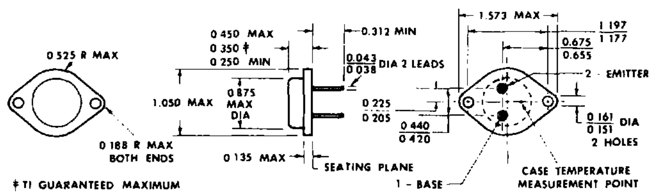
TYPES 2N1907, 2N1908
P-N-P ALLOY-DIFFUSED GERMANIUM POWER TRANSISTORS

HIGH-FREQUENCY POWER TRANSISTORS
for
MILITARY AND INDUSTRIAL APPLICATIONS

mechanical data

These transistors are in precision welded, hermetically sealed enclosures. The mounting base provides an excellent heat path from the collector junction to a heat sink. The mounting base and heat sink must be in intimate contact for maximum heat transfer. Extreme cleanliness during the assembly process prevents sealed-in contamination. The approximate weight of the unit is 18 grams.

*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)

	2N1907	2N1908
Collector-Base Voltage	100 v*	130 v*
Collector-Emitter Voltage (See Note 1)	40 v	50 v
Emitter-Base Voltage	← {1.5 v*; 2.0 v†} →	
Collector Current	← 20 a* →	
Base Current	← 3 a* →	
Safe Continuous Operating Region	See Figures 15 and 16	
Total Device Dissipation at (or below) 70°C Case Temperature (See Note 2)	← 60 w →	
Peak Collector Power Dissipation at (or below) 25°C Case Temperature (See Note 3)	800 w	1000 w
Operating Collector Junction Temperature	← 100°C* →	
Storage Temperature Range	{−55°C to +100°C*; −55°C to +110°C†}	

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

2. Derate linearly to 100°C case temperature at the rate of 2 w/C°. This corresponds to the JEDEC registered maximum value of thermal resistance, θ_{J-C}, 0.5 C°/w.

3. These values apply for rectangular waveshape. See Figure 14 for allowable pulse width and duty cycle combinations. Derate linearly to 100°C case temperature.

*Indicates JEDEC registered data.

†Texas Instruments guarantees this value in addition to the JEDEC registered value which is also shown.

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

PARAMETER		TEST CONDITIONS	2N1907 MIN	2N1907 MAX	2N1908 MIN	2N1908 MAX	UNIT
BV_{CBO}	Collector-Base Breakdown Voltage	$I_C = -10$ ma, $I_E = 0$	−100		−130		v
BV_{CEO}	Collector-Emitter Breakdown Voltage	$I_C = -200$ ma, $I_B = 0$, See Note 4	−40*		−50*		v
BV_{EBO}	Emitter-Base Breakdown Voltage	$I_E = -2$ ma, $I_C = 0$	−1.5		−1.5		v
		$I_E = -10$ ma, $I_C = 0$	−2.0		−2.0		v
I_{CBO}	Collector Cutoff Current	$V_{CB} = -3$ v, $I_E = 0$		−0.5* −0.3†			ma
		$V_{CB} = -75$ v, $I_E = 0$		−2.0			ma
		$V_{CB} = -100$ v, $I_E = 0$		−10*			ma
		$V_{CB} = -75$ v, $I_E = 0$, $T_C = +70°C$		−12			ma
		$V_{CB} = -3$ v, $I_E = 0$				−0.5* −0.3†	ma
		$V_{CB} = -100$ v, $I_E = 0$				−2.0	ma
		$V_{CB} = -130$ v, $I_E = 0$				−10*	ma
		$V_{CB} = -100$ v, $I_E = 0$, $T_C = +70°C$				−12	ma
I_{CEX}	Collector Cutoff Current	$V_{CE} = -75$v, $V_{BE} = +0.2$ v		−2.0			ma
		$V_{CE} = -100$ v, $V_{BE} = +0.2$ v				−2.0	ma
I_{EBO}	Emitter Cutoff Current	$V_{EB} = -0.5$ v, $I_C = 0$		−0.2* −0.1†		−0.2* −0.1†	ma
		$V_{EB} = -1.5$ v, $I_C = 0$		−2.0*		−2.0*	ma
h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -1.5$ v, $I_C = -1$ a, See Note 4	80		80		
		$V_{CE} = -1.5$ v, $I_C = -5$ a, See Note 4	90		90		
		$V_{CE} = -1.5$ v, $I_C = -10$ a, See Note 4	30	170	30	170	
		$V_{CE} = -1.5$ v, $I_C = -15$ a, See Note 4	20		20		
		$V_{CE} = -1.5$ v, $I_C = -10$ a, $T_C = -55°C$, See Note 4	30 (See Fig. 4)		30 (See Fig. 4)		
		$V_{CE} = -1.5$ v, $I_C = -10$ a, $T_C = +70°C$, See Note 4	15 (See Fig. 4)	100	15 (See Fig. 4)	100	
V_{BE}	Base-Emitter Voltage	$I_B = -100$ ma, $I_C = -1$ a, See Note 4		−0.4		−0.4	v
		$I_B = -500$ ma, $I_C = -5$ a, See Note 4		−0.7		−0.7	v
		$I_B = -1$ a, $I_C = -10$ a, See Note 4		−1.0		−1.0	v
		$I_B = -1.5$ a, $I_C = -15$ a, See Note 4		−1.5		−1.5	v
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -100$ ma, $I_C = -1$ a, See Note 4		−0.2		−0.2	v
		$I_B = -500$ ma, $I_C = -5$ a, See Note 4		−0.4		−0.4	v
		$I_B = -1$ a, $I_C = -10$ a, See Note 4		−0.7		−0.7	v
		$I_B = -1.5$ a, $I_C = -15$ a, See Note 4		−1.0*		−1.0*	v
$\|h_{fe}\|$	Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = -15$ v, $I_C = -0.5$ a, f = 10 mc	1.0* 2.0†		1.0* 2.0†		

