

## Infrared Transceiver 9.6 kbit/s to 115.2 kbit/s (SIR)

### Description

The TFBS4650 is one of the smallest IrDA® compliant transceivers available. It supports data rates up to 115 kbit/s. The transceiver consists of a PIN photo-diode, infrared emitter, and control IC in a single package.

### Features

- Compliant with the IrDA physical layer IrPHY 1.4 (low power specification, 9.6 kbit/s to 115.2 kbit/s)
- Link distance: 30 cm/20 cm full 15° cone with standard or low power IrDA, respectively. Emission intensity can be set by an external resistor to increase the range for extended low power spec to > 50 cm
- Typical transmission distance to standard device: 50 cm
- Small package -  
L 6.8 mm x W 2.8 mm x H 1.6 mm
- Low current consumption  
75 µA idle at 3.6 V



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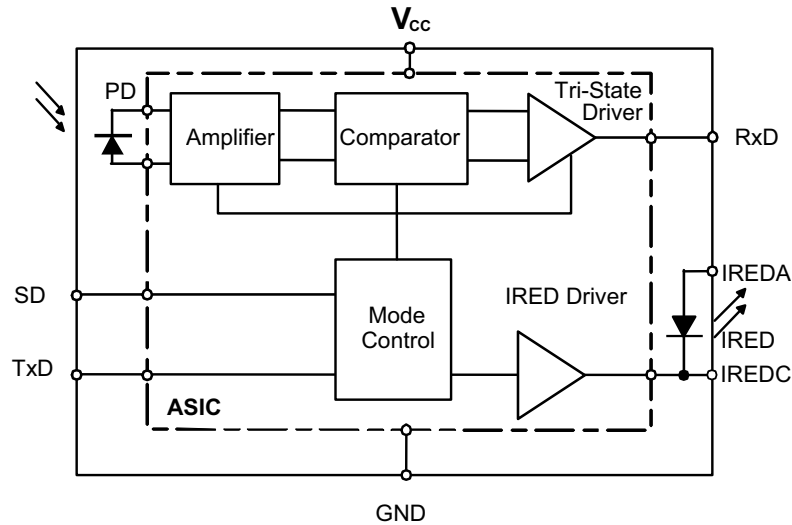
- Shutdown current 10 nA typical at 25 °C
- Operates from 2.4 V to 3.6 V within specification over full temperature range from - 25 °C to + 85 °C
- Split power supply, emitter can be driven by a separate power supply not loading the regulated. U.S. Pat. No. 6,157,476
- Lead (Pb)-free device
- Qualified for lead (Pb)-free and Sn/Pb processing (MSL4)
- Device in accordance with RoHS 2002/95/EC and WEEE 2002/96/EC

### Applications

- Mobile phone
- PDAs

### Parts Table

Part	Description	Qty / Reel
TFBS4650-TR1	Oriented in carrier tape for side view surface mounting	1000 pcs
TFBS4650-TR3	Oriented in carrier tape for side view surface mounting	2500 pcs

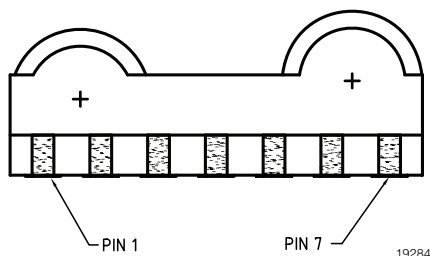
**Functional Block Diagram**


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**Pin Description**

Pin Number	Function	Description	I/O	Active
1	IREDA	IREDA Anode, connected via a current limiting resistor to $V_{CC2}$ . A separate unregulated power supply can be used.		
2	IREDC	IREDA Cathode, do not connect for standard operation		
3	TXD	Transmitter Data Input. Setting this input above the threshold turns on the transmitter. This input switches the IRED with the maximum transmit pulse width of about 50 $\mu$ s.	I	HIGH
4	RXD	Receiver Output. Normally high, goes low for a defined pulse duration with the rising edge of the optical input signal. Output is a CMOS tri-state driver, which swings between ground and $V_{CC}$ . Receiver echoes transmitter output.	O	LOW
5	SD	Shut Down. Logic Low at this input enables the receiver, enables the transmitter, and un-tri-states the receiver output. It must be driven high for shutting down the transceiver.	I	HIGH
6	$V_{CC}$	Power Supply, 2.4 V to 3.6 V. This pin provides power for the receiver and transmitter drive section. Connect $V_{CC1}$ via an optional filter.		
7	GND	Ground		

