

TYPES 2N3903, 2N3904, A5T3903, A5T3904 N-P-N SILICON TRANSISTORS

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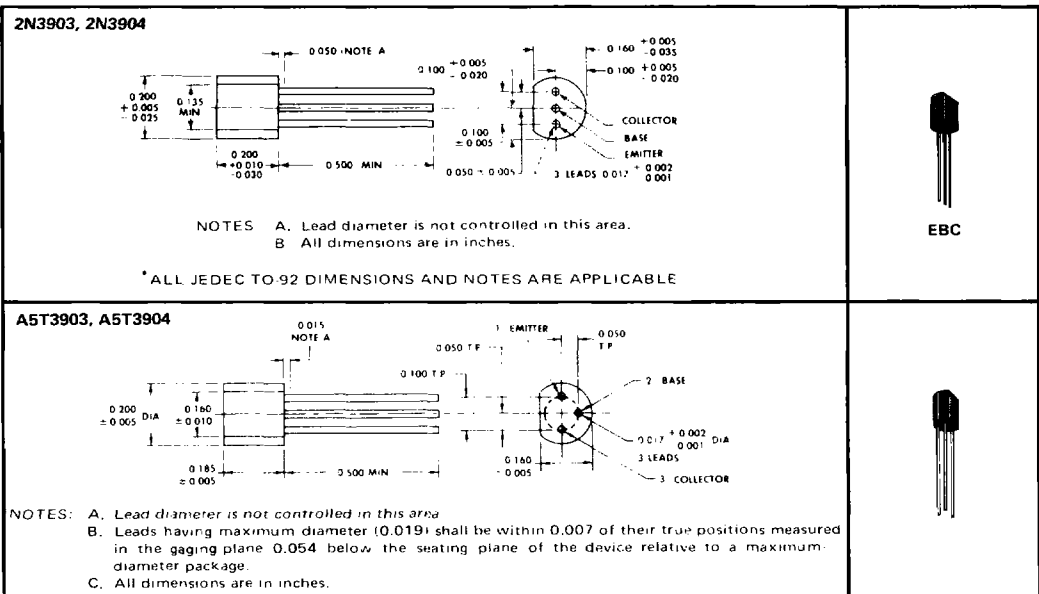
SILECT† TRANSISTORS‡

FOR GENERAL PURPOSE SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS

- For Complementary Use with P-N-P Types 2N3905, 2N3906, A5T3905, and A5T3906
- Rugged One-Piece Construction with In-Line Leads or Standard TO-18 100-mil Pin-Circle Configuration

mechanical data

These transistors are encapsulated in a plastic compound specifically designed for this purpose, using a highly mechanized process developed by Texas Instruments. The case will withstand soldering temperatures without deformation. These devices exhibit stable characteristics under high-humidity conditions and are capable of meeting MIL-STD-202C, Method 106B. The transistors are insensitive to light.



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absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)

Collector-Base Voltage	60 V*
Collector-Emitter Voltage (See Note 1)	40 V*
Emitter-Base Voltage	6 V*
Continuous Collector Current	200 mA*
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 2)	{ 625 mW§ 310 mW*
Storage Temperature Range	{ -65°C to 150°C§ -55°C to 135°C*
Lead Temperature 1/16 Inch from Case for 60 Seconds	{ 260°C§ 230°C*

NOTES: 1. This value applies between 10 μ A and 200 mA collector current when the base-emitter diode is open-circuited.
2. Derate the 625-mW rating linearly to 150°C free-air temperature at the rate of 5 mW/°C. Derate the 310-mW (JEDEC registered) rating linearly to 135°C free air temperature at the rate of 2.81 mW/°C.

*The asterisk identifies JEDEC registered data for the 2N3903 and 2N3904 only. This data sheet contains all applicable registered data in effect at the time of publication.

†Trademark of Texas Instruments

‡U.S. Patent No. 3,439,238

§Texas Instruments guarantees these values in addition to the JEDEC registered values which are also shown.