NOTE 4: If these parameters are measured without a heat sink, d-c collector current must not be applied longer than 250 msec.

*Indicates JEDEC registered data.

†Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

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switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS †	TYPICAL	UNIT
t_d Delay Time	$I_C = -10a$, $I_{B(1)} = -1.33a$, $I_{B(2)} = 1.33a$, $V_{BE(off)} = 2$ v, $R_L = 2\,\Omega$, See Figure 1	0.1	μsec
t_r Rise Time		0.8	μsec
t_s Storage Time		2.5	μsec
t_f Fall Time		1.0	μsec
t_T Total Switching Time		4.4	μsec

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

PARAMETER MEASUREMENT INFORMATION

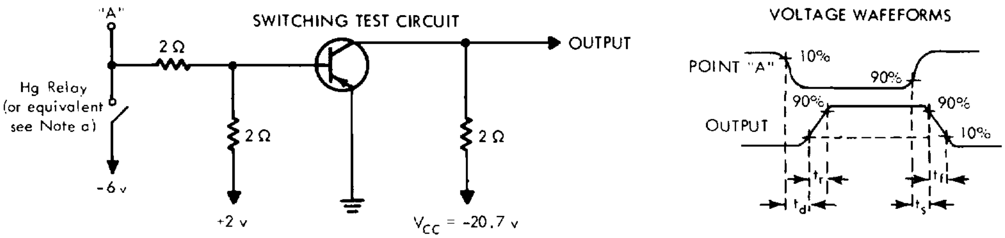

FIGURE 1

NOTES: a. The pulse at point "A" has the following characteristics: $t_r \leq 20$ nsec, $t_f \leq 20$ nsec, PW ≥ 50 μsec, duty cycle $\leq 5\%$.
b. The waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ nsec, $R_{in} \geq 1$ MΩ, $C_{in} \leq 20$ pf.

