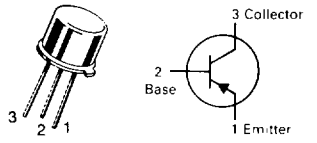
2N4404
2N4405

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

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 Ambient	$R_{\theta JA}$	140	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W

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

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,	t_d	—	15	ns
Rise Time	I_C = −500 mAdc, I_{B1} = −50 mAdc)	t_r	—	25	ns
Storage Time	(V_{CC} = −30 Vdc, I_C = −500 mAdc,	t_s	—	175	ns
Fall Time	I_{B1} = I_{B2} = −50 mAdc)	t_f	—	35	ns

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

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 — TURN-ON

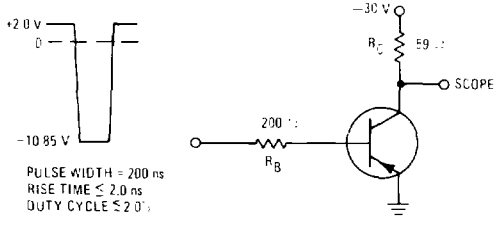
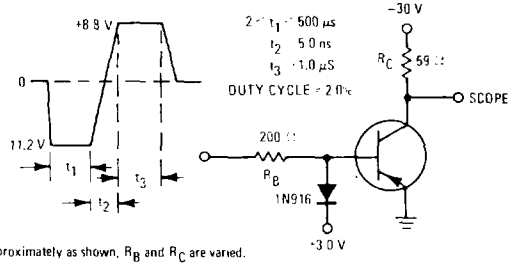


FIGURE 2 — TURN-OFF



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

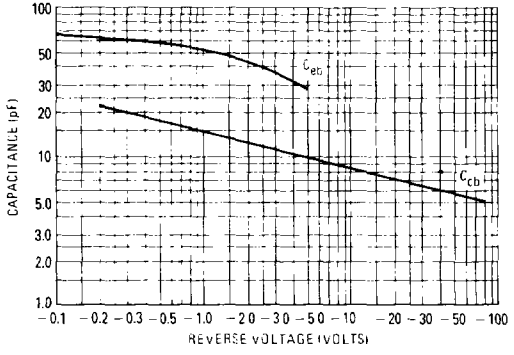


FIGURE 4 — CHARGE DATA

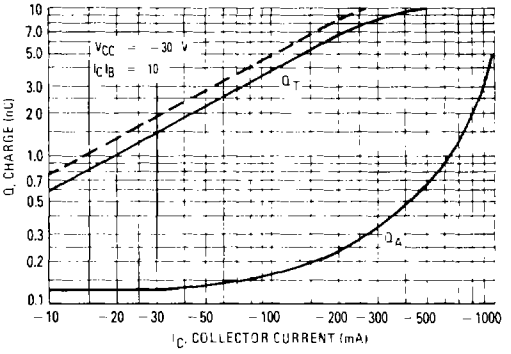


FIGURE 5 — DELAY TIME

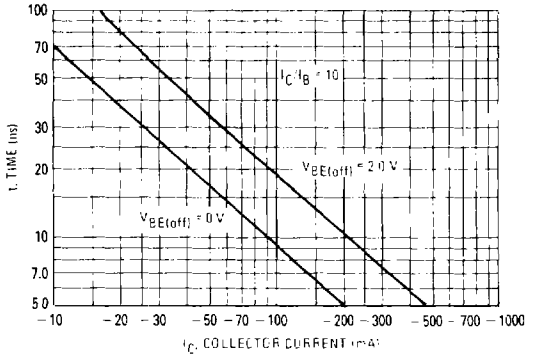


FIGURE 6 — RISE TIME

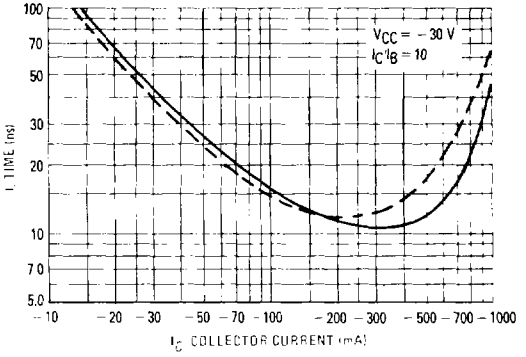


FIGURE 7 — STORAGE TIME

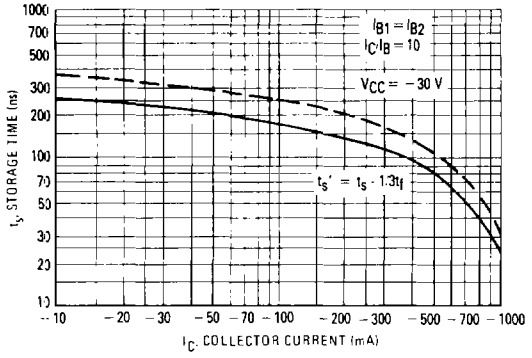
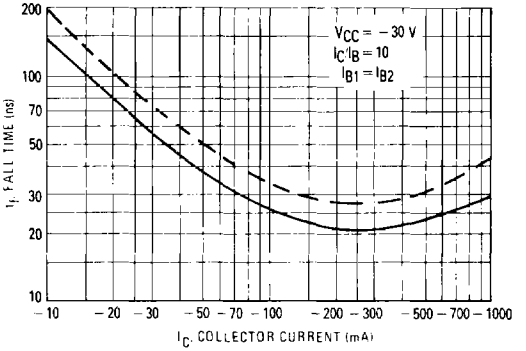


