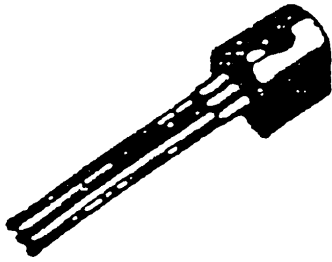


SEMELAB

358-812



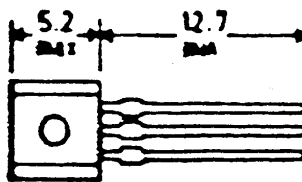
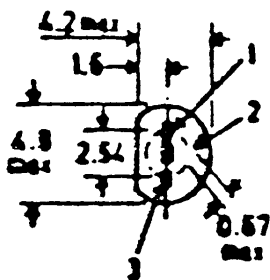
2N3903

2N3904

MECHANICAL DATA

GENERAL PURPOSE
TRANSISTOR

NPN SILICON



TO-92

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	40	Vdc
Collector-Base Voltage	V_{CB0}	60	Vdc
Emitter-Base Voltage	V_{EB0}	6.0	Vdc
Collector Current — Continuous	I_C	200	mA dc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	625 5.0	mW mW/°C
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

*Indicates Data in addition to JEDEC Requirements.

SEMELAB

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	8.0	—	Vdc
Base Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$)	I_{BL}	—	50	nA dc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{EB} = 3.0\text{ Vdc}$)	I_{CEX}	—	50	nA dc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 0.1\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)	β_{FE}	20	—	—
	2N3903	40	—	—
	2N3904	—	—	—
($I_C = 1.0\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)		35	—	—
	2N3903	70	—	—
	2N3904	—	—	—
($I_C = 10\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)		50	150	—
	2N3903	100	300	—
	2N3904	—	—	—
($I_C = 50\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)		30	—	—
	2N3903	60	—	—
	2N3904	—	—	—
($I_C = 100\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)		15	—	—
	2N3903	30	—	—
	2N3904	—	—	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$) ($I_C = 50\text{ mAdc}$, $I_B = 5.0\text{ mAdc}$)	$V_{CE(sat)}$	—	0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$) ($I_C = 50\text{ mAdc}$, $I_B = 5.0\text{ mAdc}$)	$V_{BE(sat)}$	0.85 —	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10\text{ mAdc}$, $V_{CE} = 20\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	250 300	—	MHz
	2N3903	—	—	—
	2N3904	—	—	—

ELECTRICAL CHARACTERISTICS (continued) ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Output Capacitance ($V_{CE} = 5.0\text{ Vdc}$, $f_c = 0.1 - 1.0\text{ MHz}$)	C_{obo}	—	4.0	pF
Input Capacitance ($V_{BE} = 0.5\text{ Vdc}$, $f_c = 0.1 - 1.0\text{ MHz}$)	C_{ibo}	—	8.0	pF
Input Impedance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{ie}	2N3903: 1.0 2N3904: 1.0	8.0 10	k ohms
Voltage Feedback Ratio ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{re}	2N3903: 0.1 2N3904: 0.5	5.0 8.0	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	2N3903: 50 2N3904: 100	200 400	—
Output Admittance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{oe}	1.0	40	μhos
Noise Figure ($R_C = 100\ \mu\text{A}$, $V_{CE} = 5.0\text{ Vdc}$, $R_S = 1.0\text{ k ohms}$, $f = 10\text{ Hz to }15.7\text{ kHz}$)	NF	—	2N3903: 6.0 2N3904: 5.0	dB

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	$(V_{CE} = 3.0\text{ Vdc}$, $V_{BE} = 0.5\text{ Vdc}$, $I_C = 10\text{ mA}$, $I_{B1} = 1.0\text{ mA}$)	t_d	—	35	ns
Rise Time		t_r	—	35	ns
Storage Time	$(V_{CC} = 3.0\text{ Vdc}$, $I_C = 10\text{ mA}$, $I_{B1} = I_{B2} = 1.0\text{ mA}$)	t_s	—	2N3903: 175 2N3904: 200	ns
Fall Time		t_f	—	50	ns

(1) Pulse Test. Pulse Width $\leq 300\ \mu\text{s}$. Duty Cycle $\leq 2.0\%$.

