $V_{BE} = 1.5$ V		-1				-1			mA
		$V_{CE} = -80$ V, $V_{BE} = 1.5$ V				-1				-1	
		$V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$		-5				-5			
		$V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$				-5				-5	
I_{EBO}	Emitter Cutoff Current	$V_{EB} = -7$ V, $I_C = 0$		-5		-5		-5		-5	mA
h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -2$ V, $I_C = -1$ A, See Notes 5 and 6	25	90	25	90	50	180	50	180	
		$V_{CE} = -2$ V, $I_C = -3$ A, See Notes 5 and 6	15		15		30		30		
		$V_{CE} = -4$ V, $I_C = -10$ A, See Notes 5 and 6	4		4		4		4		
V_{BE}	Base-Emitter Voltage	$V_{CE} = -2$ V, $I_C = -5$ A, See Notes 5 and 6		-2		-2		-1.8		-1.8	V
		$V_{CE} = -4$ V, $I_C = -10$ A, See Notes 5 and 6		-4		-4		-4		-4	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -0.4$ A, $I_C = -4$ A, See Notes 5 and 6		-1		-1					V
		$I_B = -0.5$ A, $I_C = -5$ A, See Notes 5 and 6						-1		-1	
		$I_B = -2$ A, $I_C = -10$ A, See Notes 5 and 6		-4		-4		-4		-4	
h_{fe}	Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = -10$ V, $I_C = -0.5$ A, f = 1 kHz	25	250	25	250	25	250	25	250	
$\|h_{fe}\|$	Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = -10$ V, $I_C = -0.5$ A, f = 1 MHz	4		4		4		4		
f_{hfe}	Small-Signal Common-Emitter Forward Current Transfer Ratio Cutoff Frequency	$V_{CE} = -10$ V, $I_C = -0.5$ A, See Note 7	30		30		30		30		kHz
C_{obo}	Common-Base Open-Circuit Output Capacitance	$V_{CB} = -10$ V, $I_E = 0$, f = 100 kHz		500		500		500		500	pF

NOTES: 5. These parameters must be measured using pulse techniques. $t_p = 300$ μs, duty cycle $\leq 2\%$.

6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

7. f_{hfe} is the frequency at which the magnitude of the small-signal forward current transfer ratio is 0.707 of its low-frequency value. For this device, the reference measurement is made at 1 kHz.

*Indicates JEDEC registered data

thermal characteristics

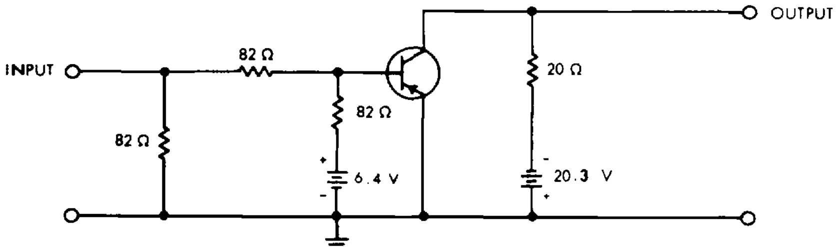
PARAMETER		MAX	UNIT
$\theta_{J\text{-}C}$	Junction-to-Case Thermal Resistance	1.17	deg/W
$\theta_{J\text{-}A}$	Junction-to-Free-Air Thermal Resistance	43.7	

switching characteristics at 25°C case temperature

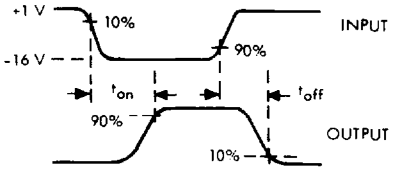
PARAMETER		TEST CONDITIONS†	TYP	UNIT
t_{on}	Turn-On Time	$I_C = -1$ A, $I_{B(1)} = -100$ mA, $I_{B(2)} = 100$ mA,	0.35	µs
t_{off}	Turn-Off Time	$V_{BE(off)} = 3.7$ V, $R_L = 20\ \Omega$, See Figure 1	0.8	

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

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

FIGURE 1

NOTES: a. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\ \Omega$, $t_p = 10\ \mu s$, 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.