TYPICAL CHARACTERISTICS

COMMON-EMITTER COLLECTOR CHARACTERISTICS
(Low-Voltage Region)

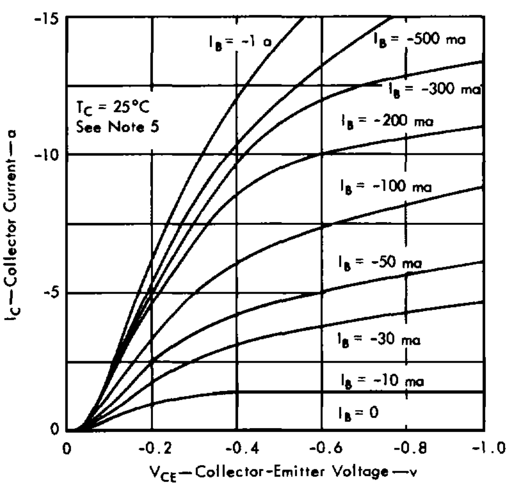

FIGURE 2

COMMON-EMITTER COLLECTOR CHARACTERISTICS
(High-Voltage Region)

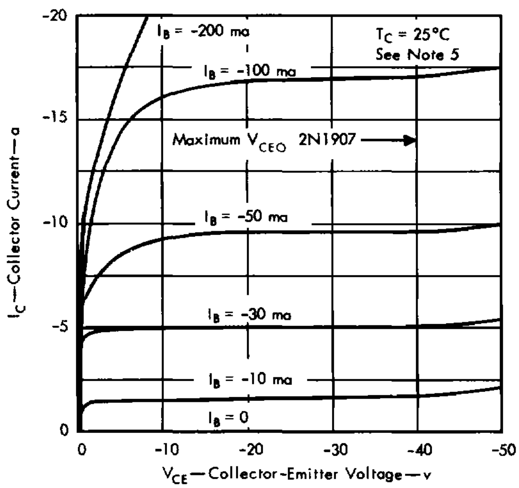

FIGURE 3

NOTE 5: These characteristics were measured using pulse techniques. PW = 300 μsec, Duty Cycle $\leq 2\%$.

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TYPES 2N1907, 2N1908
P-N-P ALLOY-DIFFUSED GERMANIUM POWER TRANSISTORS

