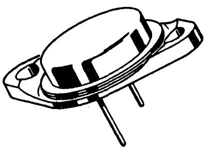
2N4904 (SILICON)
2N4905
2N4906

PNP power transistors for use in power amplifier and switching circuits. Complement to NPN 2N4913 thru 2N4915.



CASE 11
(TO-3)

MAXIMUM RATINGS

Rating	Symbol	2N4904	2N4905	2N4906	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	Vdc
Collector-Base Voltage	V_{CB}	40	60	80	Vdc
Emitter-Base Voltage	V_{EB}	← 5.0 →			Vdc
Collector Current – Continuous	I_C	← 5.0 →			Adc
Base Current	I_B	← 1.0 →			Adc
Total Device Dissipation $T_C = 25°C$ Derate above 25°C	P_D	← 87.5 → ← 0.5 →			Watts W/°C
Operating & Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	2.0	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage [1] ($I_C = 0.2$ Adc, $I_B = 0$) 2N4904 2N4905 2N4906	11	$V_{CEO(sus)}$	40 60 80	- - -	Vdc
Collector Cutoff Current (V_{CE} = Rated V_{CEO}, $I_B = 0$)		I_{CEO}	-	1.0	mAdc
Collector Cutoff Current (V_{CE} = Rated V_{CEO}, $V_{BE(off)} = 1.5$ Vdc) (V_{CE} = Rated V_{CEO}, $V_{BE(off)} = 1.5$ Vdc, $T_C = 150°C$)	5, 6	I_{CEX}	- -	0.1 2.0	mAdc
Collector Cutoff Current (V_{CB} = Rated V_{CB}, $I_E = 0$)		I_{CBO}	-	0.1	mAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	-	1.0	mAdc
ON CHARACTERISTICS [1]					
DC Current Gain ($I_C = 2.5$ Adc, $V_{CE} = 2.0$ Vdc) ($I_C = 5.0$ Adc, $V_{CE} = 2.0$ Vdc)	1	h_{FE}	25 7.0	100 -	-
Collector-Emitter Saturation Voltage ($I_C = 2.5$ Adc, $I_B = 0.25$ Adc) ($I_C = 5.0$ Adc, $I_B = 1.0$ Adc)	2, 3, 4	$V_{CE(sat)}$	- -	1.0 1.5	Vdc
Base-Emitter On Voltage ($I_C = 2.5$ Adc, $V_{CE} = 2.0$ Vdc)	3, 4	$V_{BE(on)}$	-	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain–Bandwidth Product ($I_C = 1.0$ Adc, $V_{CE} = 10$ Vdc, f = 1.0 MHz)		f_T	4.0	-	MHz
Small-Signal Current Gain ($I_C = 0.5$ Adc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)		h_{fe}	40	-	