TYPICAL CHARACTERISTICS

2N3789, 2N3790
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

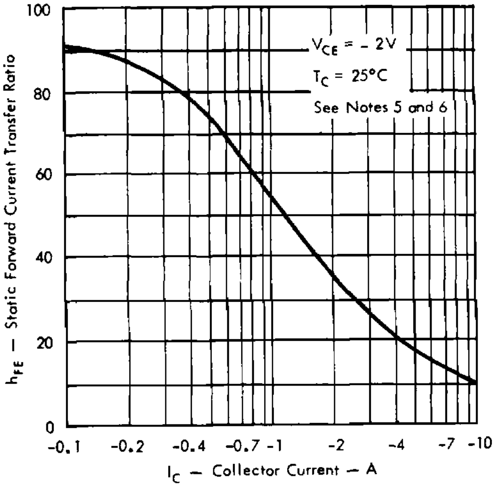


FIGURE 2

2N3791, 2N3792
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

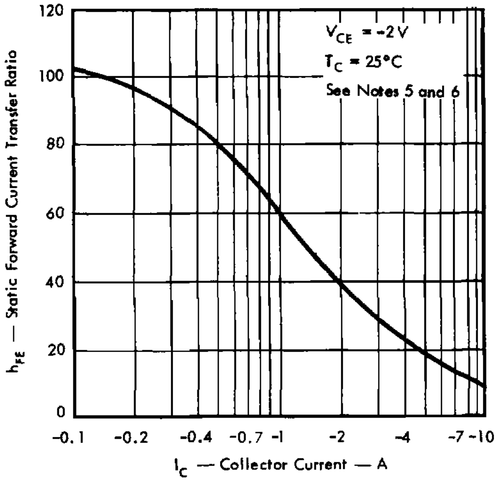


FIGURE 3

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

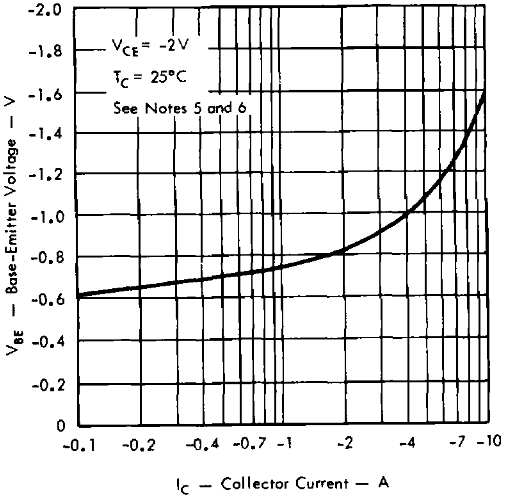


FIGURE 4

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

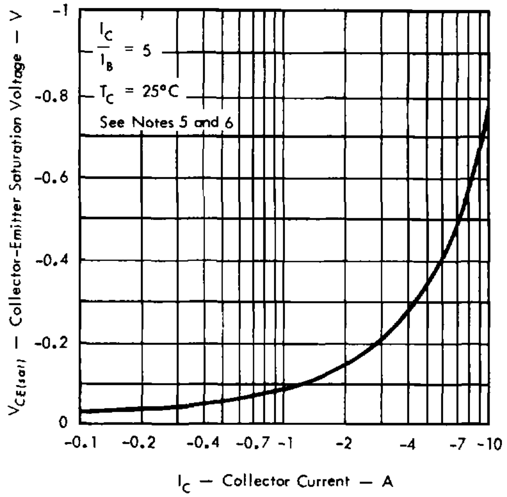


FIGURE 5

NOTES: 5. These parameters must be measured using pulse techniques. t_p = 300 μs, duty cycle $\leq$ 2%.