FIGURE 1 - DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

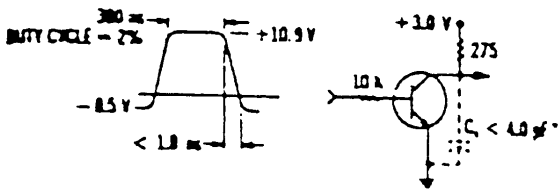
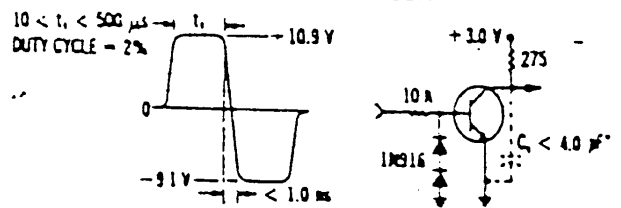


FIGURE 2 - STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

— $T_J = 25^\circ\text{C}$ --- $T_J = 125^\circ\text{C}$

FIGURE 3 - CAPACITANCE

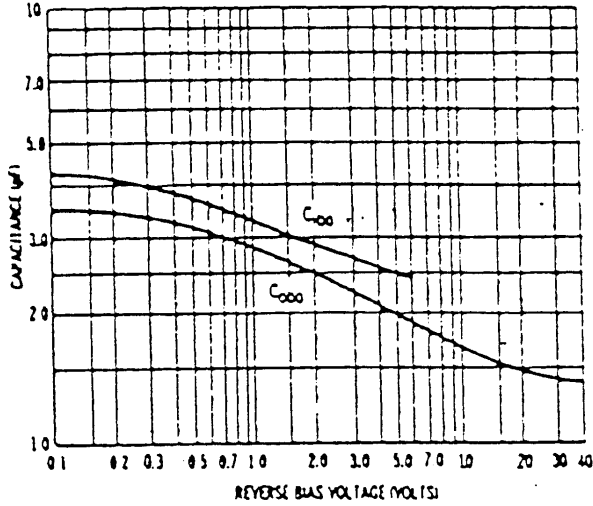