**Pinout**

 TFBS4650, bottom view  
 weight 0.05 g


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### Absolute Maximum Ratings

Reference point Pin, GND unless otherwise noted.

Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Parameter	Test Conditions	Symbol	Min	Typ.	Max	Unit
Supply voltage range, transceiver	$0\text{ V} < V_{CC2} < 6\text{ V}$	$V_{CC1}$	- 0.5		6.0	V
Supply voltage range, transmitter	$0\text{ V} < V_{CC1} < 3.6\text{ V}$	$V_{CC2}$	- 0.5		6.0	V
Voltage at RXD	All states	$V_{in}$	- 0.5		$V_{CC} + 0.5$	V
Input voltage range, transmitter TXD	Independent of $V_{CC1}$ or $V_{CC2}$	$V_{in}$	- 0.5		6.0	V
Input currents	For all pins, except IRED anode pin		- 40		40	mA
Output sinking current					20	mA
Power dissipation		$P_D$			250	mW
Junction temperature		$T_J$			125	°C
Ambient temperature range (operating)		$T_{amb}$	- 25		+ 85	°C
Storage temperature range		$T_{stg}$	- 40		+ 100	°C
Soldering temperature ***)	see section Recommended Solder Profile					°C
Repetitive pulse output current	$< 90\ \mu\text{s}$ , $t_{on} < 20\%$	$I_{IRED} (RP)$			500	mA
Average output current (transmitter)		$I_{IRED} (DC)$			100	mA
Virtual source size	Method: (1-1/e) encircled energy	d	0.8			mm
Maximum Intensity for Class 1	IEC60825-1 or EN60825-1, edition Jan. 2001	$I_e$			*) (500)**)	mW/sr

\*) Due to the internal limitation measures the device is a "class1" device.

\*\*\*) IrDA specifies the max. intensity with 500 mW/sr

\*\*\*\*) Sn/Pb-free soldering. The product passed VISHAY's standard convection reflow profile soldering test.

### Definitions:

In the Vishay transceiver data sheets the following nomenclature is used for defining the IrDA operating modes:

SIR: 2.4 kbit/s to 115.2 kbit/s, equivalent to the basic serial infrared standard with the physical layer version IrPhY 1.0

MIR: 576 kbit/s to 1152 kbit/s

FIR: 4 Mbit/s

VFIR: 16 Mbit/s

MIR and FIR were implemented with IrPhY 1.1, followed by IrPhY 1.2, adding the SIR Low Power Standard. IrPhY 1.3 extended the Low Power Option to MIR and FIR and VFIR was added with IrPhY 1.4. A new version of the standard in any case obsoletes the former version.



## Electrical Characteristics

### Transceiver

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 2.4\text{ V}$  to  $3.6\text{ V}$  unless otherwise noted.

Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Parameter	Test Conditions	Symbol	Min	Typ.	Max	Unit
Supply voltage range		$V_{CC}$	2.4		3.6	V
Dynamic supply current						
Idle, dark ambient	SD = Low (< 0.8 V), $E_{eamb} = 0\text{ klx}$ , $E_e < 4\text{ mW/m}^2$ $-25\text{ }^{\circ}\text{C} \leq T \leq +85\text{ }^{\circ}\text{C}$	$I_{CC}$		90	130	$\mu\text{A}$
Idle, dark ambient	SD = Low (< 0.8 V), $E_{eamb} = 0\text{ klx}$ , $E_e < 4\text{ mW/m}^2$ $T = +25\text{ }^{\circ}\text{C}$	$I_{CC}$		75		$\mu\text{A}$
Peak supply current during transmission	SD = Low, TXD = High	$I_{CCPK}$		2	3	mA
Shutdown supply current dark ambient	SD = High (> $V_{CC} - 0.5\text{ V}$ ), $T = 25\text{ }^{\circ}\text{C}$ , $E_e = 0\text{ klx}$	$I_{SD}$			0.1	$\mu\text{A}$
Shutdown supply current, dark ambient	SD = High (> $V_{CC} - 0.5\text{ V}$ ), $-25\text{ }^{\circ}\text{C} \leq T \leq +85\text{ }^{\circ}\text{C}$	$I_{SD}$			1.0	$\mu\text{A}$
Operating temperature range		$T_A$	-25		+85	$^{\circ}\text{C}$
Input voltage low (TXD, SD)		$V_{IL}$	-0.5		0.5	V
Input voltage high	$V_{CC} = 2.4\text{ V}$ to $3.6\text{ V}$	$V_{IH}$	$V_{CC} - 0.5$		6.0	V
Input voltage threshold SD	$V_{CC} = 2.4\text{ V}$ to $3.6\text{ V}$		0.9	1.35	1.8	V
Output voltage low	$V_{CC} = 2.4\text{ V}$ to $3.6\text{ V}$ $C_{LOAD} = 15\text{ pF}$	$V_{OL}$	-0.5		$V_{CC} \times 0.15$	V
Output voltage high	$V_{CC} = 2.4\text{ V}$ to $3.6\text{ V}$ $C_{LOAD} = 15\text{ pF}$	$V_{OH}$	$V_{CC} \times 0.8$		$V_{CC} + 0.5$	V
RXD to $V_{CC}$ pull-up impedance	SD = $V_{CC}$ $V_{CC} = 2.4\text{ V}$ to $5\text{ V}$	$R_{RXD}$		500		$\text{k}\Omega$
Input capacitance (TXD, SD)		$C_I$			6	pF

## Optoelectronic Characteristics

### Receiver

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 2.4\text{ V}$  to  $3.6\text{ V}$  unless otherwise noted.

Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Parameter	Test Conditions	Symbol	Min	Typ.	Max	Unit
Sensitivity: Minimum irradiance $E_e$ in angular range **)	9.6 kbit/s to 115.2 kbit/s $\lambda = 850\text{ nm}$ to $900\text{ nm}$	$E_e$		40 (4.0)	81 (8.1)	$\text{mW}/\text{m}^2$ ( $\mu\text{W}/\text{cm}^2$ )
Maximum irradiance $E_e$ in angular range ***)	$\lambda = 850\text{ nm}$ to $900\text{ nm}$	$E_e$	5 (500)			$\text{kW}/\text{m}^2$ ( $\text{mW}/\text{cm}^2$ )
No receiver output input irradiance	According to IrDA IrPHY 1.4, Appendix A1, fluorescent light specification	$E_e$	4 (0.4)			$\text{mW}/\text{m}^2$ ( $\mu\text{W}/\text{cm}^2$ )
Rise time of output signal	10 % to 90 %, $C_L = 15\text{ pF}$	$t_r(\text{RXD})$	20		100	ns
Fall time of output signal	90 % to 10 %, $C_L = 15\text{ pF}$	$t_f(\text{RXD})$	20		100	ns
RXD pulse width of output signal, 50%****)	Input pulse width $1.63\text{ }\mu\text{s}$	$t_{PW}$	1.7	2.0	2.9	$\mu\text{s}$
Receiver start up time	Power on delay			100	150	$\mu\text{s}$
Latency		$t_L$		50	200	$\mu\text{s}$

\*) This parameter reflects the backlight test of the IrDA physical layer specification to guarantee immunity against light from fluorescent lamps

\*\*) IrDA sensitivity definition: Minimum Irradiance  $E_e$  In Angular Range, power per unit area. The receiver must meet the BER specification while the source is operating at the minimum intensity in angular range into the minimum half-angle range at the maximum Link Length

\*\*\*) Maximum Irradiance  $E_e$  In Angular Range, power per unit area. The optical delivered to the detector by a source operating at the maximum intensity in angular range at Minimum Link Length must not cause receiver overdrive distortion and possible related link errors. If placed at the Active Output Interface reference plane of the transmitter, the receiver must meet its bit error ratio (BER) specification.

