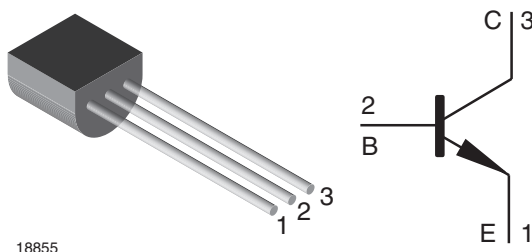


Small Signal Transistor (NPN)

Features

- NPN Silicon Epitaxial Planar Transistor for switching and amplifier applications.
- As complementary type, the PNP transistor 2N3906 is recommended.
- On special request, this transistor is also manufactured in the pin configuration TO-18.
- This transistor is also available in the SOT-23 case with the type designation MMBT3904.



Mechanical Data

Case: TO-92 Plastic case

Weight: approx. 177 mg

Packaging Codes/Options:

BULK / 5 k per container 20 k/box

TAP / 4 k per Ammopack 20 k/box

Parts Table

Part	Type differentiation	Ordering code	Remarks
2N3904		2N3904-BULK or 2N3904-TAP	Bulk / Ammopack

Absolute Maximum Ratings

$T_{amb} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified

Parameter	Test condition	Symbol	Value	Unit
Collector - emitter voltage		V_{CEO}	40	V
Collector - base voltage		V_{CBO}	60	V
Emitter - base voltage		V_{EBO}	6.0	V
Collector current		I_C	200	mA
Power dissipation	$T_A = 25\text{ }^{\circ}\text{C}$	P_{tot}	625	mW
	$T_C = 25\text{ }^{\circ}\text{C}$	P_{tot}	1.5	W

Maximum Thermal Resistance

Parameter	Test condition	Symbol	Value	Unit
Thermal resistance junction to ambient air		$R_{\theta JA}$	250 ¹⁾	$^{\circ}\text{C/W}$
Junction temperature		T_j	150	$^{\circ}\text{C}$
Storage temperature range		T_S	- 65 to + 150	$^{\circ}\text{C}$

¹⁾ Valid provided that leads are kept at ambient temperature.

Electrical DC Characteristics

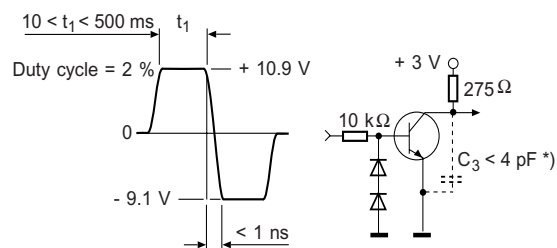
Parameter	Test condition	Symbol	Min	Typ	Max	Unit
Collector - base breakdown voltage	$I_C = 10\ \mu\text{A}$, $I_E = 0$	$V_{(BR)CBO}$	60			V
Collector - emitter breakdown voltage	$I_C = 1\ \text{mA}$, $I_B = 0$	$V_{(BR)CEO}$	40			V
Emitter - base breakdown voltage	$I_E = 10\ \mu\text{A}$, $I_C = 0$	$V_{(BR)EBO}$	6			V
Collector saturation voltage	$I_C = 10\ \text{mA}$, $I_B = 1\ \text{mA}$	V_{CEsat}			0.2	V
	$I_C = 50\ \text{mA}$, $I_B = 5\ \text{mA}$	V_{CEsat}			0.3	V
Base saturation voltage	$I_C = 10\ \text{mA}$, $I_B = 1\ \text{mA}$	V_{BEsat}			0.85	V
	$I_C = 50\ \text{mA}$, $I_B = 5\ \text{mA}$	V_{BEsat}			0.95	V
Collector-emitter cut-off current	$V_{EB} = 3\ \text{V}$, $V_{CE} = 30\ \text{V}$	I_{CEV}			50	nA
Emitter-base cut-off current	$V_{EB} = 3\ \text{V}$, $V_{CE} = 30\ \text{V}$	I_{EBV}			50	nA
DC current gain	$V_{CE} = 1\ \text{V}$, $I_C = 0.1\ \text{mA}$	h_{FE}	40			
	$V_{CE} = 1\ \text{V}$, $I_C = 1\ \text{mA}$	h_{FE}	70			
	$V_{CE} = 1\ \text{V}$, $I_C = 10\ \text{mA}$	h_{FE}	100	300		
	$V_{CE} = 1\ \text{V}$, $I_C = 50\ \text{mA}$	h_{FE}	60			
	$V_{CE} = 1\ \text{V}$, $I_C = 100\ \text{mA}$	h_{FE}	30			

