

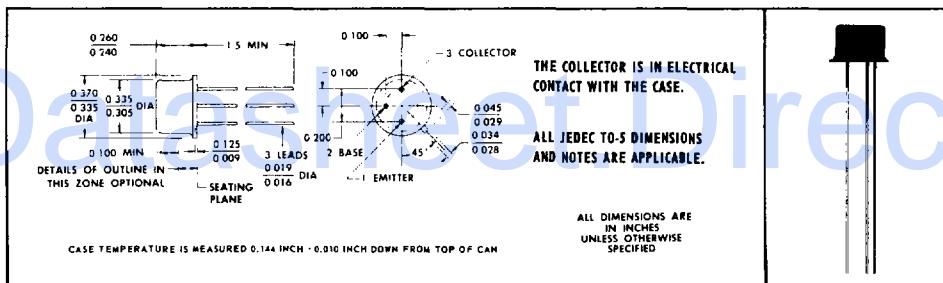
TYPE 2N4300

N-P-N EPITAXIAL PLANAR SILICON POWER TRANSISTOR

FOR POWER-AMPLIFIER AND HIGH-SPEED-SWITCHING APPLICATIONS

- **15 W at 100°C Case Temperature**
- **Max $V_{CE(sat)}$ of 0.3 V at 1 A I_C**
- **Typ t_{on} of 130 ns at 1 A I_C**
- **Min f_T of 30 MHz**

***mechanical data**



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

Collector-Base Voltage	100 V
Collector-Emitter Voltage (See Note 1)	80 V
Emitter-Base Voltage	8 V
Continuous Collector Current	2 A
Peak Collector Current (See Note 2)	4 A
Continuous Base Current	1 A
Continuous Emitter Current	3 A
Safe Operating Region at (or below) 100°C Case Temperature	See Figure 7
Continuous Device Dissipation at (or below) 100°C Case Temperature (See Note 3).	15 W
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 4)	1 W
Operating Collector Junction Temperature Range	-65°C to 200°C
Storage Temperature Range	-65°C to 200°C
Lead Temperature $\frac{1}{16}$ Inch from Case for 10 Seconds	230°C

NOTES: 1. This value applies when the base-emitter diode is open-circuited.

2. This value applies for $t_p \leq 0.3$ ms, duty cycle $\leq 10\%$.

3. Derate linearly to 200°C case temperature at the rate of 0.15 W/deg.

4. Derate linearly to 200°C free-air temperature at the rate of 5.72 mW/deg.

*Indicates JEDEC registered data.

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

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
$V_{(BR)CEO}$ Collector-Emitter Breakdown Voltage	$I_C = 30 \text{ mA}, I_B = 0$, See Note 5	80		V
I_{CEO} Collector Cutoff Current	$V_{CE} = 40 \text{ V}, I_B = 0$		1	μA
I_{CES} Collector Cutoff Current	$V_{CE} = 90 \text{ V}, V_{BE} = 0$		10	μA
	$V_{CE} = 90 \text{ V}, V_{BE} = 0, T_C = 150^\circ\text{C}$		75	
I_{EBO} Emitter Cutoff Current	$V_{EB} = 5 \text{ V}, I_C = 0$		0.5	μA
	$V_{EB} = 8 \text{ V}, I_C = 0$		10	
h_{FE} Static Forward Current Transfer Ratio	$V_{CE} = 2 \text{ V}, I_C = 1 \text{ A}$, See Notes 5 and 6	30	120	
	$V_{CE} = 2 \text{ V}, I_C = 2 \text{ A}$, See Notes 5 and 6		15	
V_{BE} Base-Emitter Voltage	$V_{CE} = 2 \text{ V}, I_C = 2 \text{ A}$, See Notes 5 and 6		1.2	V
$V_{CE(sat)}$ Collector-Emitter Saturation Voltage	$I_B = 100 \text{ mA}, I_C = 1 \text{ A}$, See Notes 5 and 6		0.3	V
	$I_B = 200 \text{ mA}, I_C = 2 \text{ A}$, See Notes 5 and 6		0.5	
h_{fe} Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = 5 \text{ V}, I_C = 1 \text{ A}, f = 1 \text{ kHz}$	30		
$ h_{fe} $ Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = 10 \text{ V}, I_C = 1 \text{ A}, f = 15 \text{ MHz}$	2		

NOTES: 5. These parameters must be measured using pulse techniques. $t_p = 300 \mu\text{s}$, duty cycle $\leq 2\%$.

