2N4404
2N4405

CASE 79, STYLE 1
TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.25 7.15	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0)		I_{CBO}	—	25	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	25	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)	2N4404 2N4405	h_{FE}	30 75	— —	—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N4404 2N4405		40 100	— —	
(I_C = 150 mAdc, V_{CE} = 5.0 Vdc)(1)	2N4404 2N4405		40 100	120 300	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)(1)	2N4404 2N4405		30 50	— —	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 150 mAdc, I_B = 15 mAdc)(1) (I_C = 500 mAdc, I_B = 50 mAdc)(1)		$V_{CE(sat)}$	— — —	0.15 0.2 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)(1)		$V_{BE(sat)}$	— 0.85	0.8 1.2	Vdc
Base-Emitter On Voltage (I_C = 150 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	600	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	10	pF
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{eb}	—	75	pF

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ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_s	—	175	ns
Fall Time		t_f	—	35	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 – TURN-ON

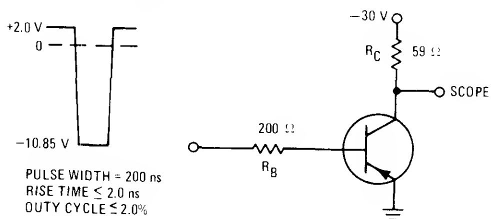
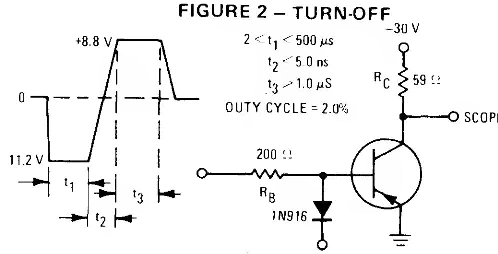


FIGURE 2 – TURN-OFF



To obtain data for curves, voltage levels are approximately as shown, R_B and R_C are varied.