TYPICAL CHARACTERISTICS

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

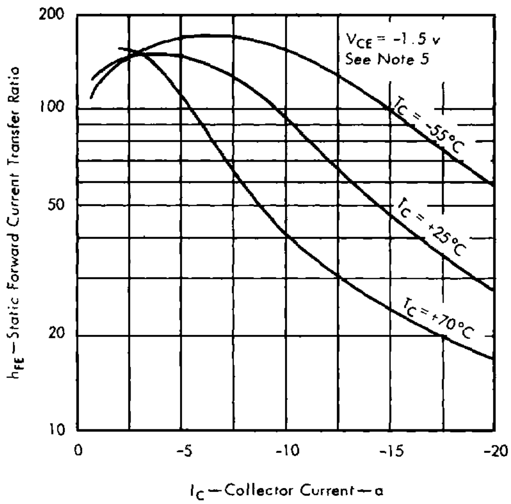

FIGURE 4

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

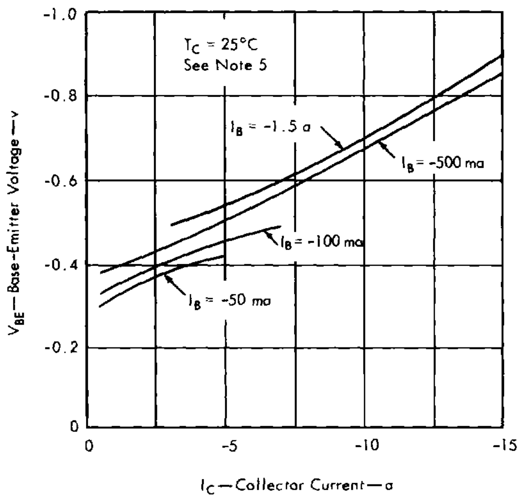

FIGURE 5

BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE

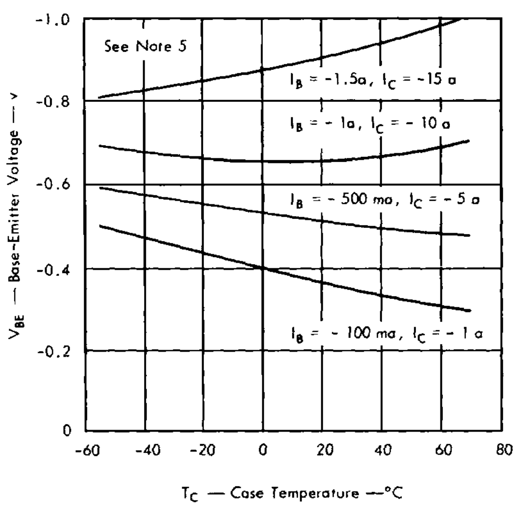

FIGURE 6

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE

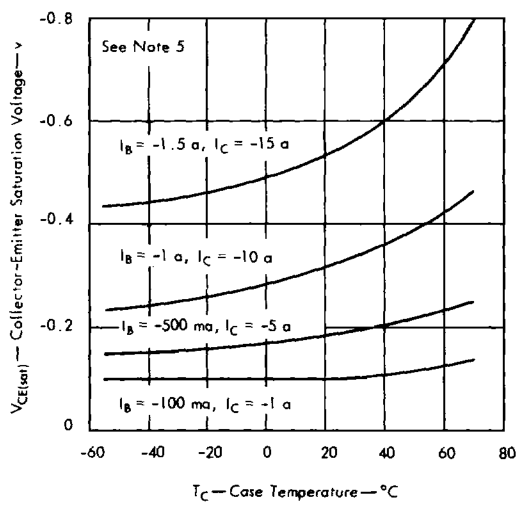

FIGURE 7

NOTE 5: These characteristics were measured using pulse techniques. PW = 300 μsec., Duty Cycle ≤ 2%.