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

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*thermal characteristics

PARAMETER	MAX	UNIT
θ_{J-C} Junction-to-Case Thermal Resistance	6.66	deg/W
θ_{J-A} Junction-to-Free-Air Thermal Resistance	175	

*Indicates JEDEC registered data.

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switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS†			TYP	UNIT
t_{on} Turn-On Time	$I_C = 1 \text{ A},$	$I_{B(1)} = 100 \text{ mA},$	$I_{B(2)} = -100 \text{ mA},$	0.13	
t_{off} Turn-Off Time	$V_{BE(off)} = -3.7 \text{ V},$	$R_L = 20 \Omega,$	See Figure 1	1.5	μs

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

PARAMETER MEASUREMENT INFORMATION

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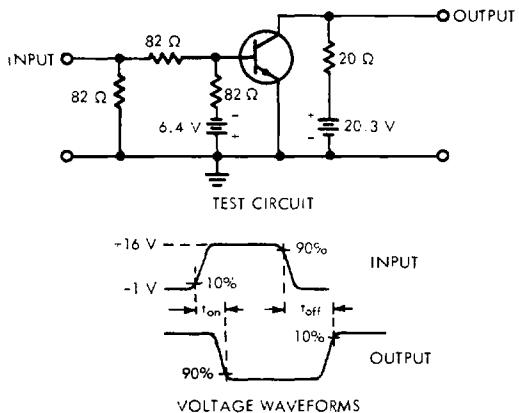