TRANSIENT CHARACTERISTICS

——— 25°C – – – 100°C

FIGURE 3 – CAPACITANCES

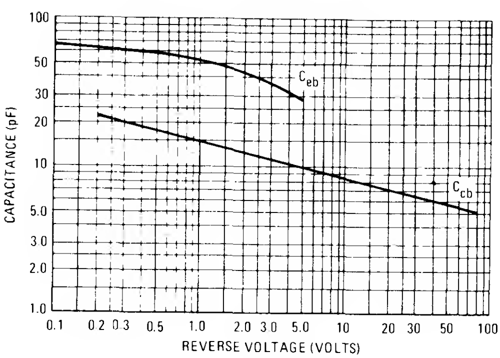


FIGURE 4 – CHARGE DATA

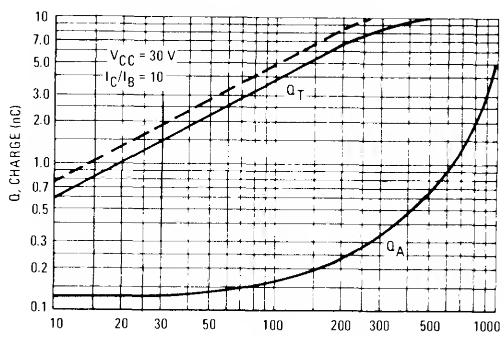


FIGURE 5 – DELAY TIME

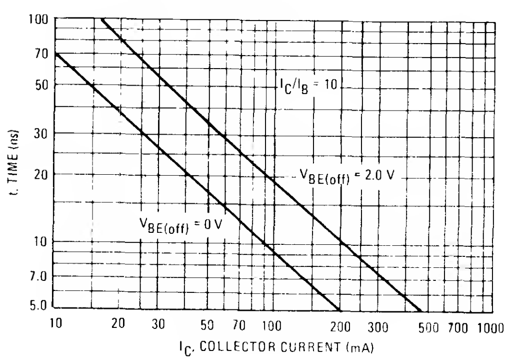


FIGURE 6 – RISE TIME

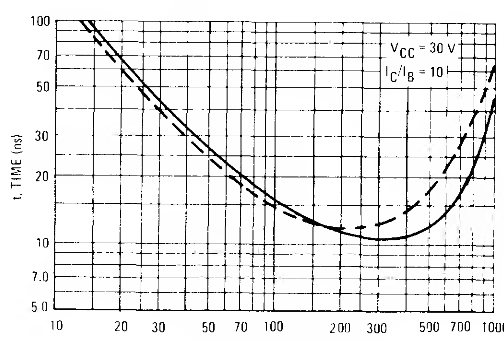


FIGURE 7 – STORAGE TIME

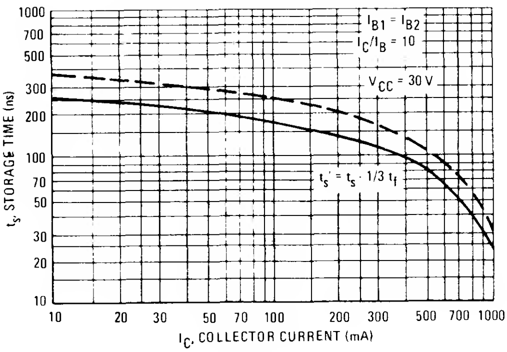
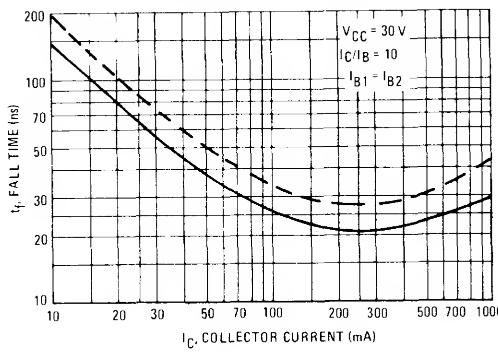


FIGURE 8 – FALL TIME



SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

$V_{CE} = 10$ Vdc, $T_A = 25°C$

FIGURE 9 – FREQUENCY EFFECTS

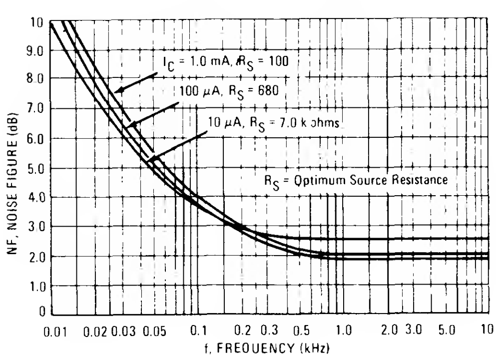
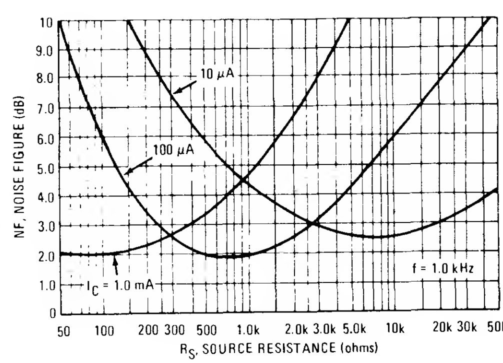


FIGURE 10 – SOURCE RESISTANCE EFFECTS



h PARAMETERS

$V_{CE} = 10$ Vdc, f = 1.0 kHz, $T_A = 25°C$

This group of graphs illustrates the relationship of the "h" parameters for this series of transistors. To obtain these curves, 4 units were selected and identified by number – the same units were used to develop curves on each graph

FIGURE 11 – CURRENT GAIN

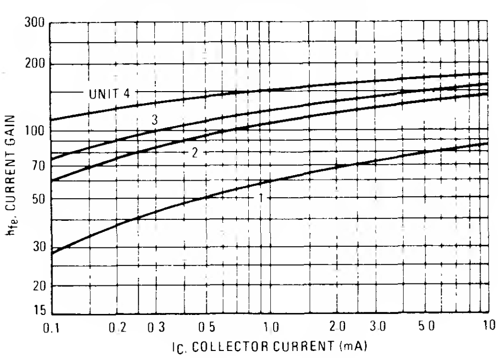


FIGURE 12 – INPUT IMPEDANCE

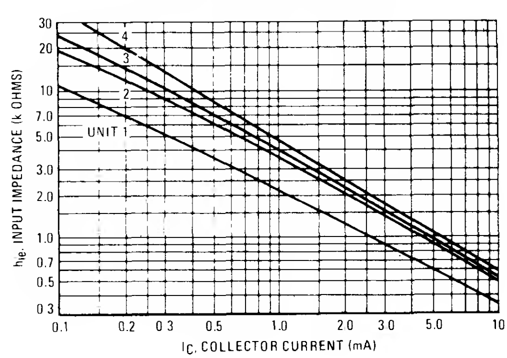


FIGURE 13 – VOLTAGE FEEDBACK RATIO

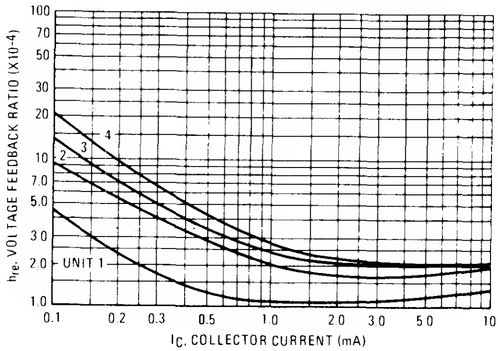
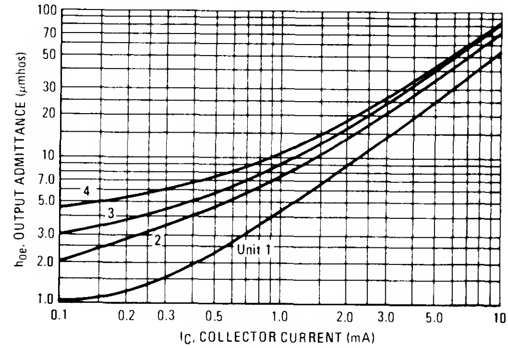


