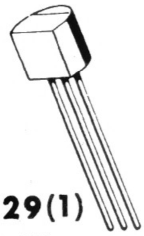
2N3903 (SILICON)
2N3904



CASE 29(1)
(TO-92)

NPN silicon annular transistors, designed for general-purpose switching and amplifier applications, features one-piece, injection-molded plastic package for high reliability. The 2N3903 and 2N3904 are complementary with PNP types 2N3905 and 2N3906, respectively.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	60	Vdc
Emitter-Base Voltage	V_{EB}	6.0	Vdc
Collector Current	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C T_A = 60°C Derate above 25°C	P_D	310 210 2.81	mW mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW

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

Characteristic	Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		BV_{CBO}	60	-	Vdc
Collector-Emitter Breakdown Voltage* (I_C = 1.0 mAdc, I_B = 0)		BV_{CEO}*	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		BV_{EBO}	6.0	-	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)		I_{CEX}	-	50	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)		I_{BL}	-	50	nAdc
ON CHARACTERISTICS					
DC Current Gain*	15	h_{FE}*			-
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) 2N3903			20	-	
2N3904			40	-	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) 2N3903			35	-	
2N3904			70	-	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc) 2N3903			50	150	
2N3904			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) 2N3903			30	-	
2N3904			60	-	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc) 2N3903			15	-	
2N3904			30	-	
Collector-Emitter Saturation Voltage*	16, 17	$V_{CE(sat)}$*			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			-	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			-	0.3	
Base-Emitter Saturation Voltage*	17	$V_{BE(sat)}$*			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			-	0.95	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) 2N3903		f_T	250	-	MHz
2N3904			300	-	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	3	C_{ob}	-	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	3	C_{ib}	-	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N3903	13	h_{ie}	0.5	8.0	k ohms
2N3904			1.0	10	
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N3903	14	h_{re}	0.1	5.0	X 10-4
2N3904			0.5	8.0	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N3903	11	h_{fe}	50	200	-
2N3904			100	400	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	12	h_{oe}	1.0	40	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohms, f = 10 Hz to 15.7 kHz) 2N3903	9, 10	NF	-	6.0	dB
2N3904			-	5.0	
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	1, 5	t_d	-	35	ns
Rise Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	1, 5, 6	t_r	-	35	ns
Storage Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc) 2N3903	2, 7	t_s	-	175	ns
2N3904			-	200	
Fall Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	2, 8	t_f	-	50	ns

* Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

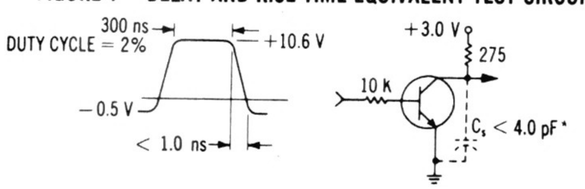
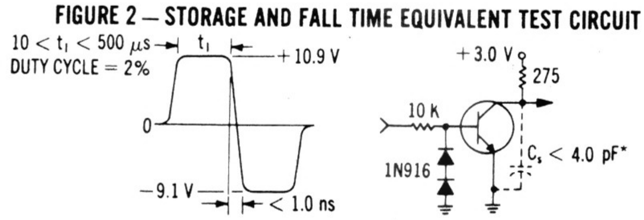


FIGURE 2 — STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TRANSIENT CHARACTERISTICS