\*\*\*\*) RXD output is edge triggered by the rising edge of the optical input signal. The output pulse duration is independent of the input pulse duration.

For more definitions see the document "Symbols and Terminology" on the Vishay Website (<http://www.vishay.com/docs/82512/82512.pdf>).



**Transmitter**

T<sub>amb</sub> = 25 °C, V<sub>CC</sub> = 2.4 V to 3.6 V unless otherwise noted.

Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Parameter	Test Conditions	Symbol	Min	Typ.	Max	Unit
IRED operating current, current controlled	The IRED current is internally controlled but also can be reduced by an external resistor R1	I <sub>D</sub>	200		400	mA
Output leakage IRED current	T <sub>amb</sub> = 85°C	I <sub>IRED</sub>			1	µA
Output radiant intensity *)	α = 0°, 15°, TXD = High, SD = Low, V <sub>CC1</sub> = 3.0 V, V <sub>CC2</sub> = 3.0 V, R1 = 30 Ω (resulting in about 50 mA drive current)	I <sub>e</sub>	4		150	mW/sr
Output radiant intensity *)	α = 0°, 15°, TXD = High, SD = Low, V <sub>CC1</sub> = 3.0 V, V <sub>CC2</sub> = 3.0 V, R1 = 0 Ω, I <sub>f</sub> = 300 mA	I <sub>e</sub>		25		mW/sr
Output radiant intensity *)	V <sub>CC1</sub> = 5.0 V, α = 0°, 15° TXD = Low or SD = High (Receiver is inactive as long as SD = High)	I <sub>e</sub>			0.04	mW/sr
Saturation voltage of IRED driver	V <sub>CC</sub> = 3.0 V, I <sub>f</sub> = 50 mA	V <sub>CEsat</sub>		0.4		V
Peak - emission wavelength		λ <sub>p</sub>	880	886	900	nm
Optical rise time, Optical fall time		t <sub>ropt</sub> , t <sub>fopt</sub>	20		100	ns
Optical output pulse duration	Input pulse width t < 30 µs Input pulse width t ≥ 30 µs	t <sub>opt</sub> t <sub>opt</sub>	30	t 50	300	µs µs
Optical output pulse duration	Input pulse width t = 1.63 µs	t <sub>opt</sub>	1.45	1.61	2.2	µs
Optical overshoot					20	%

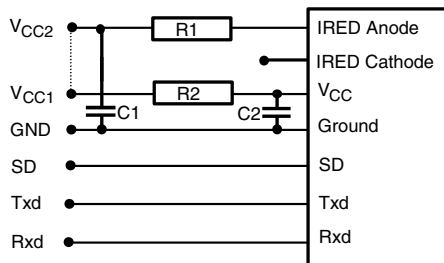
\*) The radiant intensity can be adjusted by the external current limiting resistor to adapt the intensity to the desired value. The given value is for minimum current consumption. This transceiver can be adapted to > 50 cm operation by increasing the current to > 200 mA, e.g. operating the transceiver without current control resistor (i.e. R1 = 0 Ω) and using the internal current control.