[1] Pulse Test: PW = 300 μs, Duty Cycle ≈ 2.0%

FIGURE 1 — NORMALIZED DC CURRENT GAIN

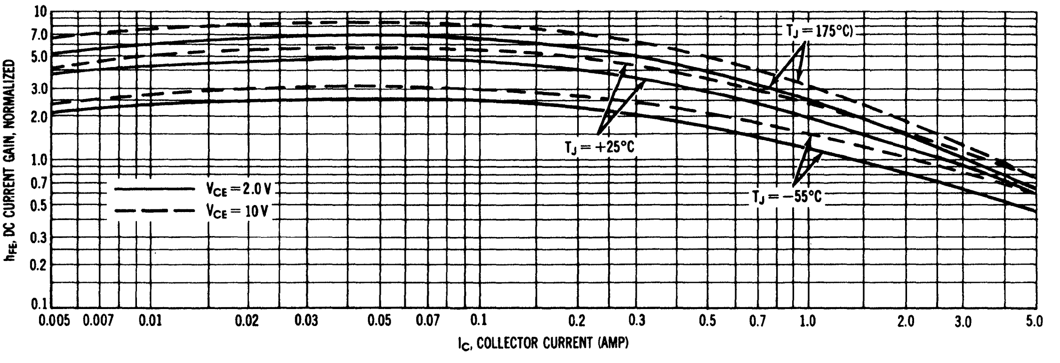


FIGURE 2 — COLLECTOR SATURATION REGION

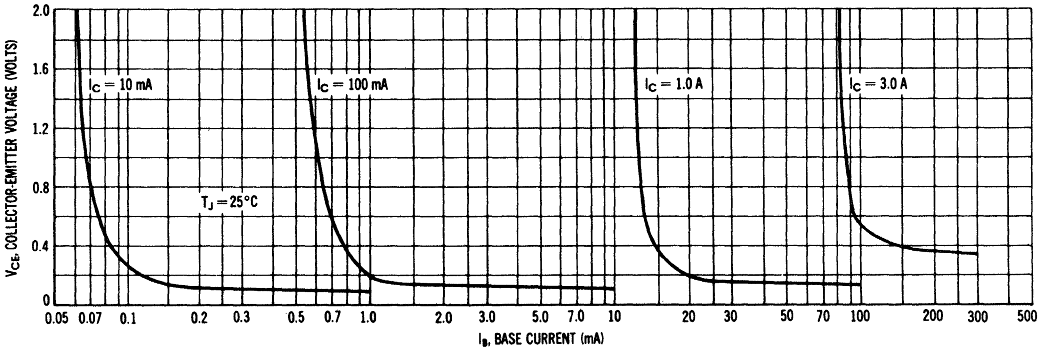


FIGURE 3 — "ON" VOLTAGE

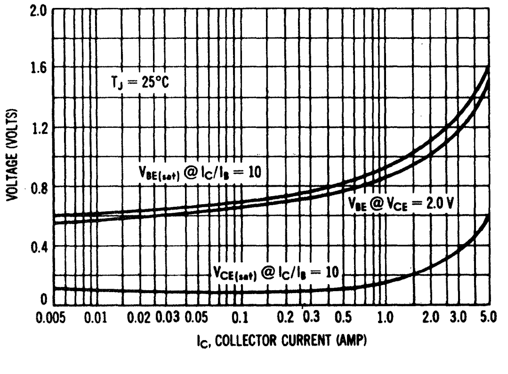
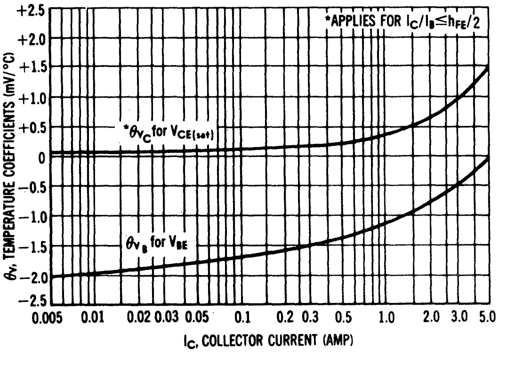