— T_J = 25°C   - - - T_J = 125°C

FIGURE 3 — CAPACITANCE

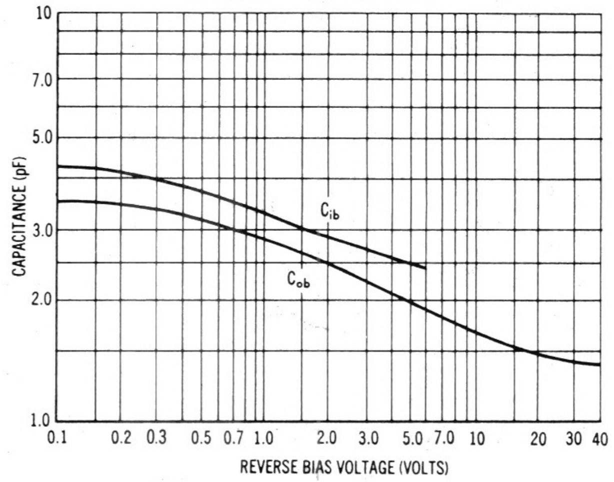


FIGURE 4 — CHARGE DATA

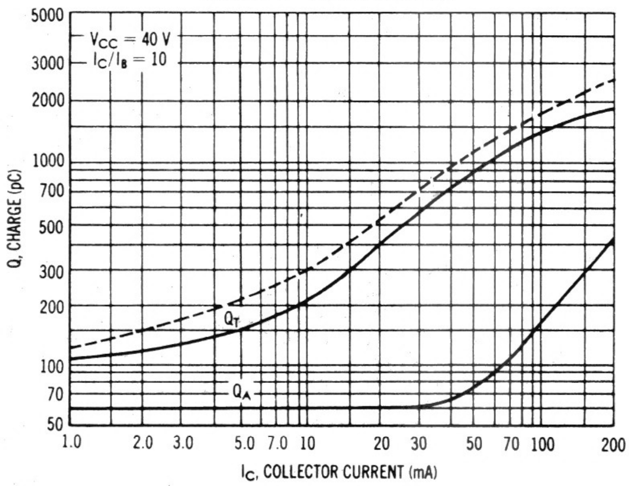


FIGURE 5 — TURN-ON TIME

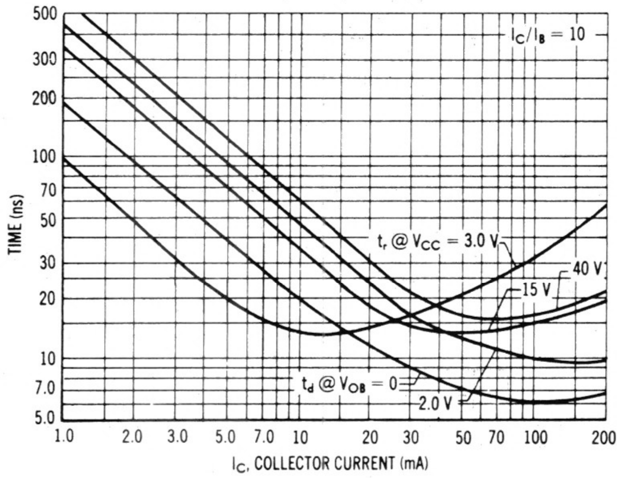


FIGURE 6 — RISE TIME

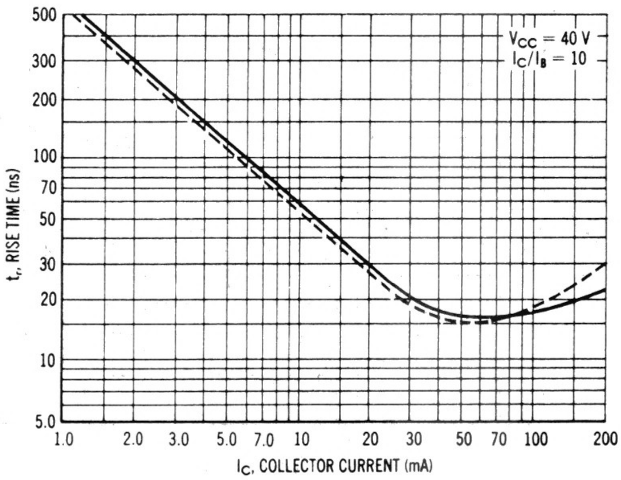