**Table 1.  
Truth table**

Inputs			Outputs	
SD	TXD	Optical input Irradiance mW/m <sup>2</sup>	RXD	Transmitter
high	x	x	Tri-state floating with a weak pull-up to the supply voltage	0
low	high	x	low (echo on)	I <sub>e</sub>
low	high > 50 µs	x	high	0
low	low	< 4	high	0
low	low	> Min. irradiance E <sub>e</sub> < Max. irradiance E <sub>e</sub>	low (active)	0
low	low	> Max. irradiance E <sub>e</sub>	x	0

**Recommended Circuit Diagram**

Operated at a clean low impedance power supply the TFBS4650 needs only one additional external component when the IRED drive current should be minimized for minimum current consumption according the low power IrDA standard. When combined operation in IrDA and Remote Control is intended no current limiting resistor is recommended. However, depending on the entire system design and board layout, additional components may be required (see figure 1). When long wires are used for bench tests, the capacitors are mandatory for testing rise/fall time correctly.



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Figure 1. Recommended Application Circuit

The capacitor C1 is buffering the supply voltage V<sub>CC2</sub> and eliminates the inductance of the power supply line. This one should be a small ceramic version or other fast capacitor to guarantee the fast rise time of the IRED current. The resistor R1 is necessary for controlling the IRED drive current when the internally controlled current is too high for the application.

Vishay transceivers integrate a sensitive receiver and a built-in power driver. The combination of both needs a careful circuit board layout. The use of thin, long, resistive and inductive wiring should be avoided. The inputs (TXD, SD) and the output RXD should be directly (DC) coupled to the I/O circuit.

The capacitor C2 combined with the resistor R2 is the low pass filter for smoothing the supply voltage.

As already stated above R2, C1 and C2 are optional and depend on the quality of the supply voltages V<sub>CCx</sub> and injected noise. An unstable power supply with dropping voltage during transmission may reduce the sensitivity (and transmission range) of the transceiver.

The placement of these parts is critical. It is strongly

recommended to position C2 as close as possible to the transceiver power supply pins.

When connecting the described circuit to the power supply, low impedance wiring should be used.

In case of extended wiring the inductance of the power supply can cause dynamically a voltage drop at V<sub>CC2</sub>. Often some power supplies are not able to follow the fast current rise time. In that case another 10 µF cap at V<sub>CC2</sub> will be helpful.

Keep in mind that basic RF-design rules for circuit design should be taken into account. Especially longer signal lines should not be used without termination. See e.g. "The Art of Electronics" Paul Horowitz, Wienfield Hill, 1989, Cambridge University Press, ISBN: 0521370957.

**Table 2.**  
**Recommended Application Circuit Components**

Component	Recommended Value
C1, C2	0.1 µF, Ceramic Vishay part# VJ 1206 Y 104 J XXMT
R1	See table 3
R2	47 Ω, 0.125 W (V <sub>CC1</sub> = 3 V)

**Table 3.**  
**Recommended resistor R1 [Ω]**

V <sub>CC2</sub> [V]	Minimized current consumption, IrDA Low power compliant
2.7	24
3.0	30
3.3	36

## Recommended Solder Profiles

### Solder Profile for Sn/Pb soldering

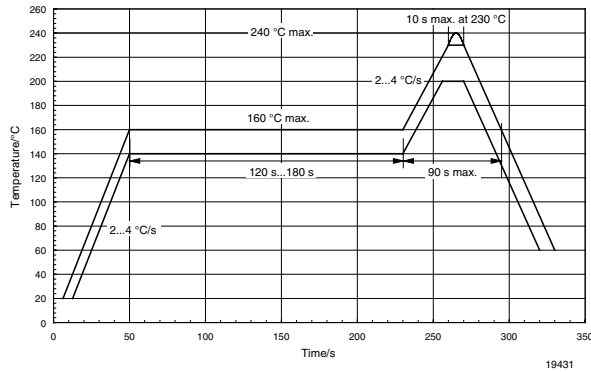


Figure 2. Recommended Solder Profile for Sn/Pb soldering

### Lead (Pb)-Free, Recommended Solder Profile

The TFBS4650 is a lead (Pb)-free transceiver and qualified for lead (Pb)-free processing. For lead (Pb)-free solder paste like Sn(3.0-4.0)Ag(0.5-0.9)Cu, there are two standard reflow profiles: Ramp-Soak-Spike (RSS) and Ramp-To-Spike (RTS). The Ramp-Soak-Spike profile was developed primarily for reflow ovens heated by infrared radiation. With widespread use of forced convection reflow ovens the Ramp-To-Spike profile is used increasingly. Shown below in figure 3 is VISHAY's recommended profiles for use with the TFBS4650 transceivers. For more details please refer to Application note: SMD Assembly Instruction.