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TYPICAL CHARACTERISTICS

2N1907
NORMALIZED COLLECTOR-EMITTER BREAKDOWN VOLTAGE
vs
BASE-EMITTER RESISTANCE

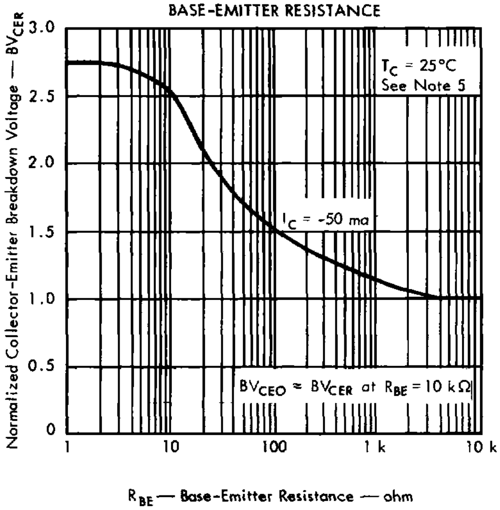

FIGURE 8

2N1908
NORMALIZED COLLECTOR-EMITTER BREAKDOWN VOLTAGE
vs
BASE-EMITTER RESISTANCE

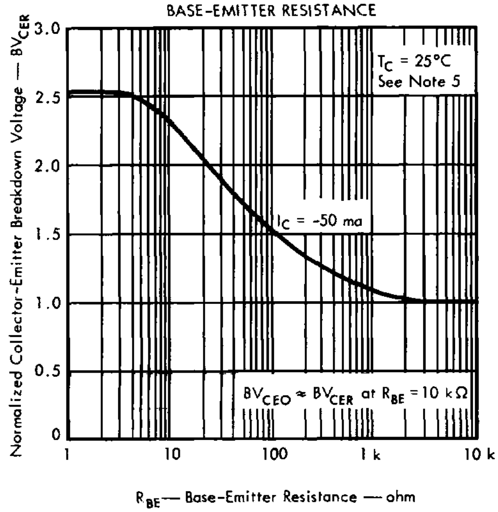

FIGURE 9

2N1907
COLLECTOR CUTOFF CURRENT
vs
COLLECTOR-BASE VOLTAGE

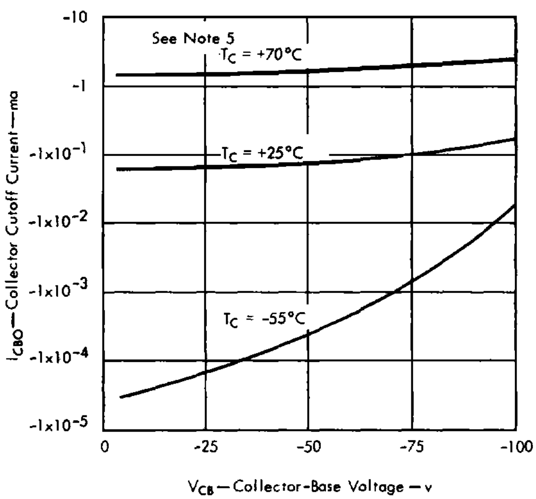

FIGURE 10

2N1908
COLLECTOR CUTOFF CURRENT
vs
COLLECTOR-BASE VOLTAGE

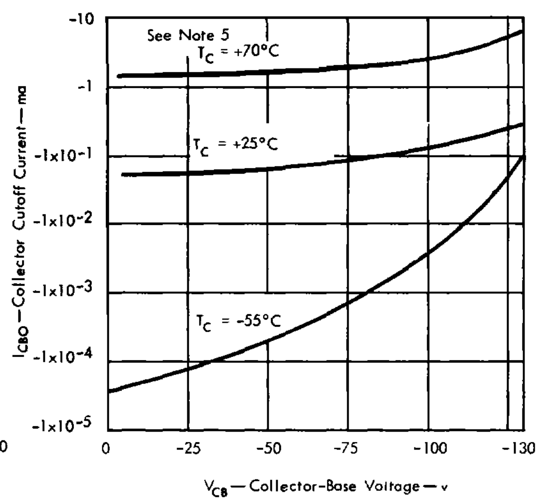

FIGURE 11

NOTE 5: These characteristics were measured using pulse techniques. PW = 300 μsec., Duty Cycle ≤ 2%.

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THERMAL CHARACTERISTICS

CASE TEMPERATURE
DISSIPATION DERATING CURVE

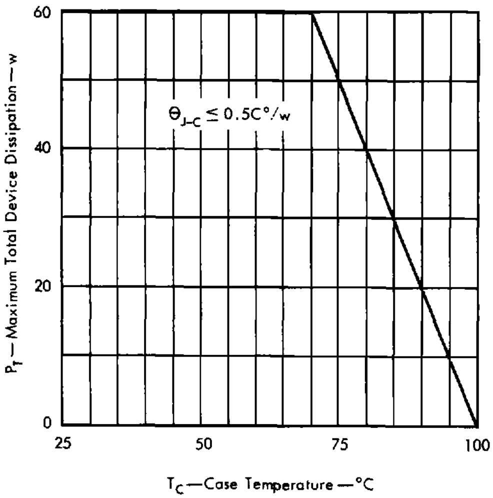

FIGURE 12

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE

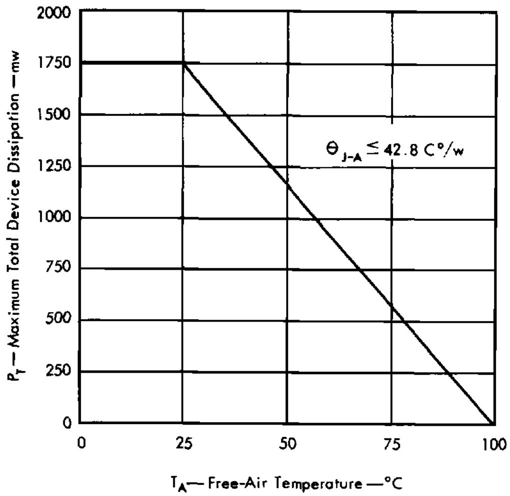

FIGURE 13

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PEAK-POWER- COEFFICIENT CURVE