FIGURE 4 - CHARGE DATA

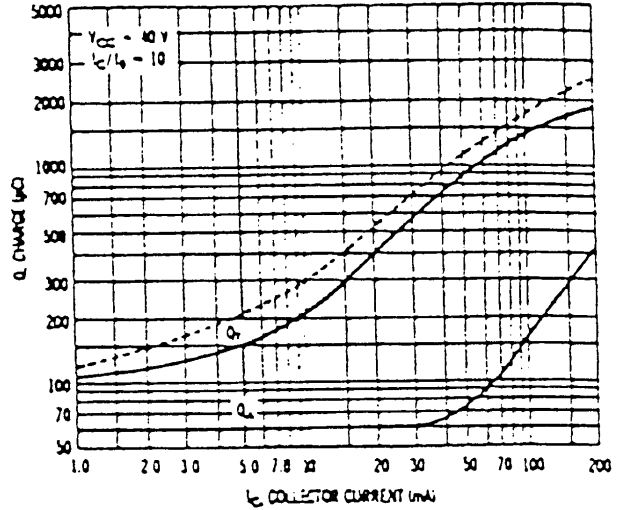


FIGURE 5 - TURN-ON TIME

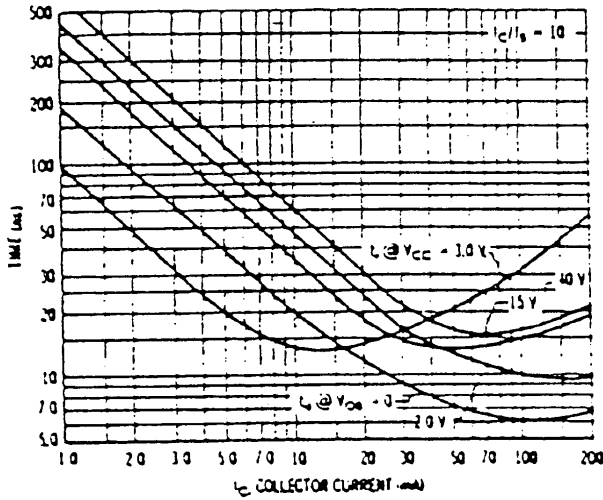


FIGURE 6 - RISE TIME

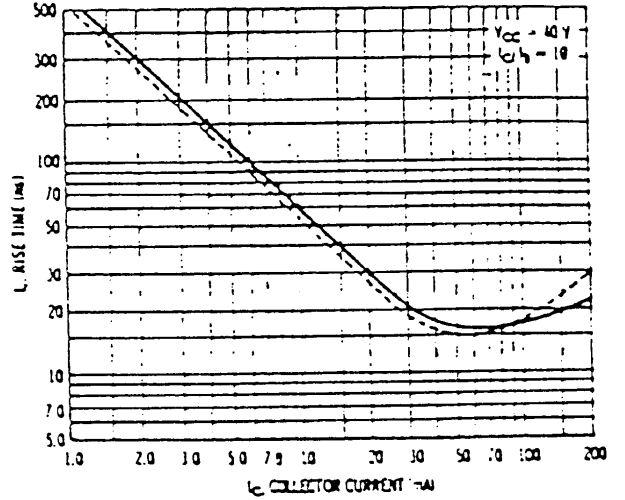


FIGURE 7 - STORAGE TIME

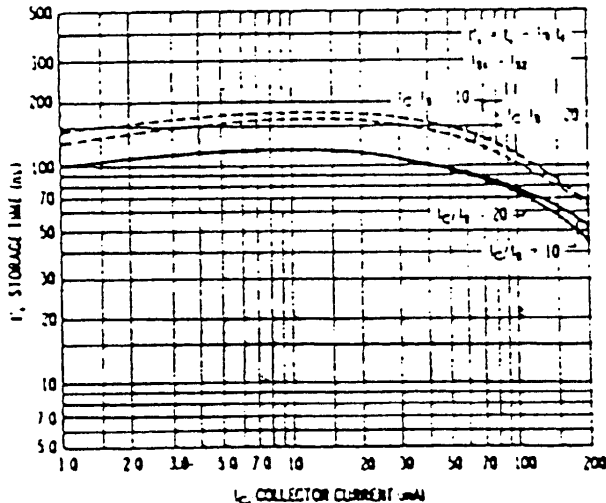
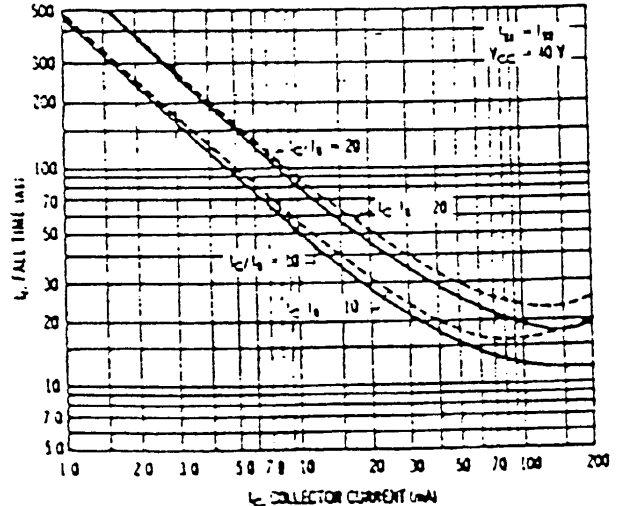


