Jameco Part Number 38359TI

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

BULLETIN NO. DL-S 7311576, NOVEMBER 1971 – REVISED MARCH 1973

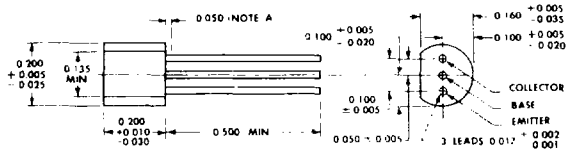
SILECT† TRANSISTORS‡
FOR GENERAL PURPOSE SATURATED-SWITCHING AND AMPLIFIER APPLICATIONS

- **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.

2N3903, 2N3904

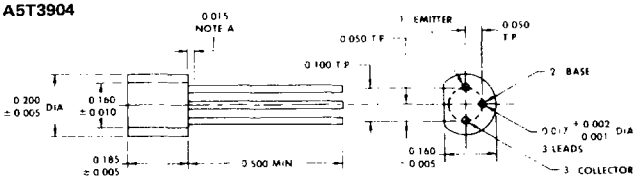


NOTES A. Lead diameter is not controlled in this area.
B. All dimensions are in inches.

*ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE

EBC

A5T3903, A5T3904



NOTES: A. *Lead diameter is not controlled in this area*
B. Leads having maximum diameter (0.019) shall be within 0.007 of their true positions measured in the gaging plane 0.054 below the seating plane of the device relative to a maximum-diameter package.
C. All dimensions are in inches.

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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 μA 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

TEXAS INSTRUMENTS
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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 μA, 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 μA, 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 μA		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	See Note 3	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	See Note 3	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	See Note 3		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	kΩ
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 μs, duty cycle ≤ 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 μA, R_G = 1 kΩ, 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.

*The asterisk identifies JEDEC registered data for the 2N3903 and 2N3904 only.

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*switching characteristics at 25°C free-air temperature

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

†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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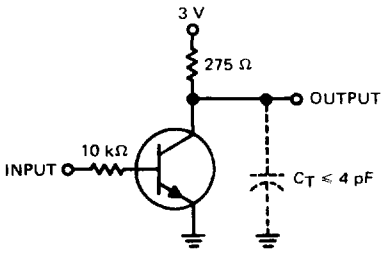
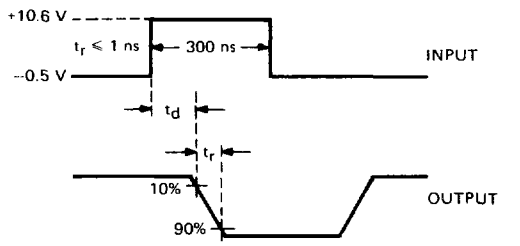
PARAMETER MEASUREMENT INFORMATION

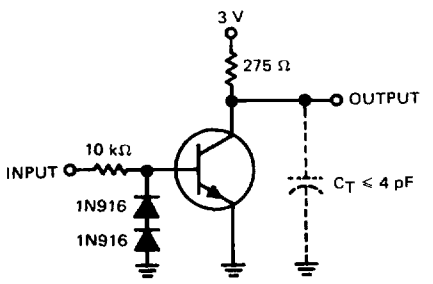


TEST CIRCUIT

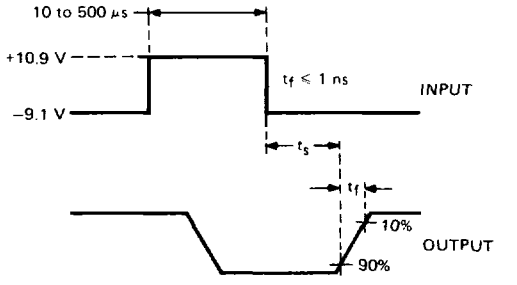


VOLTAGE WAVEFORMS

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 Ω, duty cycle = 2%.
b. Waveforms are monitored on an oscilloscope with the following characteristics: t_r ≤ 1 ns, R_{in} = 10 MΩ, C_{in} ≤ 4 pF.