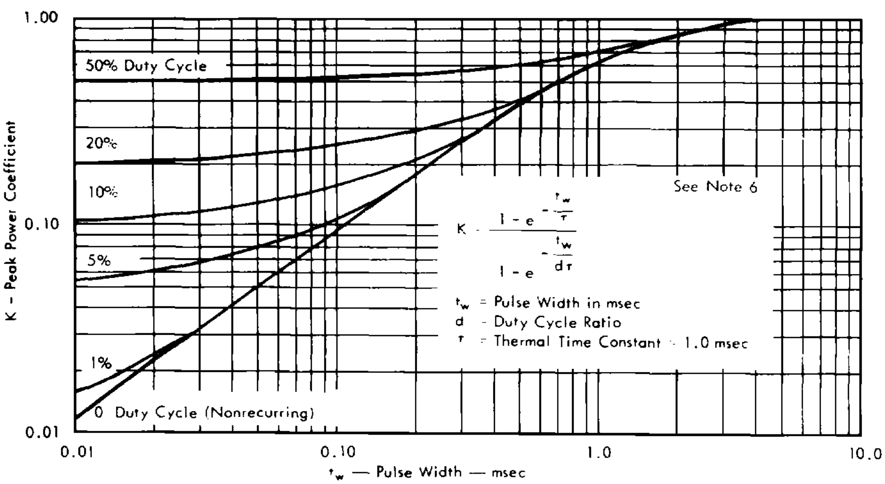

FIGURE 14

NOTE 6: When $t_w > 3.0$ msec or $d > 0.5$ (50%), operation must be confined to the continuous operating regions of Figure 15 or 16.

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MAXIMUM SAFE OPERATING REGIONS

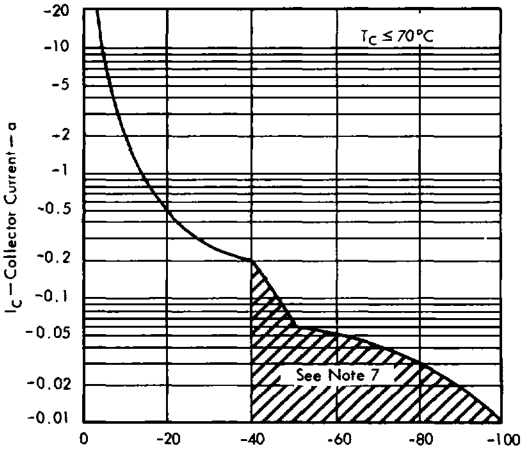

FIGURE 15

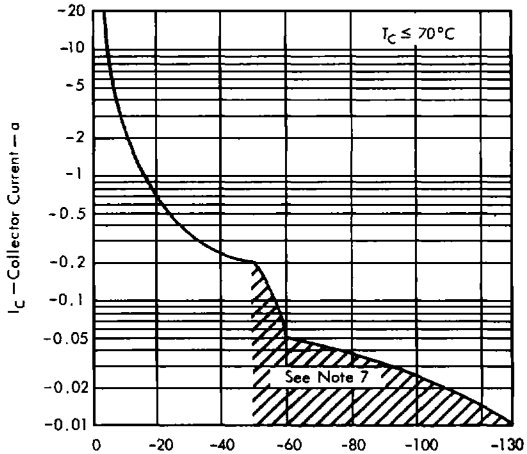

FIGURE 16

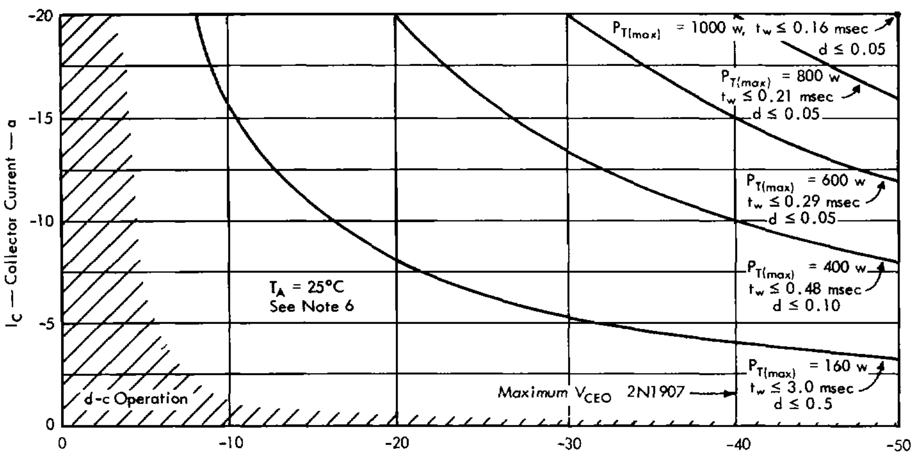

FIGURE 17

NOTES: 6. When $t_w \geq 3.0$ msec or $d \geq 0.5$ (50%), operation must be confined to the continuous operating regions of Figure 15 or 16.