FIGURE 7 — STORAGE TIME

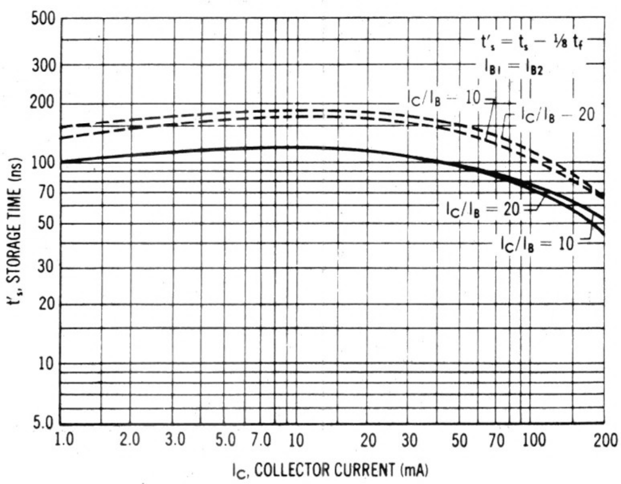
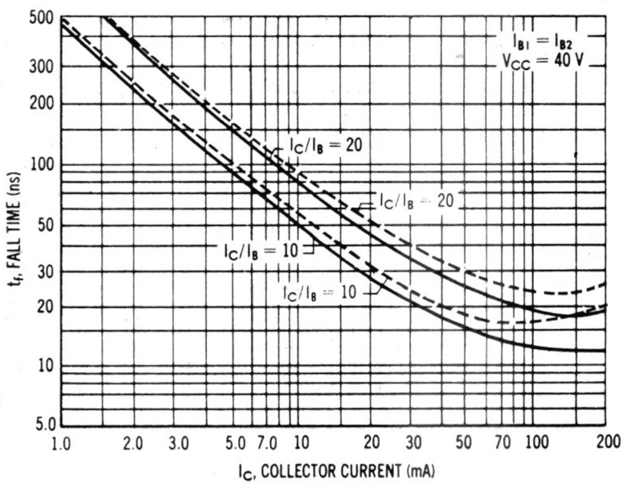


FIGURE 8 — FALL TIME



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS
$V_{CE} = 5.0$ Vdc, $T_A = 25°C$

FIGURE 9

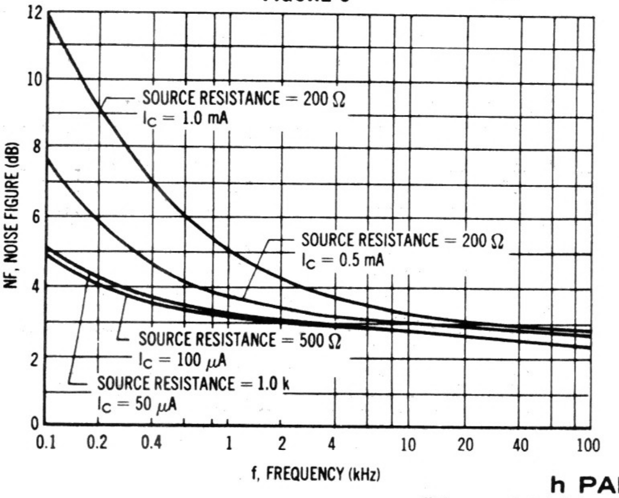
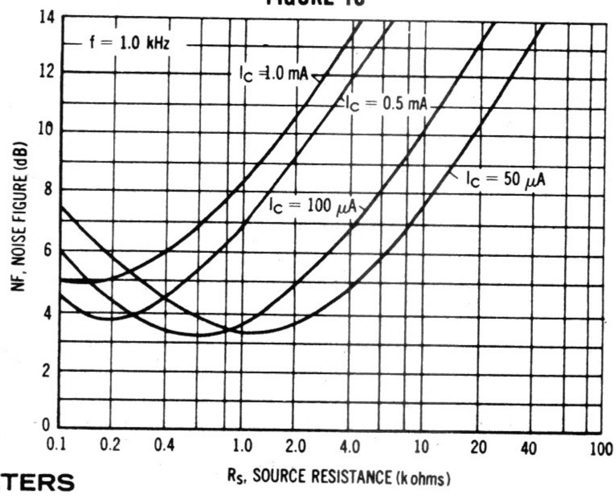