FIGURE 4 — TEMPERATURE COEFFICIENTS



TYPICAL "OFF" REGION CHARACTERISTICS

FIGURE 5 — CUT-OFF REGION

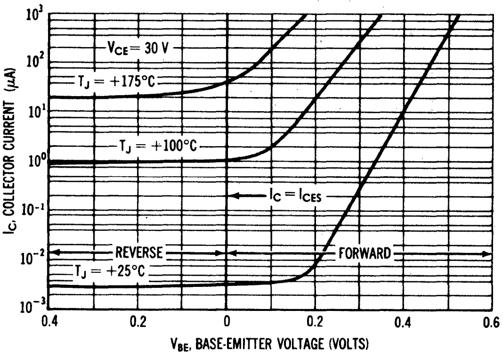


FIGURE 6 — EFFECTS OF BASE-EMITTER RESISTANCE

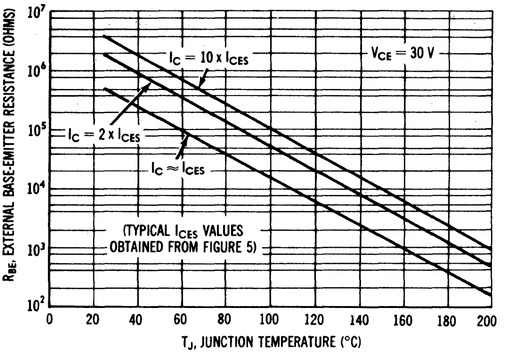


FIGURE 7 — SWITCHING TIME EQUIVALENT CIRCUIT

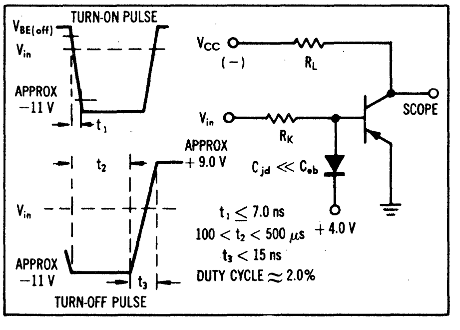


FIGURE 8 — CAPACITANCE

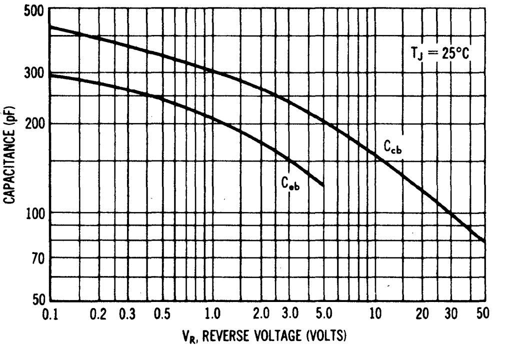


FIGURE 9 — TURN-ON TIME

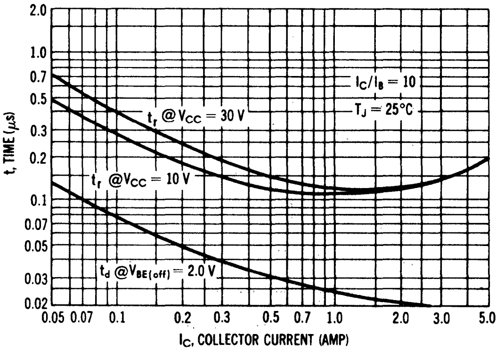
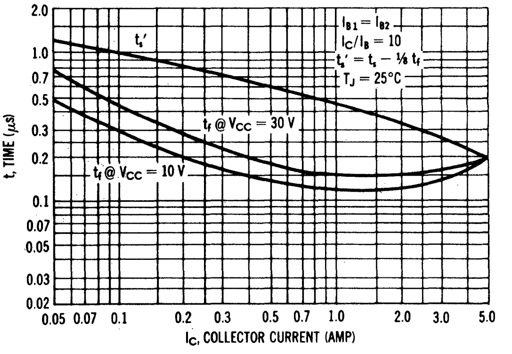
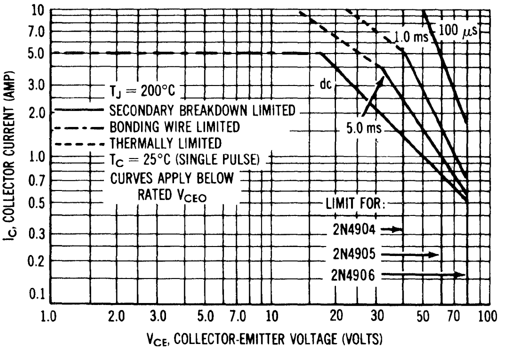


FIGURE 10 — TURN-OFF TIME



RATING AND THERMAL DATA

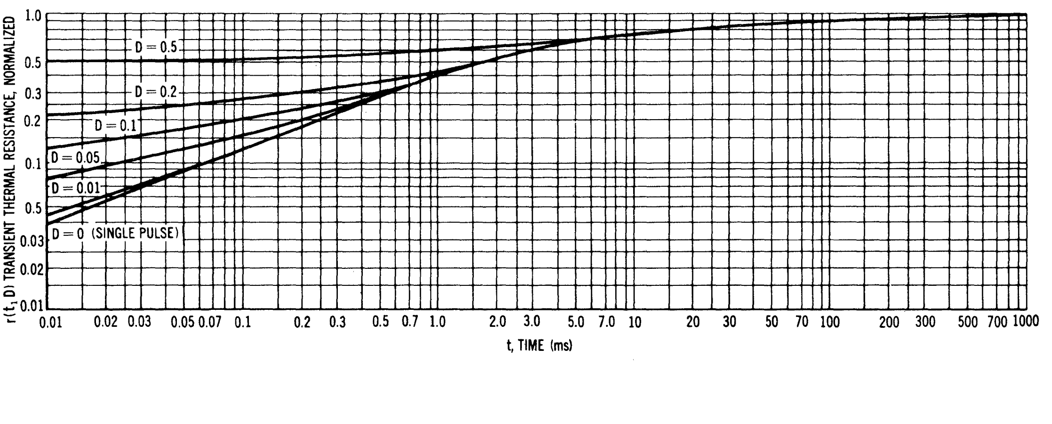
FIGURE 11 — ACTIVE-REGION SAFE OPERATING AREAS



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

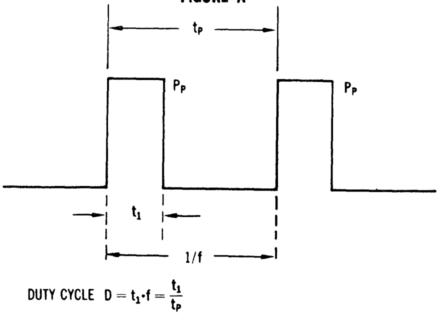
The data of Figure 11 is based on $T_{J(pk)} = 200°C$; T_C is variable depending on conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} < 200°C$. $T_{J(pk)}$ may be calculated from the data in Figure 12. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 12 — TRANSIENT THERMAL RESISTANCE



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA

FIGURE A



DUTY CYCLE $D = t_1 \cdot f = \frac{t_1}{t_P}$

PEAK PULSE POWER = P_P

A train of periodical power pulses can be represented by the model shown in Figure A. Using the model and the device thermal response, the normalized effective transient thermal resistance of Figure 12 was calculated for various duty cycles.

To find $\theta_{JC}(t)$, multiply the value obtained from Figure 12 by the steady state value θ_{JC}.

Example:

The 2N4904 is dissipating 100 watts under the following conditions: $t_1 = 0.1$ ms, $t_P = 0.5$ ms. $(D = 0.2)$

Using Figure 12, at a pulse width of 0.1 ms and D = 0.2, the reading of $r(t_1, D)$ is 0.27.

The peak rise in junction temperature is therefore

$$\Delta T = r(t) \times P_P \times \theta_{JC} = 0.27 \times 100 \times 2.0 = 54°C$$