### Wave Soldering

For TFDUxxxx and TFBSxxxx transceiver devices wave soldering is not recommended.

### Manual Soldering

Manual soldering is the standard method for lab use. However, for a production process it cannot be recommended because the risk of damage is highly dependent on the experience of the operator. Nevertheless, we added a chapter to the above mentioned application note, describing manual soldering and desoldering.

### Storage

The storage and drying processes for all VISHAY transceivers (TFDUxxxx and TFBSxxxx) are equivalent to MSL4.

The data for the drying procedure is given on labels on the packing and also in the application note "Taping, Labeling, Storage and Packing" (<http://www.vishay.com/docs/82601/82601.pdf>).

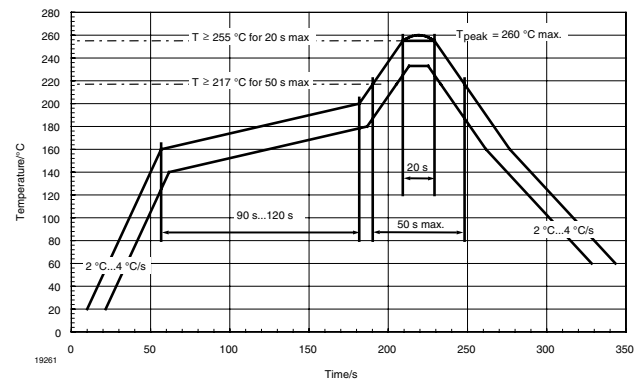
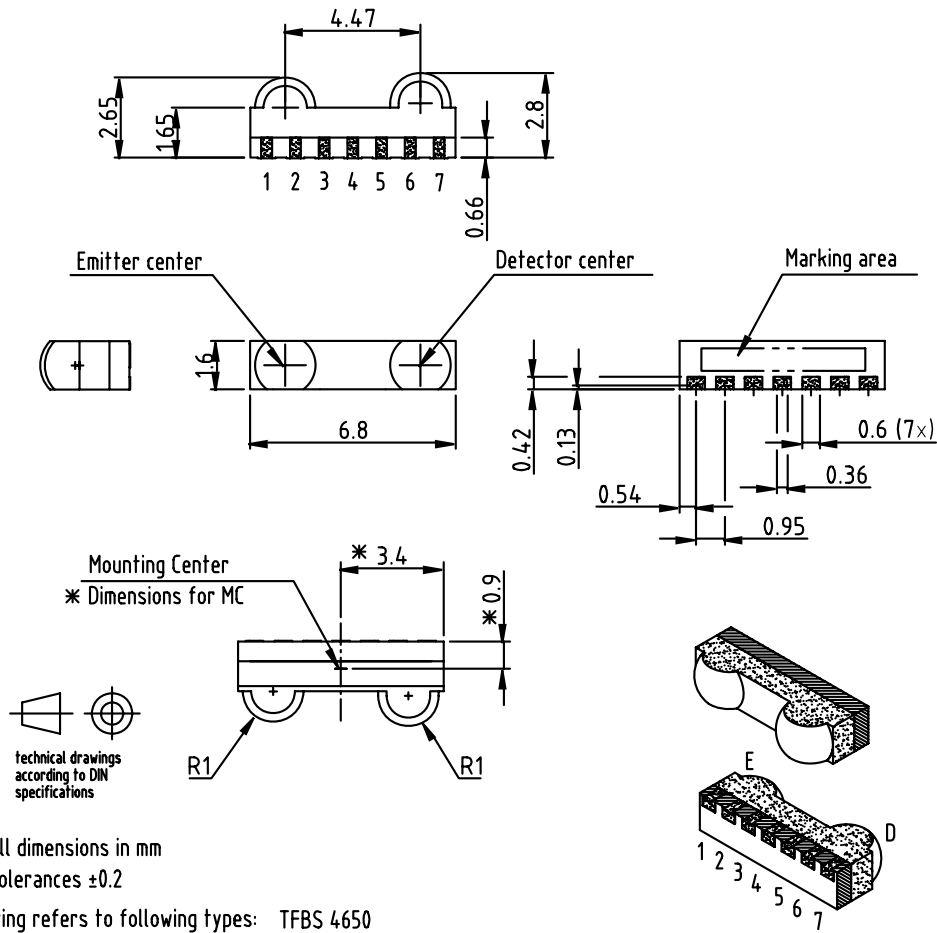