FIGURE 1

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

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TYPICAL CHARACTERISTICS

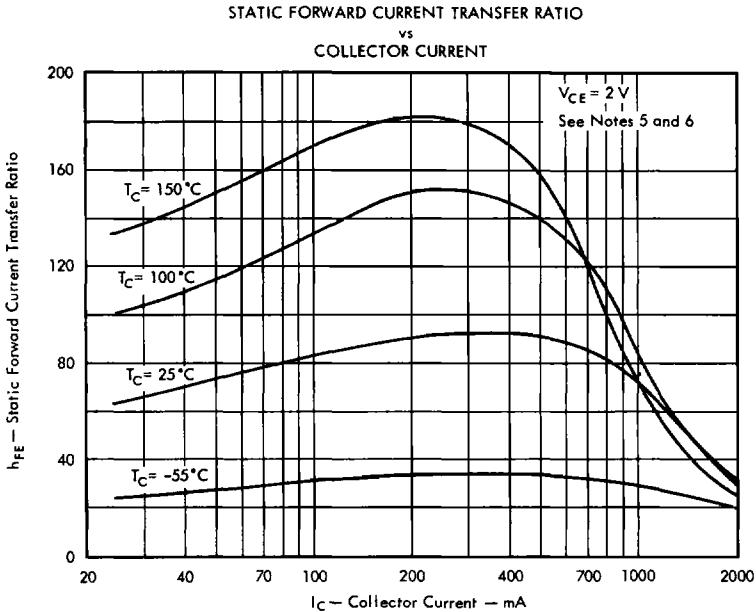


FIGURE 2

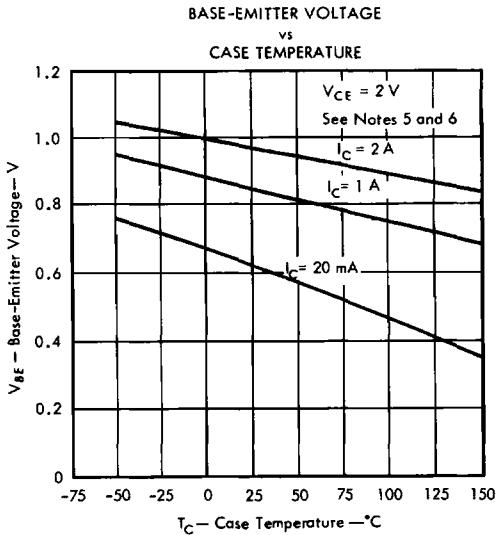


FIGURE 3

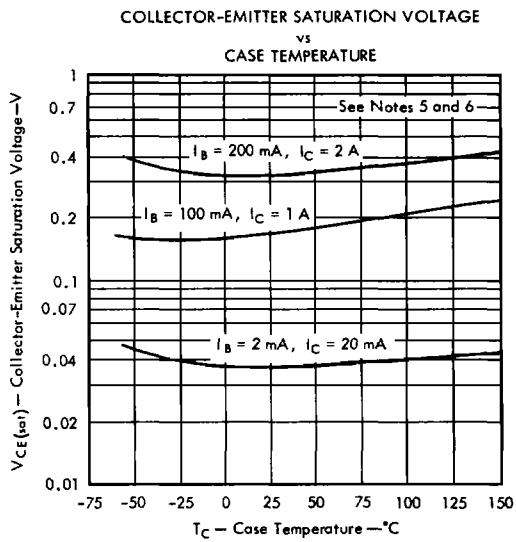


FIGURE 4

NOTES: 5. These parameters must be measured using pulse techniques. $t_p = 300\ \mu\text{s}$, duty cycle $\leq 2\%$.

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

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TYPICAL CHARACTERISTICS

NORMALIZED COLLECTOR - Emitter Breakdown Voltage
vs
Base - Emitter Resistance

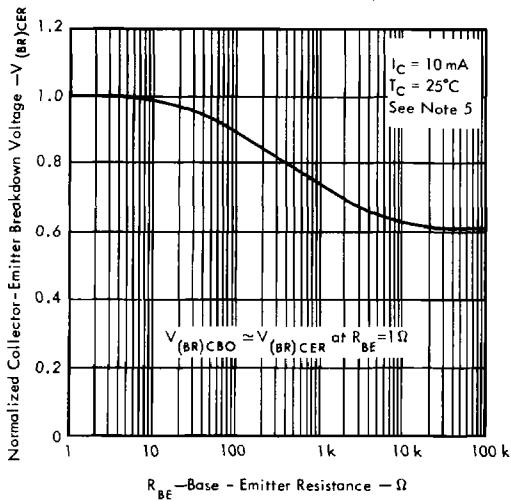


FIGURE 5

COMMON-BASE OPEN-CIRCUIT INPUT
AND OUTPUT CAPACITANCE
vs
REVERSE BIAS VOLTAGE

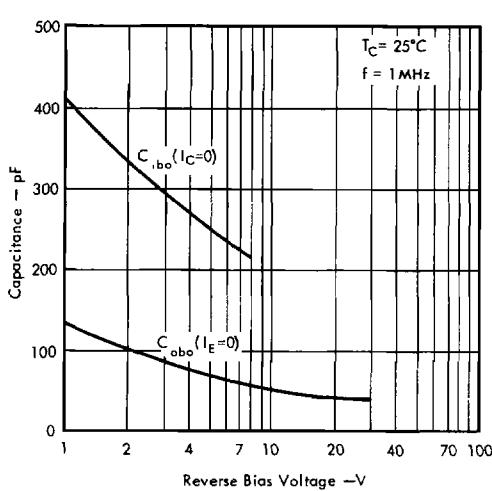


FIGURE 6

NOTE 5: These parameters must be measured using pulse techniques. $t_p = 300 \mu\text{s}$, duty cycle $\leq 2\%$.

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MAXIMUM SAFE OPERATING REGION