FIGURE 8 - FALL TIME



TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

$V_{CE} = 5.0 \text{ Vdc}$, $T_A = 25^\circ\text{C}$,
Bandwidth = 1.0 kHz

FIGURE 9

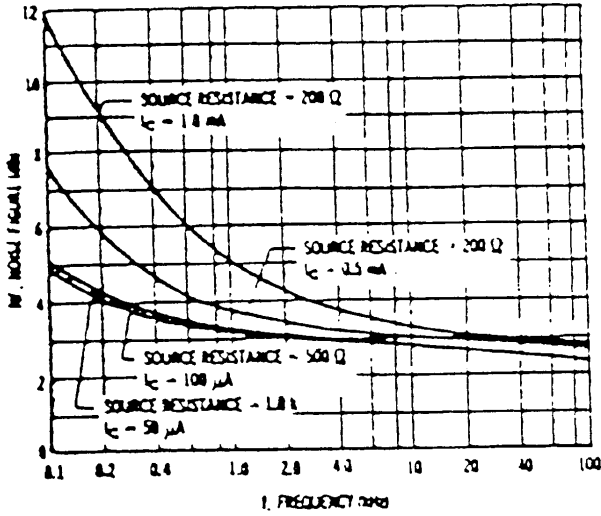
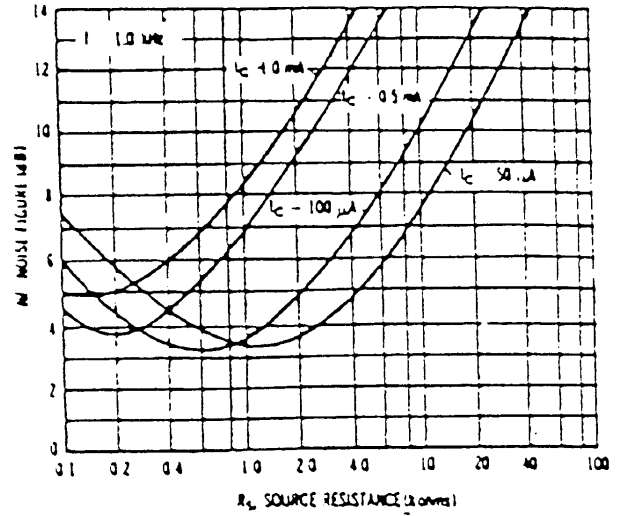


FIGURE 10



h PARAMETERS

$V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$, $T_A = 25^\circ\text{C}$