Figure 3. Solder Profile, RSS Recommendation



Package Dimensions



All dimensions in mm  
Tolerances  $\pm 0.2$

Drawing refers to following types: TFBS 4650  
TFBS 4652

Drawing-No.: 6.550-5268.01-4

Issue: 2; 06.03.06

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Figure 4. TFBS4650 mechanical dimensions, tolerance  $\pm 0.2$  mm, if not otherwise mentioned

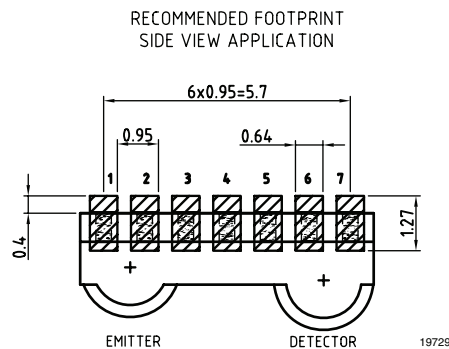
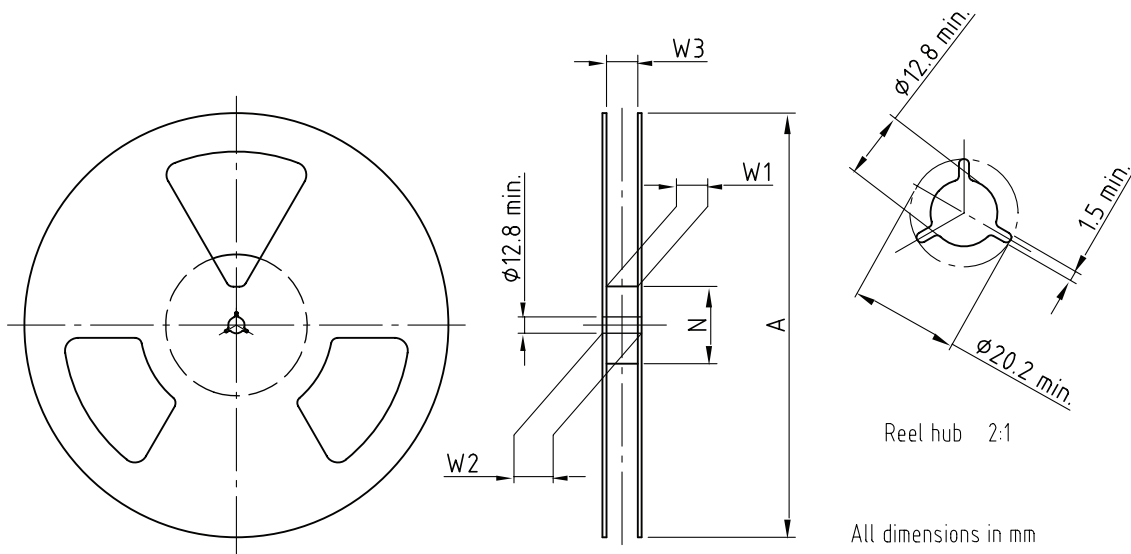


Figure 5. TFBS4650 soldering footprint, tolerance  $\pm 0.2$  mm, if not otherwise mentioned