FIGURE 10



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

FIGURE 11 — CURRENT GAIN

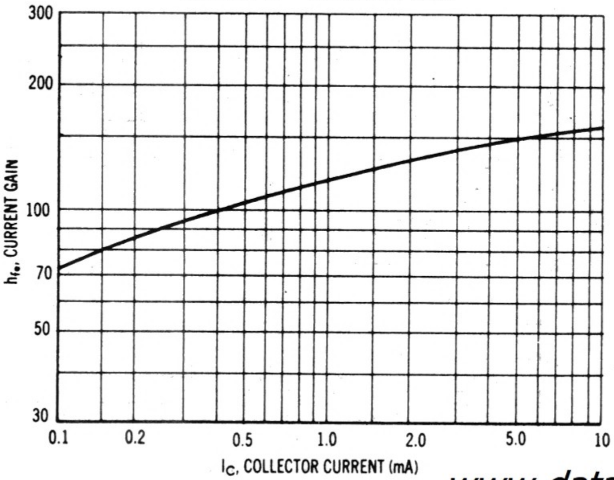


FIGURE 12 — OUTPUT ADMITTANCE

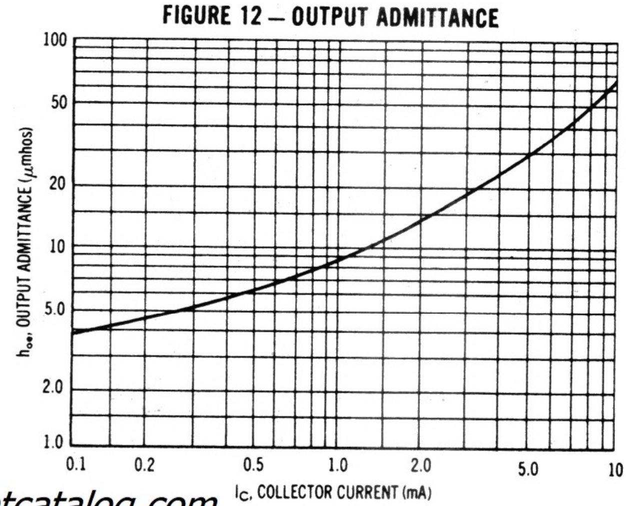


FIGURE 13 — INPUT IMPEDANCE

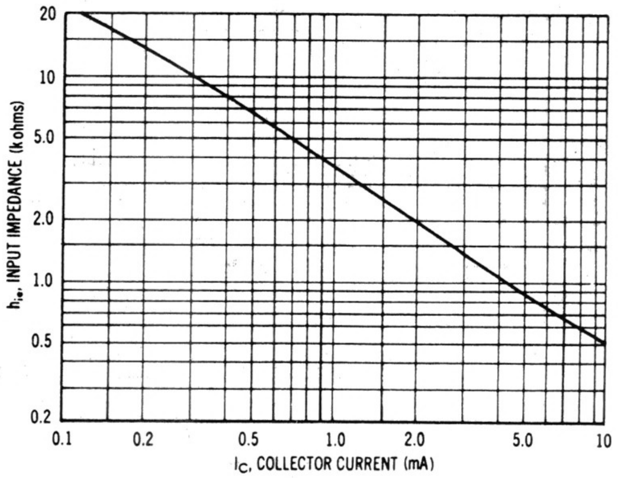
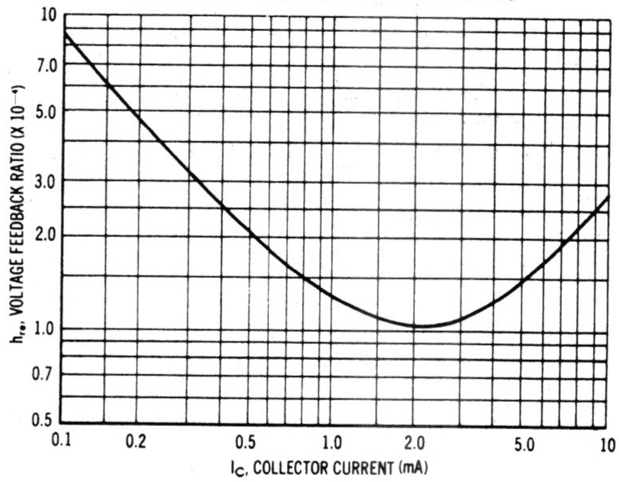


FIGURE 14 — VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 15 — NORMALIZED CURRENT GAIN