7. Operation in this region is permissible when base-emitter resistance $R_{BE} \leq 5\ \Omega$.

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THERMAL INFORMATION

TABLE I

HEAT SINK		†θ_{HS-A}
Type	Dimensions	
Bright Copper	4" x 4" x 1/8"	3.8 C°/w
	6" x 6" x 1/8"	2.2 C°/w
	8" x 8" x 1/8"	1.8 C°/w
	10" x 10" x 1/8"	1.4 C°/w
Bright Aluminum	4" x 4" x 1/8"	6.5 C°/w
	6" x 6" x 1/8"	4.5 C°/w
	8" x 8" x 1/8"	3.5 C°/w
	10" x 10" x 1/8"	2.8 C°/w
Delbert Blinn #113 or Modine 1E1155B, Unfinished (or Equivalents)		3.7 C°/w
Delbert Blinn #113 or Modine 1E1155B, Black Anodized (or Equivalents)		3.2 C°/w

†θ_{HS-A} are typical values based on convection cooling; plates and fins mounted in vertical position.

‡All transistors mounted in the center of the heat sink with two 6-32 screws at 6 inch-pounds of torque.

TABLE II

SYMBOL	DEFINITION	UNIT	VALUE
$P_{T(avg)}$	Average Power Dissipation	w	
$P_{T(max)}$	Peak Power Dissipation	w	
θ_{J-C}	Junction-to-Case Thermal Resistance	C°/w	0.5
θ_{J-A}	Junction-to-Free-Air Thermal Resistance	C°/w	42.8
θ_{C-A}	Case-to-Free-Air Thermal Resistance	C°/w	42.3
‡θ_{C-HS}	Case-to-Heat-Sink Thermal Resistance Typical With Dry Mounting Base	C°/w	0.65
	Typical with DC-11 Silicone Grease		0.45
θ_{HS-A}	Heat-Sink-to-Free-Air Thermal Resistance	C°/w	see Table 1
T_A	Free-Air Temperature	C°	
$T_{J(avg)}$	Average Junction Temperature	C°	≤100
$T_{J(max)}$	Peak Junction Temperature	C°	≤100
T_C	Case Temperature	C°	
K	Peak-Power Coefficient		see Fig. 14
t_w	Pulse Width	msec	
t_p	Pulse Period	msec	
d	Duty Cycle Ratio (t_w/t_p)		

For d-c operation, these transistors are voltage limited as well as thermally limited. Figure 12 and Figure 15 or 16 *are recommended as a guide for selecting safe voltage and current combinations.*

These transistors have a very low thermal resistance that may be fully utilized in a pulse-power application provided the pulse width is equal to (or less than) 3 milliseconds. If the power pulse is longer than 3 milliseconds, then the operating path is limited to the safe operating region described by Figure 12 *and Figure 15 or 16.*

The PEAK-POWER-COEFFICIENT CURVE shows the ratio of maximum instantaneous junction-to-case temperature rise for any pulse width and duty cycle to the *rise which occurs at 100% duty cycle. Use of this curve is best explained by the equations and example below.* See Table II for a definition of terms.

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

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

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

$$P_{T(avg)} = \frac{T_{J(avg)} - T_A}{\theta_{J-A}}$$

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

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

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

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

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

OPERATING CONDITIONS:

Heat Sink = 8" x 8" x 1/8" copper,
θ_{HS-A} = 1.8 C°/w
with DC-11 grease, θ_{C-HS} = 0.45 C°/w
$T_{J(max)}$ (design limit) = 100°C
T_A = 35°C
d = 20% (0.2)
t_w = 0.1 msec

SOLUTION:

From Figure 14 Peak-Power Coefficient,
K = 0.24, and by use of equation No. 3

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

$$P_{T(max)} = \frac{100 - 35}{0.2(0.45 + 1.8) + 0.24(0.5)} = 114 \text{ w}$$