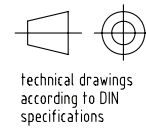
**Reel Dimensions**



Drawing-No.: 9.800-5090.01-4  
 Issue: 1; 29.11.05  
 14017

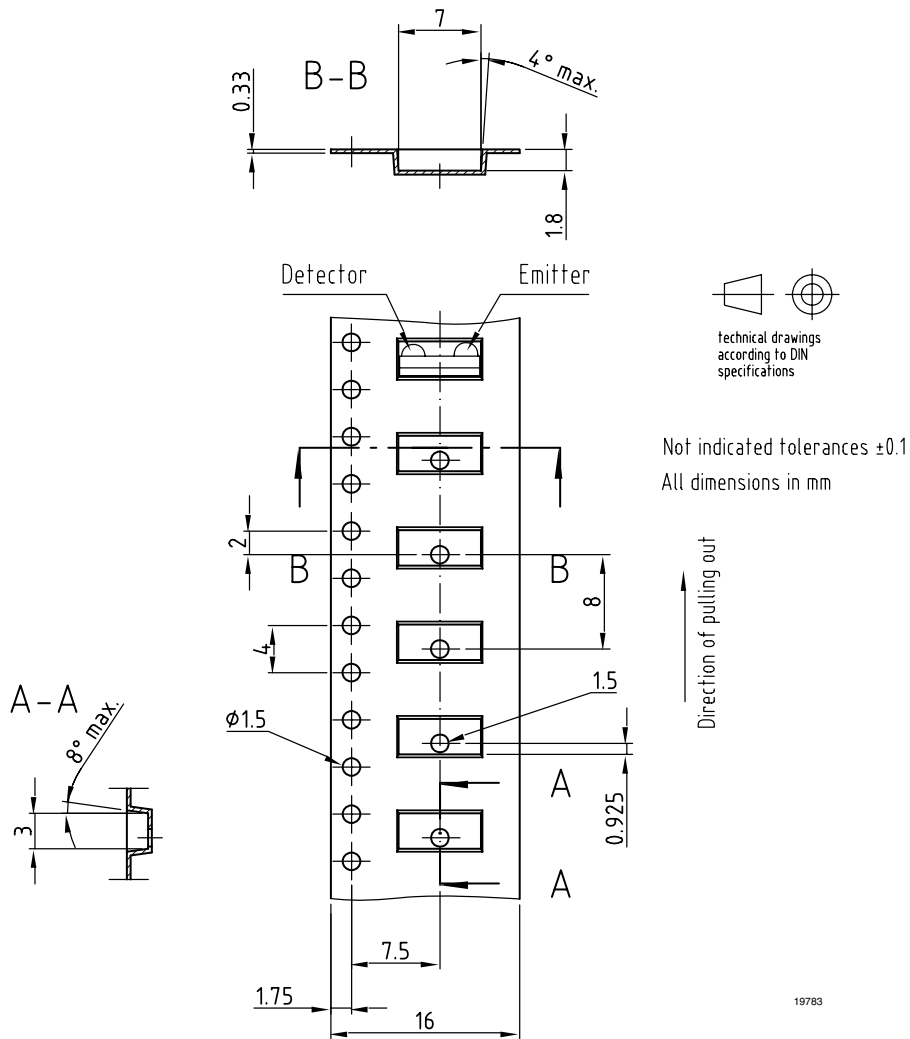
Form of the leave open  
 of the wheel is supplier specific.

Dimension acc. to IEC EN 60 286-3



Tape Width	A max.	N	$W_1$ min.	$W_2$ max.	$W_3$ min.	$W_3$ max.
mm	mm	mm	mm	mm	mm	mm
16	330	50	16.4	22.4	15.9	19.4

Tape Dimensions in mm



Drawing-No.: 9.700-5296.01-4  
Issue: 1; 08.12.04

Drawing refers to following types: TFBS 4650  
TFBS 5700

### 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.

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