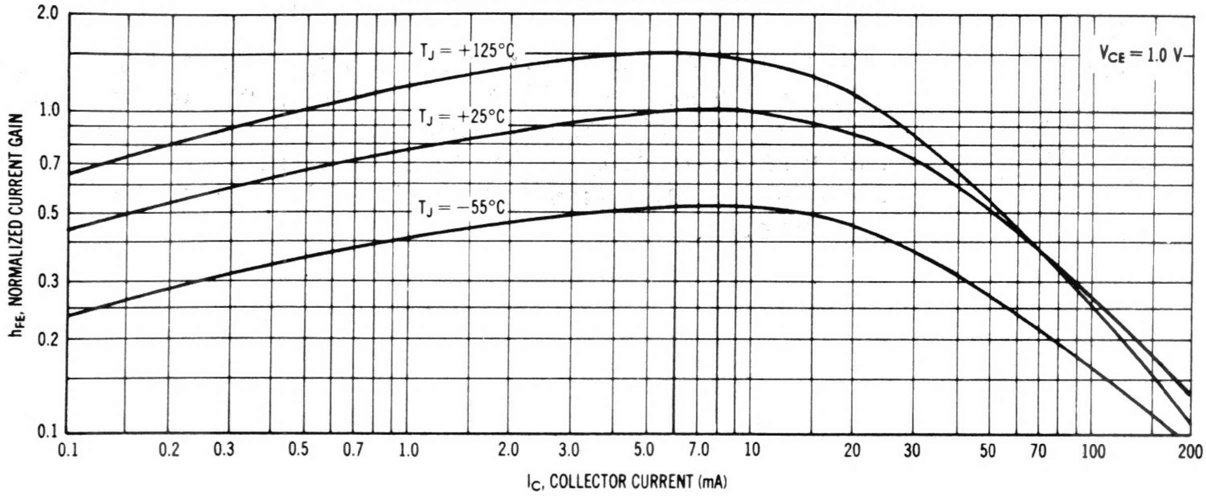


FIGURE 16 — COLLECTOR SATURATION REGION

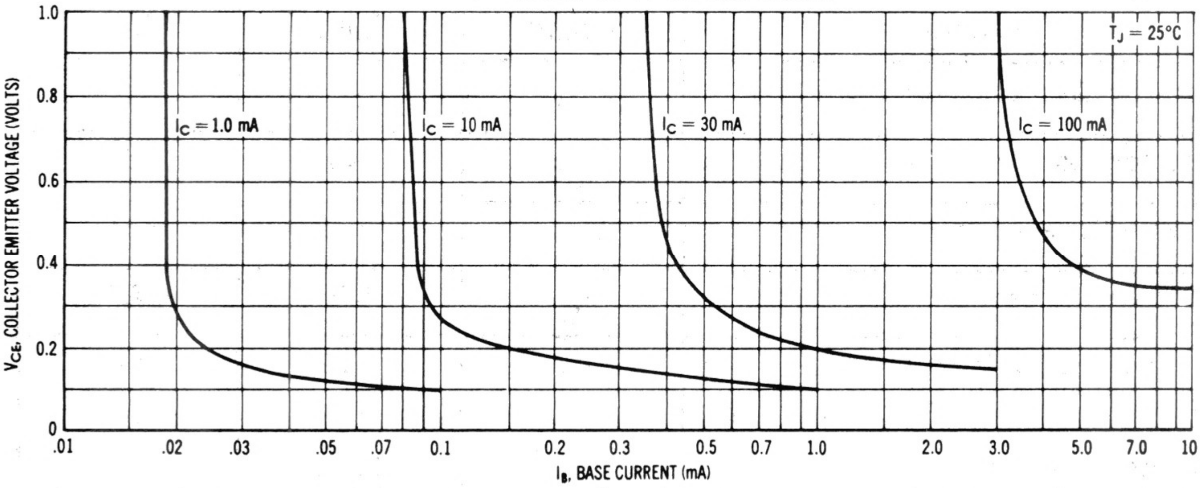


FIGURE 17 — "ON" VOLTAGES

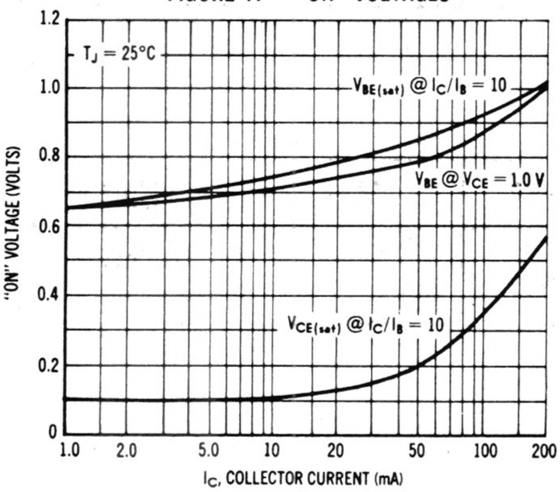


FIGURE 18 — TEMPERATURE COEFFICIENTS