FIGURE 14 – OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 15 – DC CURRENT GAIN

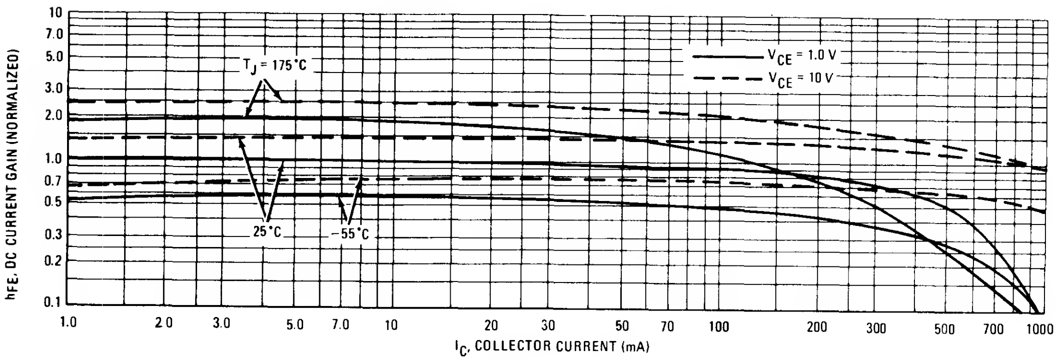


FIGURE 16 – COLLECTOR SATURATION REGION

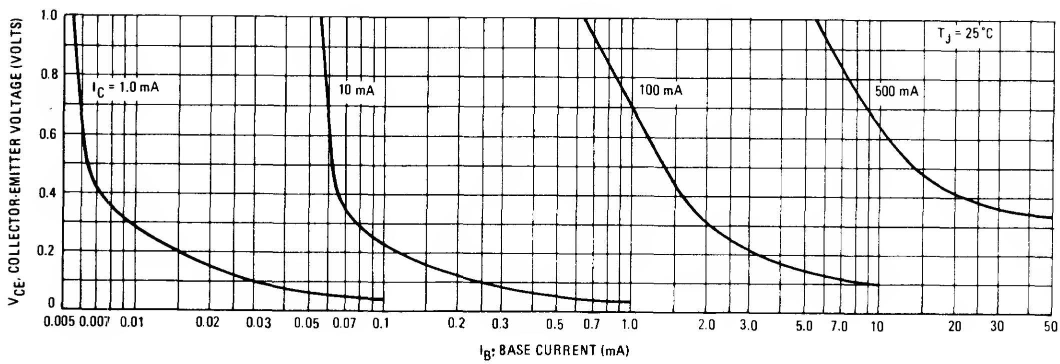


FIGURE 17 – "ON" VOLTAGES

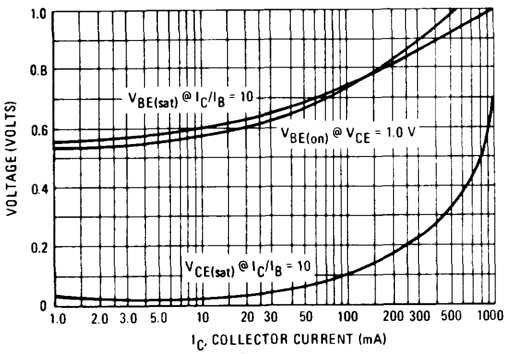
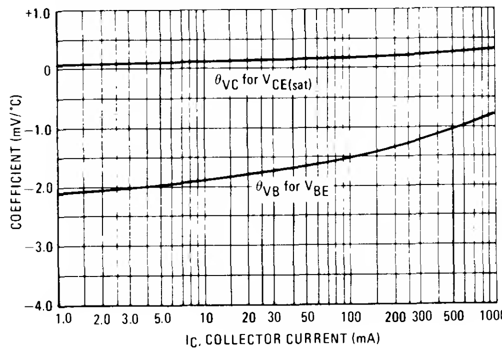


FIGURE 18 – TEMPERATURE COEFFICIENTS



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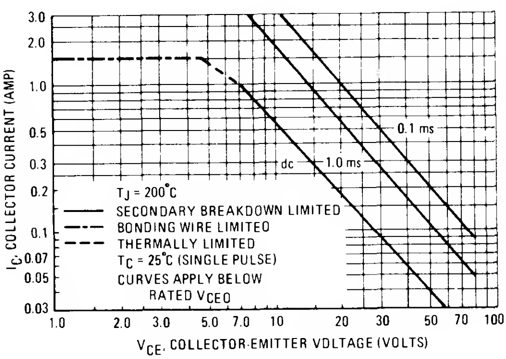
RATINGS AND THERMAL DATA

FIGURE 19 – SAFE OPERATING AREA



The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 19 is based upon $T_{J(pk)}$ = 200°C. T_C is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 200°C$. $T_{J(pk)}$ may be calculated from the data in Figure 20. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.