FIGURE 11 - CURRENT GAIN

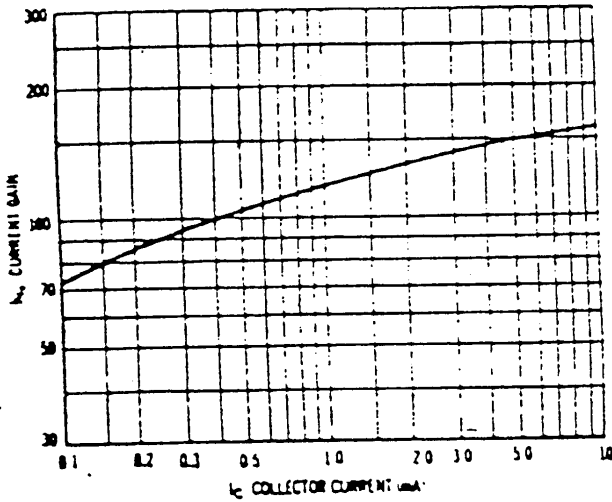


FIGURE 12 - OUTPUT ADMITTANCE

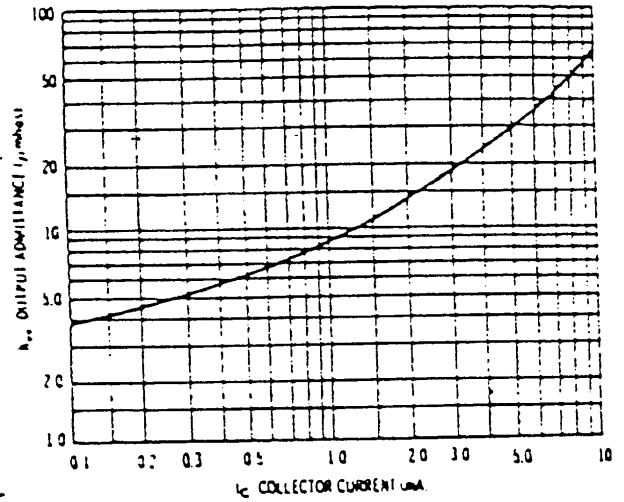


FIGURE 13 - INPUT IMPEDANCE

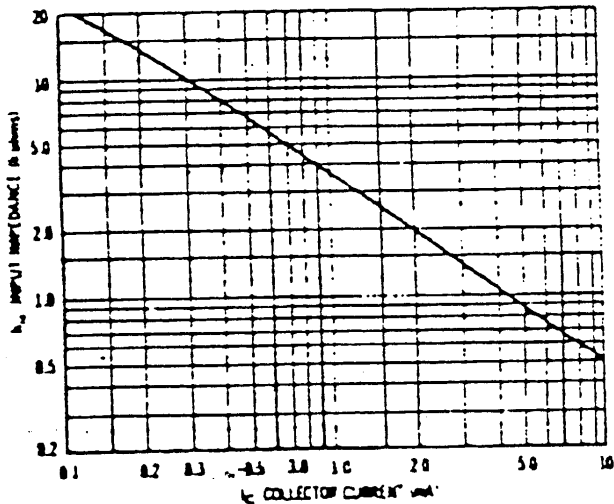
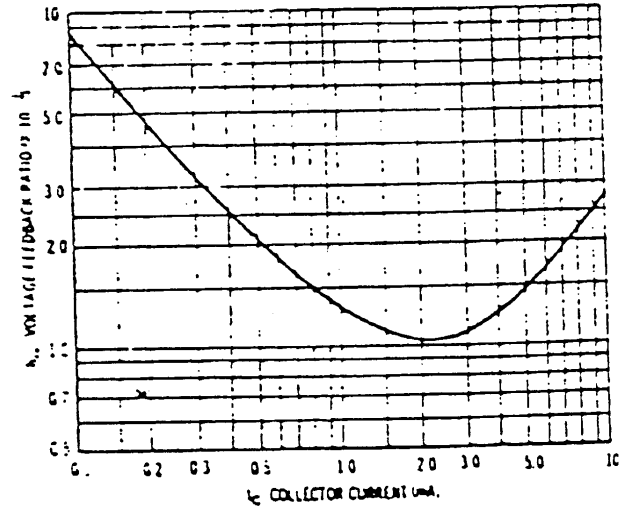