USES CHIP N14

TYPES 2N3903, 2N3904, A5T3903, A5T3904

N-P-N SILICON TRANSISTORS

*electrical characteristics at 25°C free-air temperature

PARAMETER	TEST CONDITIONS	2N3903, A5T3903		2N3904, A5T3904		UNIT
		MIN	MAX	MIN	MAX	
$V_{(BR)CBO}$ Collector-Base Breakdown Voltage	$I_C = 10 \mu A, I_E = 0$	60		60		V
$V_{(BR)CEO}$ Collector-Emitter Breakdown Voltage	$I_C = 1 mA, I_B = 0$, See Note 3	40		40		V
$V_{(BR)EBO}$ Emitter-Base Breakdown Voltage	$I_E = 10 \mu A, I_C = 0$	6		6		V
I_{CEV} Collector Cutoff Current	$V_{CE} = 30 V, V_{BE} = -3 V$		50		50	nA
I_{BEV} Base Cutoff Current	$V_{CE} = 30 V, V_{BE} = -3 V$		-50		-50	nA
h_{FE} Static Forward Current Transfer Ratio	$V_{CE} = 1 V, I_C = 100 \mu A$	20		40		
	$V_{CE} = 1 V, I_C = 1 mA$	35		70		
	$V_{CE} = 1 V, I_C = 10 mA$	50	150	100	300	
	$V_{CE} = 1 V, I_C = 50 mA$	30		60		
	$V_{CE} = 1 V, I_C = 100 mA$	15		30		
V_{BE} Base-Emitter Voltage	$I_B = 1 mA, I_C = 10 mA$	0.65	0.85	0.65	0.85	V
	$I_B = 5 mA, I_C = 50 mA$		0.95		0.95	
$V_{CE(sat)}$ Collector-Emitter Saturation Voltage	$I_B = 1 mA, I_C = 10 mA$		0.2		0.2	V
	$I_B = 5 mA, I_C = 50 mA$		0.3		0.3	
h_{ie} Small-Signal Common-Emitter Input Impedance	$V_{CE} = 10 V,$ $I_C = 1 mA,$ $f = 1 kHz$	1	8	1	10	k Ω
h_{fe} Small-Signal Common-Emitter Forward Current Transfer Ratio		50	200	100	400	
h_{re} Small-Signal Common-Emitter Reverse Voltage Transfer Ratio		0.1 x 10 ⁻⁴	5 x 10 ⁻⁴	0.5 x 10 ⁻⁴	8 x 10 ⁻⁴	
h_{oe} Small-Signal Common-Emitter Output Admittance		1	40	1	40	μmho
$ h_{fe} $ Small-Signal Common-Emitter Forward Current Transfer Ratio		$V_{CE} = 20 V, I_C = 10 mA, f = 100 MHz$	2.5		3	
f_T Transition Frequency	$V_{CE} = 20 V, I_C = 10 mA$, See Note 4	250		300		MHz
C_{obo} Common-Base Open-Circuit Output Capacitance	$V_{CB} = 5 V, I_E = 0,$ $f = 100 kHz$ to 1 MHz		4		4	pF
C_{ibo} Common-Base Open-Circuit Input Capacitance	$V_{EB} = 0.5 V, I_C = 0,$ $f = 100 kHz$ to 1 MHz		8		8	pF

NOTES: 3. These parameters must be measured using pulse techniques. $t_w = 300 \mu s$, duty cycle $\leq 2\%$.

4. To obtain f_T , the $|h_{fe}|$ response with frequency is extrapolated at the rate of -6 dB per octave from $f = 100 MHz$ to the frequency at which $|h_{fe}| = 1$.

*operating characteristics at 25°C free-air temperature

PARAMETER	TEST CONDITIONS	2N3903 A5T3903		2N3904 A5T3904		UNIT
		MIN	MAX	MIN	MAX	
\overline{NF} Average Noise Figure	$V_{CE} = 5 V, I_C = 100 \mu A, R_G = 1 k\Omega,$ Noise Bandwidth = 15.7 kHz, See Note 5		6		5	dB

NOTE 5: Average Noise Figure is measured in an amplifier with response down 3 dB at 10 Hz and 10 kHz and a high-frequency rolloff of 6 dB/octave.

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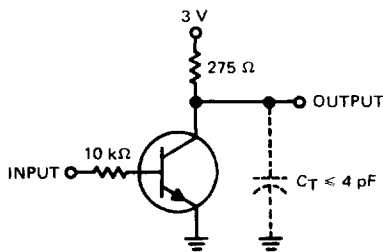
*switching characteristics at 25°C free-air temperature

PARAMETER	TEST CONDITIONS†			2N3903	2N3904	UNIT
				A5T3903	A5T3904	
t_d Delay Time	$I_C = 10 \text{ mA}$, $R_L = 275 \Omega$,	$I_{B(1)} = 1 \text{ mA}$,	$V_{BE(off)} = -0.5 \text{ V}$, See Figure 1	MAX	MAX	ns
t_r Rise Time				35	35	
t_s Storage Time	$I_C = 10 \text{ mA}$, $R_L = 275 \Omega$,	$I_{B(1)} = 1 \text{ mA}$,	$I_{B(2)} = -1 \text{ mA}$, See Figure 2	175	200	ns
t_f Fall Time				50	50	

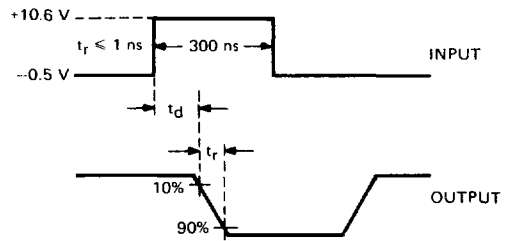
†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters. Nominal base current for delay and rise times is calculated using the minimum value of V_{BE} . Nominal base currents for storage and fall times are calculated using the maximum value of V_{BE} .

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PARAMETER MEASUREMENT INFORMATION

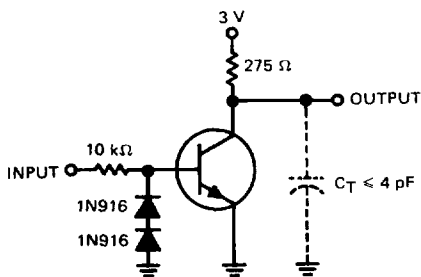


TEST CIRCUIT

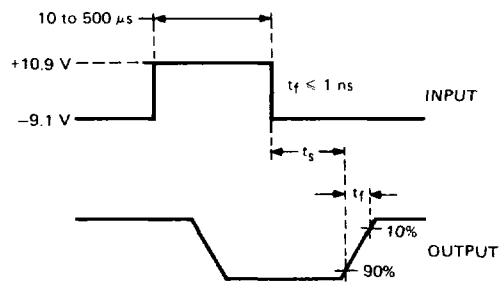


VOLTAGE WAVEFORMS

FIGURE 1—DELAY AND RISE TIMES



TEST CIRCUIT



VOLTAGE WAVEFORMS

FIGURE 2—STORAGE AND FALL TIMES

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{out} = 50 \Omega$, duty cycle = 2%.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 1 \text{ ns}$, $R_{in} = 10 \text{ M}\Omega$, $C_{in} \leq 4 \text{ pF}$.