Electrical AC Characteristics

Parameter	Test condition	Symbol	Min	Typ	Max	Unit
Input impedance	$V_{CE} = 10\ \text{V}$, $I_C = 1\ \text{mA}$, $f = 1\ \text{kHz}$	h_{ie}	1		10	k Ω
Voltage feedback ratio	$V_{CE} = 10\ \text{V}$, $I_C = 1\ \text{mA}$, $f = 1\ \text{kHz}$	h_{re}	0.5×10^{-4}		8×10^{-4}	
Gain - bandwidth product	$V_{CE} = 20\ \text{V}$, $I_C = 10\ \text{mA}$, $f = 100\ \text{MHz}$	f_T	300			MHz
Collector - base capacitance	$V_{CB} = 5\ \text{V}$, $f = 100\ \text{kHz}$	C_{CBO}			4	pF
Emitter - base capacitance	$V_{CB} = 0.5\ \text{V}$, $f = 100\ \text{kHz}$	C_{EBO}			8	pF
Small signal current gain	$V_{CE} = 10\ \text{V}$, $I_C = 1\ \text{mA}$, $f = 1\ \text{kHz}$	h_{fe}	100		400	
Output admittance	$V_{CE} = 1\ \text{V}$, $I_C = 1\ \text{mA}$, $f = 1\ \text{kHz}$	h_{oe}	1		40	μS
Noise figure	$V_{CE} = 5\ \text{V}$, $I_C = 100\ \mu\text{A}$, $R_G = 1\ \text{k}\Omega$, $f = 10...15000\ \text{kHz}$	NF			5	dB

Switching Characteristics

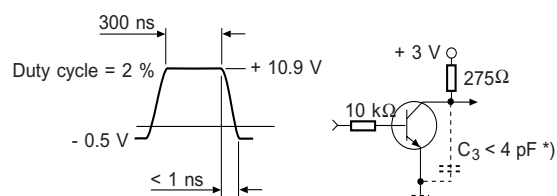
Parameter	Test condition	Symbol	Min	Typ	Max	Unit
Delay time (see fig.1)	$I_{B1} = 1\ \text{mA}$, $I_C = 10\ \text{mA}$	t_d			35	ns
Rise time (see fig.1)	$I_{B1} = 1\ \text{mA}$, $I_C = 10\ \text{mA}$	t_r			35	ns
Storage time (see fig.2)	- $I_{B1} = I_{B2} = 1\ \text{mA}$, $I_C = 10\ \text{mA}$	t_s			200	ns
Fall time (see fig.2)	- $I_{B1} = I_{B2} = 1\ \text{mA}$, $I_C = 10\ \text{mA}$	t_f			50	ns