6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

MAXIMUM SAFE OPERATING REGIONS

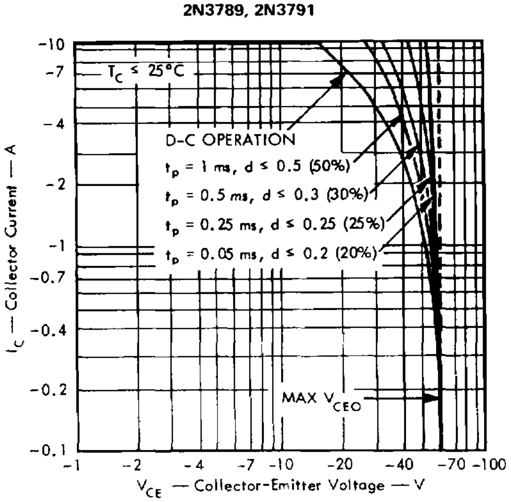


FIGURE 6

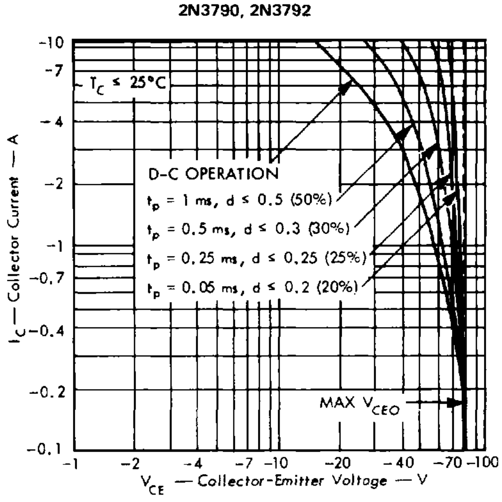


FIGURE 7

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THERMAL INFORMATION

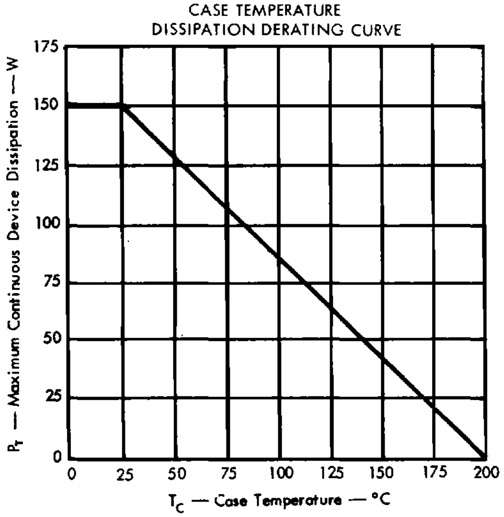

FIGURE 8

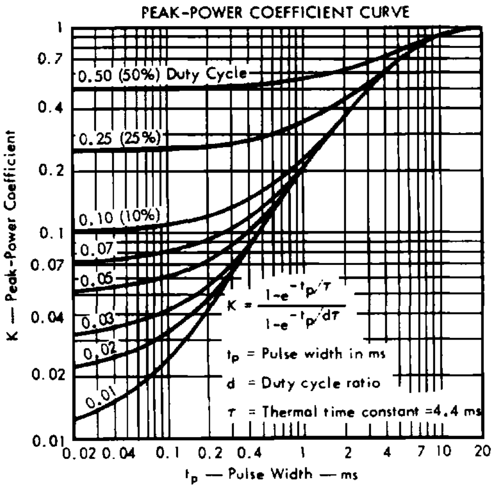

FIGURE 9

SYMBOL DEFINITION

SYMBOL	DEFINITION	VALUE	UNIT
$P_{T(av)}$	Average Power Dissipation		W
$P_{T(max)}$	Peak Power Dissipation		W
$\theta_{J\text{-}A}$	Junction-to-Free-Air Thermal Resistance	43.7	deg/W
$\theta_{J\text{-}C}$	Junction-to-Case Thermal Resistance	1.17	deg/W
$\theta_{C\text{-}A}$	Case-to-Free-Air Thermal Resistance	42.5	deg/W
$\theta_{C\text{-}HS}$	Case-to-Heat-Sink Thermal Resistance		deg/W
$\theta_{HS\text{-}A}$	Heat-Sink-to-Free-Air Thermal Resistance		deg/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 9	
t_p	Pulse Width		ms
t_x	Pulse Period		ms
d	Duty Cycle Ratio (t_p/t_x)		

Equation No. 1 — Application: d-c power dissipation, heat sink used.

$$P_{T(av)} = \frac{T_{J(av)} - T_A}{\theta_{J\text{-}C} + \theta_{C\text{-}HS} + \theta_{HS\text{-}A}} \quad \text{for } 25\,°\text{C} \leq T_C \leq 200°\text{C, as in Figure 8.}$$

Equation No. 2 — Application: d-c power dissipation, no heat sink used.

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

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

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(\theta_{C\text{-}HS} + \theta_{HS\text{-}A}) + K\,\theta_{J\text{-}C}} \quad \text{for } 25\,°\text{C} \leq T_C \leq 200°\text{C}$$

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

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,\theta_{C\text{-}A} + K\theta_{J\text{-}C}} \quad \text{for } 25°\text{C} \leq T_A \leq 200°\text{C}$$

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

OPERATING CONDITIONS:

$\theta_{C\text{-}HS} + \theta_{HS\text{-}A} = 2.25$ deg/W (From information supplied with heat sink.)

$T_{J(av)}$ (design limit) $= 200°$C

$T_A = 50°$C

$d = 10\%$ (0.1)

$t_p = 0.1$ ms

Solution:

From Figure 9, Peak-Power Coefficient
K = 0.11 and by use of equation No. 3

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d\,(\theta_{C\text{-}HS} + \theta_{HS\text{-}A}) + K\,\theta_{J\text{-}C}}$$

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

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