FIGURE 14 - VOLTAGE FEEDBACK RATIO



TYPICAL STATIC CHARACTERISTICS
FIGURE 15 - DC CURRENT GAIN

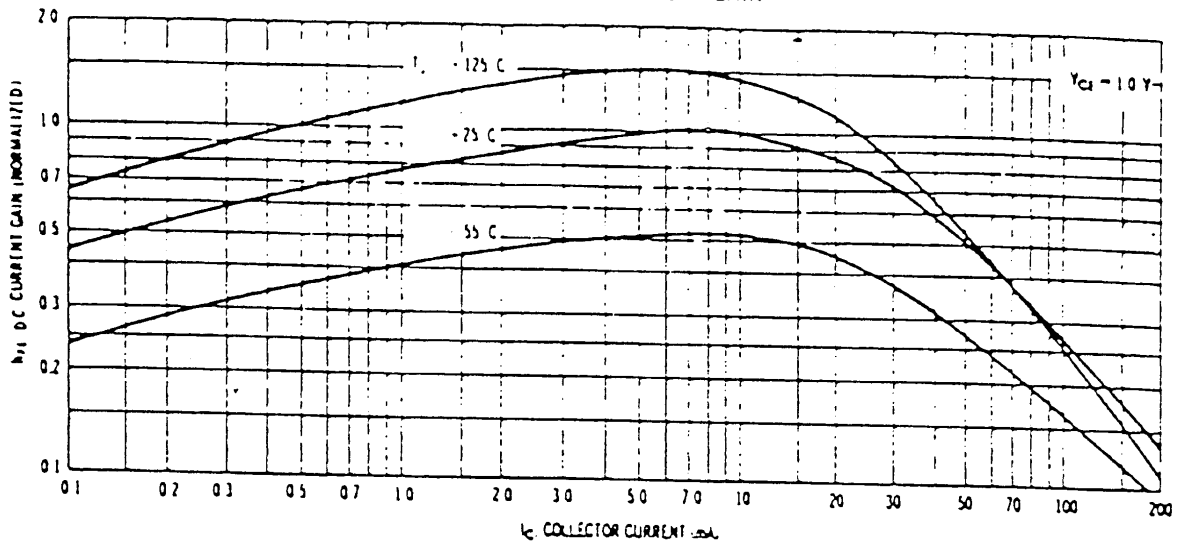


FIGURE 16 - COLLECTOR SATURATION REGION

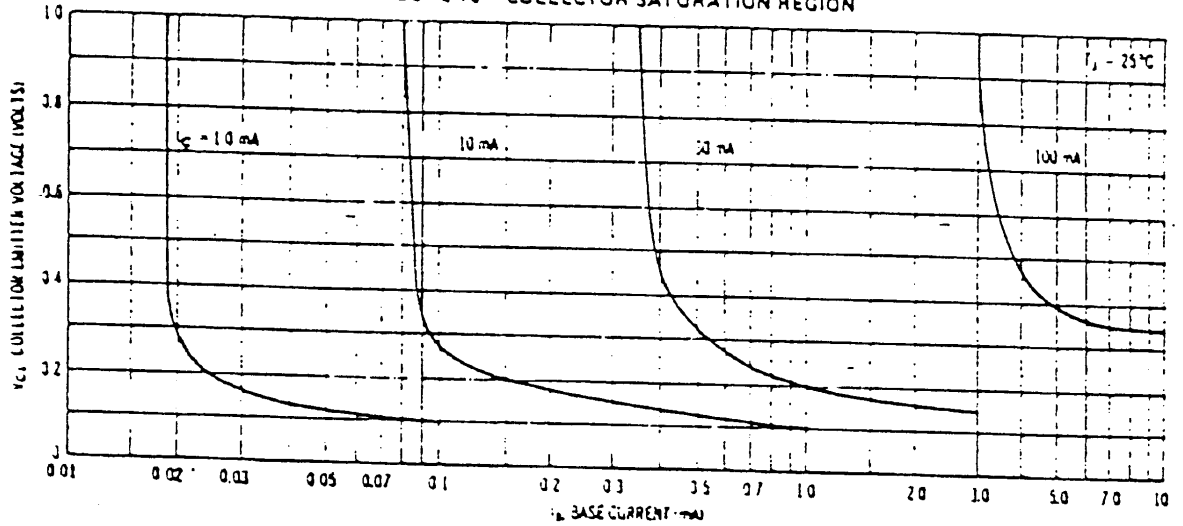


FIGURE 17 - "ON" VOLTAGES

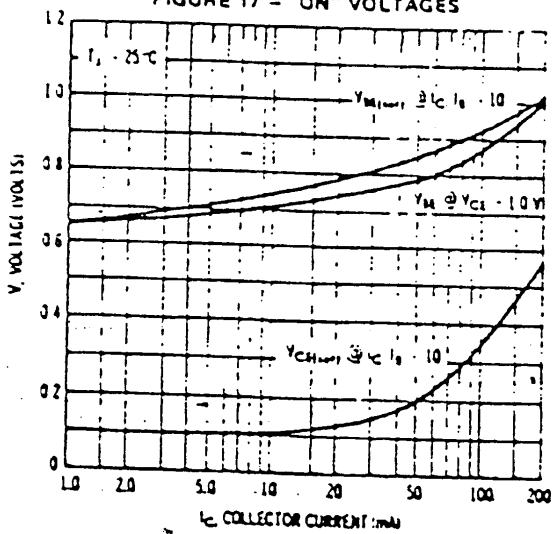
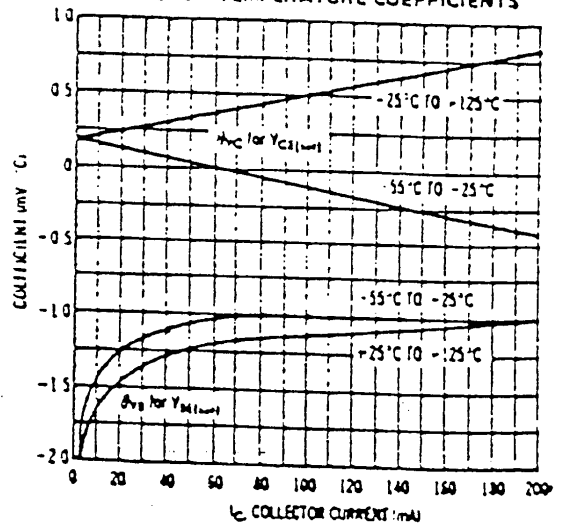


FIGURE 18 - TEMPERATURE COEFFICIENTS



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