*) total shunt capacitance of test jig and connectors

18969

Figure 1. Test Circuit for Storage and Fall Time



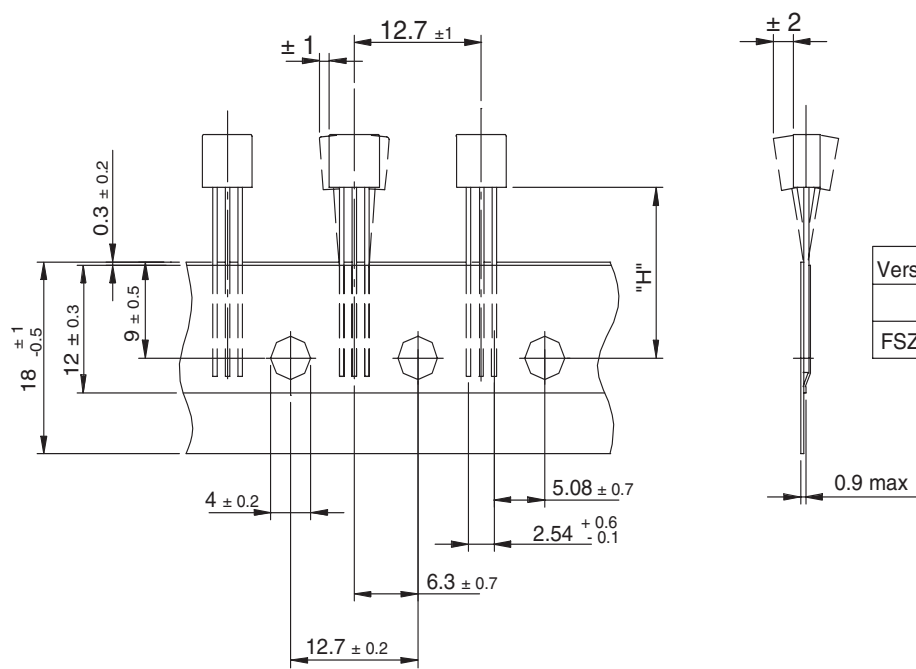
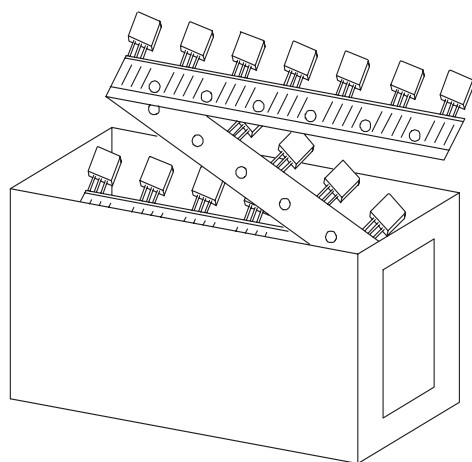
*) total shunt capacitance of test jig and connectors

18968

Figure 2. Test Circuit for Delay and Rise Time

Packaging for Radial Taping

Dimensions in mm

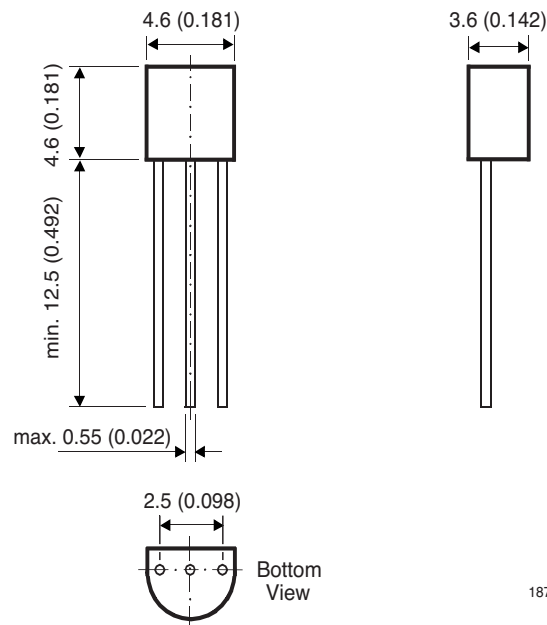


Measure limit over 20 index - holes: ± 1

Vers.	Dim. "H"
FSZ	27 ± 0.5

18787

Package Dimensions in mm (Inches)



Ozone Depleting Substances Policy Statement

It is the policy of Vishay Semiconductor GmbH to

1. Meet all present and future national and international statutory requirements.
2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Vishay Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively
2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Vishay Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

We reserve the right to make changes to improve technical design
and may do so without further notice.

Parameters can vary in different applications. All operating parameters must be validated for each customer application by the customer. Should the buyer use Vishay Semiconductors products for any unintended or unauthorized application, the buyer shall indemnify Vishay Semiconductors against all claims, costs, damages, and expenses, arising out of, directly or indirectly, any claim of personal damage, injury or death associated with such unintended or unauthorized use.

Vishay Semiconductor GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany
Telephone: 49 (0)7131 67 2831, Fax number: 49 (0)7131 67 2423