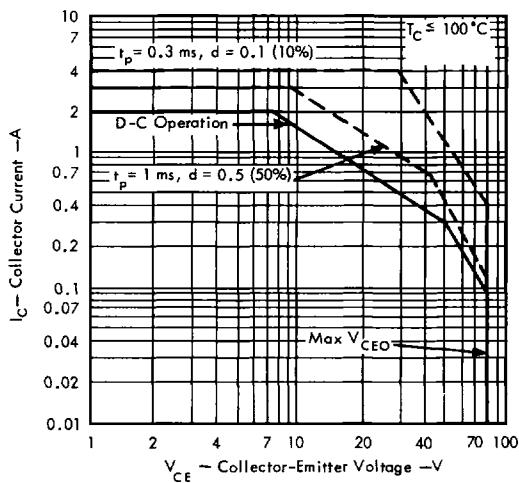


FIGURE 7

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THERMAL INFORMATION

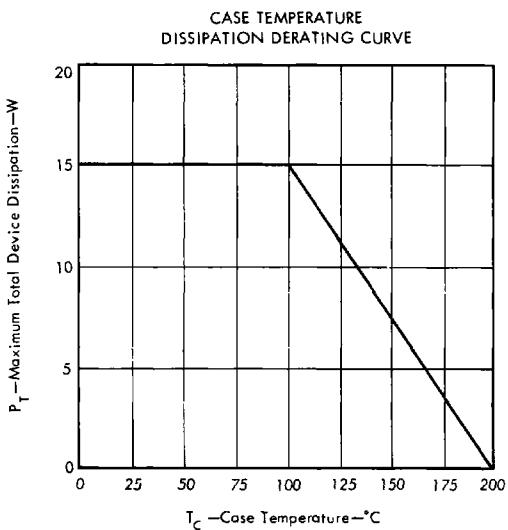


FIGURE 8

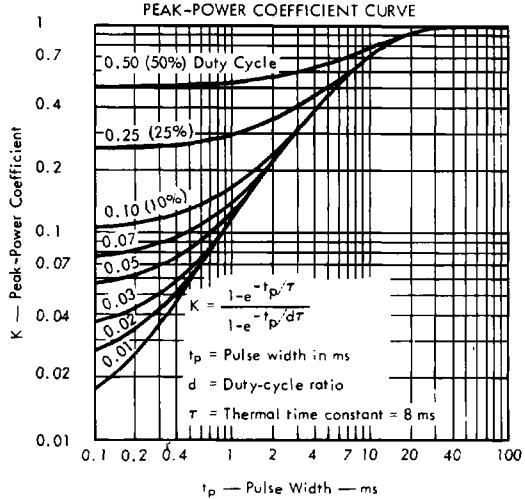


FIGURE 9

SYMBOL DEFINITION

SYMBOL	DEFINITION	VALUE	UNIT
P _{T(avg)}	Average Power Dissipation		W
P _{T(max)}	Peak Power Dissipation		W
θ _{J-A}	Junction-to-Free-Air Thermal Resistance	175	deg/W
θ _{J-C}	Junction-to-Case Thermal Resistance	6.66	deg/W
θ _{C-A}	Case-to-Free-Air Thermal Resistance	168	deg/W
θ _{C-HS}	Case-to-Heat-Sink Thermal Resistance		deg/W
θ _{HS-A}	Heat-Sink-to-Free-Air Thermal Resistance		deg/W
T _A	Free-Air Temperature		°C
T _C	Case Temperature		°C
T _{J(avg)}	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)		

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

OPERATING CONDITIONS:

θ_{C-HS} + θ_{HS-A} = 7 deg/W (From information supplied with heat sink.)

$$T_J(avg) \text{ (design limit)} = 200^\circ\text{C}$$

$$T_A = 50^\circ\text{C}$$

$$d = 10\% (0.1)$$

$$t_p = 0.1 \text{ ms}$$

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

$$P_{T(avg)} = \frac{T_J(avg) - T_A}{\theta_{C-HS} + \theta_{HS-A}} \quad \text{for } 100^\circ\text{C} \leq T_C \leq 200^\circ\text{C}$$

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

$$P_{T(avg)} = \frac{T_J(avg) - T_A}{\theta_{J-A}} \quad \text{for } 25^\circ\text{C} \leq T_A \leq 200^\circ\text{C}$$

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

$$P_{T(max)} = \frac{T_{J(max)} - T_A}{d(\theta_{C-HS} + \theta_{HS-A}) + K \theta_{J-C}} \quad \text{for } 100^\circ\text{C} \leq T_C \leq 200^\circ\text{C}$$

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

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

Solution:

From Figure 9, Peak-Power Coefficient

$$K = 0.105 \text{ and by use of equation No. 3}$$

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

$$P_{T(max)} = \frac{200 - 50}{0.1(7) + 0.105(6.66)} = 107 \text{ W}$$