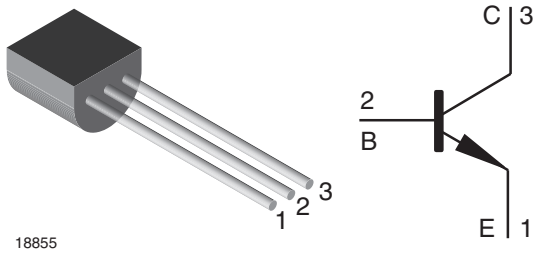
Small Signal Transistor (NPN)

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 °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 °C	P_{tot}	625	mW
	T_C = 25 °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)]	°C/W
Junction temperature		T_j	150	°C
Storage temperature range		T_S	- 65 to + 150	°C

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

Electrical DC Characteristics

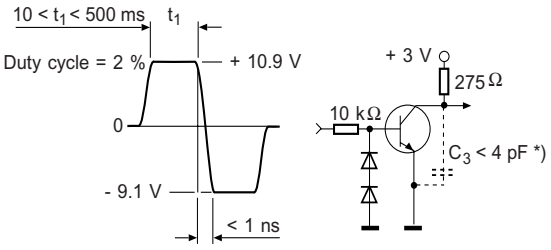
Parameter	Test condition	Symbol	Min	Typ	Max	Unit
Collector - base breakdown voltage	I_C = 10 μA, I_E = 0	$V_{(BR)CBO}$	60			V
Collector - emitter breakdown voltage	I_C = 1 mA, I_B = 0	$V_{(BR)CEO}$	40			V
Emitter - base breakdown voltage	I_E = 10 μA, I_C = 0	$V_{(BR)EBO}$	6			V
Collector saturation voltage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

Electrical AC Characteristics

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

Switching Characteristics

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



*) total shunt capacitance of test jig and connectors

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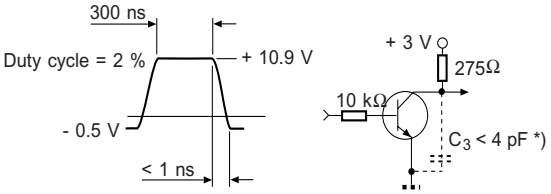
Figure 1. Test Circuit for Storage and Fall Time



*) total shunt capacitance of test jig and connectors

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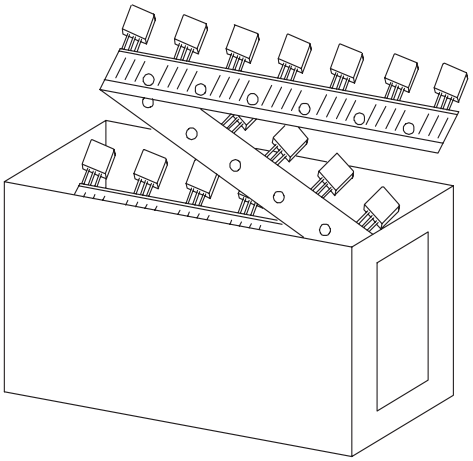
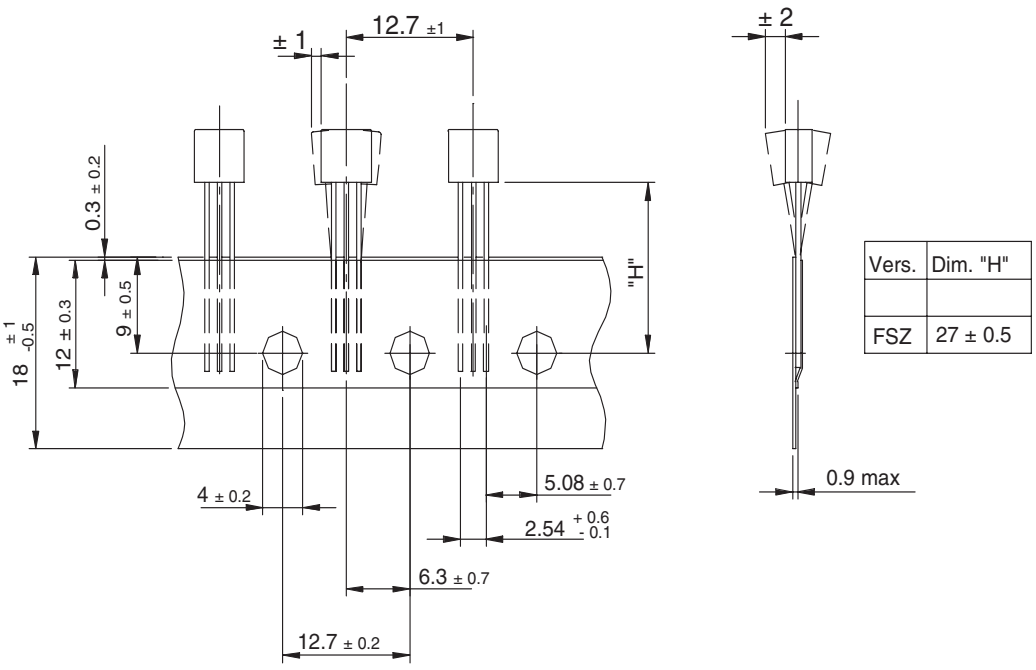
Figure 2. Test Circuit for Delay and Rise Time

Packaging for Radial Taping

Dimensions in mm





Vers.	Dim. "H"
FSZ	27 ± 0.5

Measure limit over 20 index - holes: ± 1

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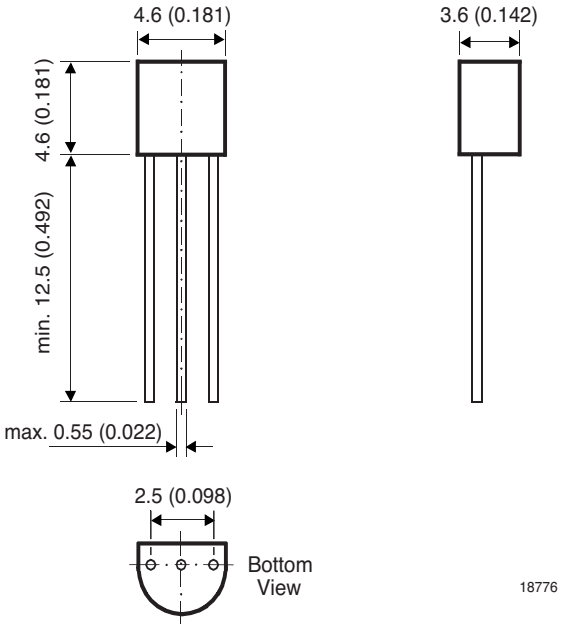
Package Dimensions in mm (Inches)



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 operatingsystems 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.

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