FIGURE 8 — FALL TIME



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SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

FIGURE 9 — FREQUENCY EFFECTS

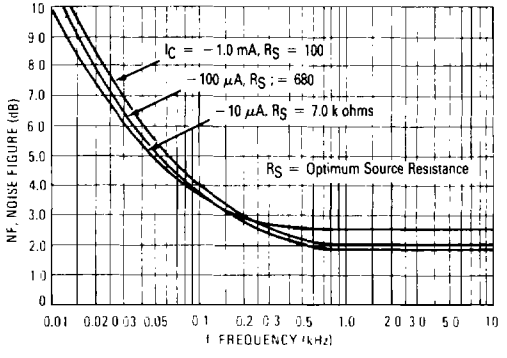
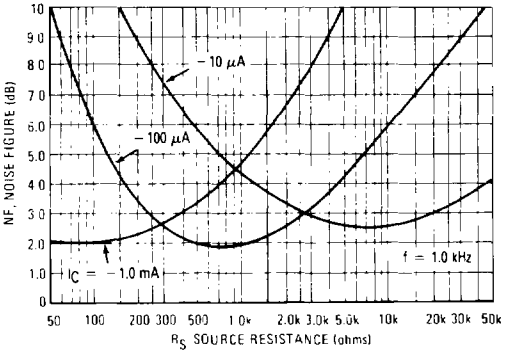


FIGURE 10 — SOURCE RESISTANCE EFFECTS



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

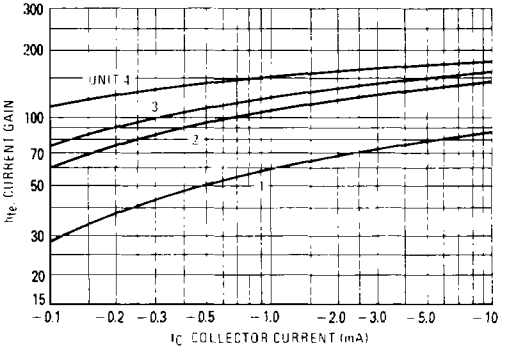


FIGURE 12 — INPUT IMPEDANCE

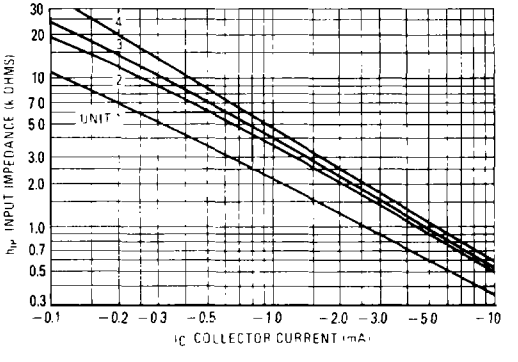


FIGURE 13 — VOLTAGE FEEDBACK RATIO

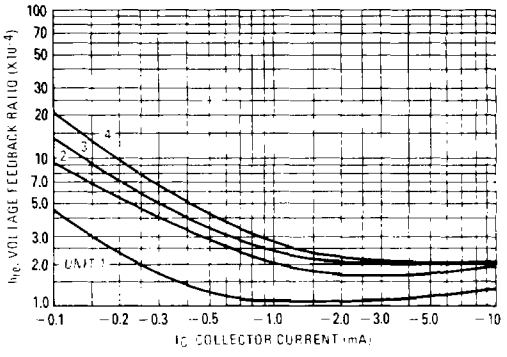
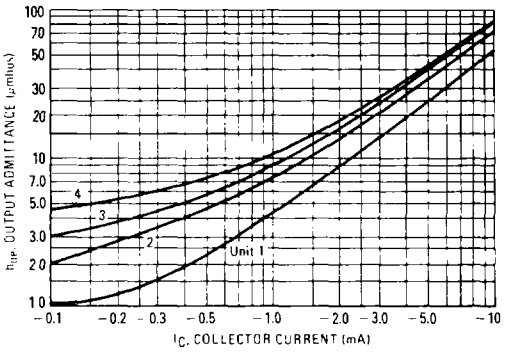


FIGURE 14 — OUTPUT ADMITTANCE



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STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN

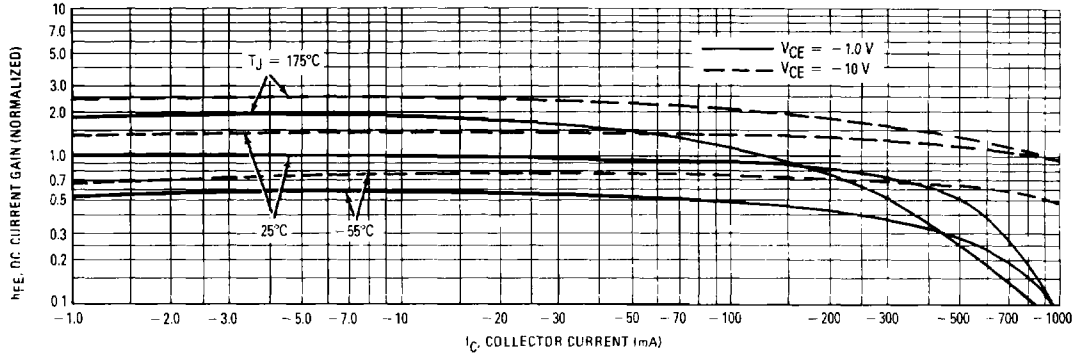


FIGURE 16 — COLLECTOR SATURATION REGION

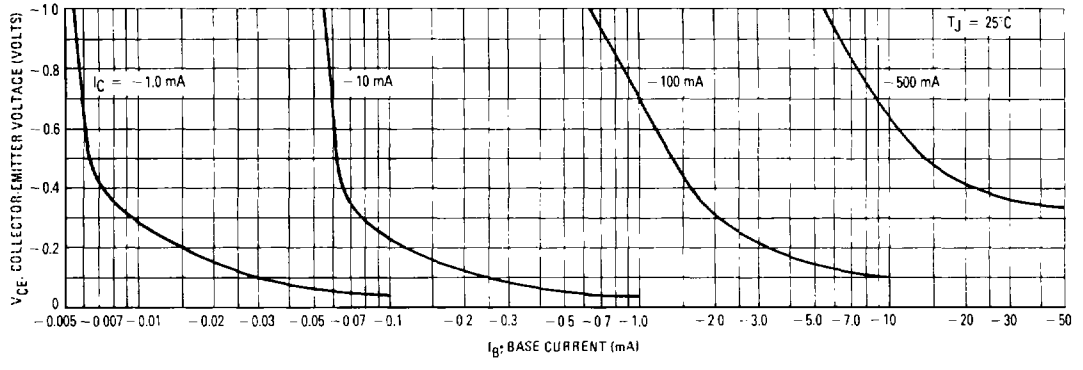


FIGURE 17 — "ON" VOLTAGES

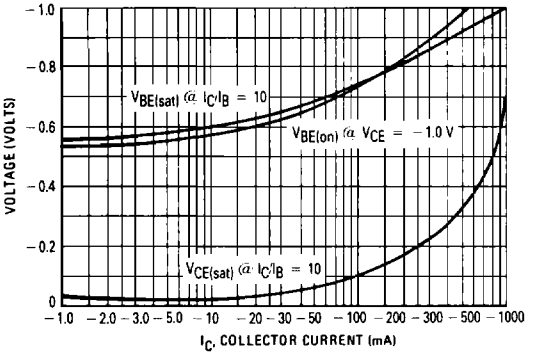
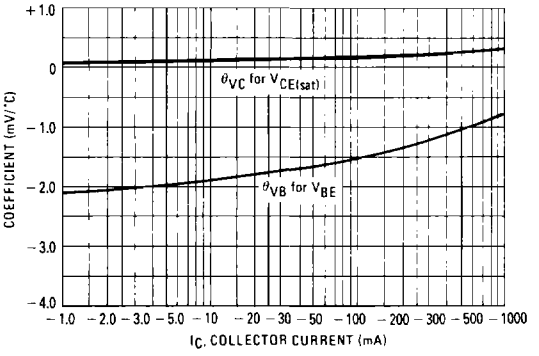


FIGURE 18 — TEMPERATURE COEFFICIENTS



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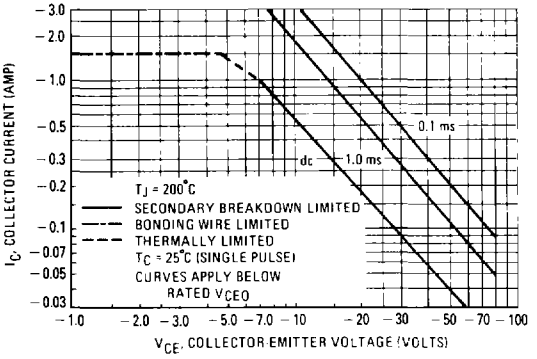
RATINGS AND THERMAL DATA

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.