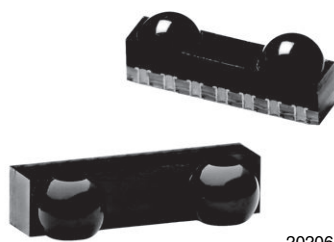


## Infrared Transceiver, 9.6 kbit/s to 115.2 kbit/s (SIR)



20206


**RoHS**  
COMPLIANT

### 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 x W x H in mm): 6.8 x 2.8 x 1.6
- Low current consumption 75 µA idle at 3.6 V
- Shutdown current 10 nA typical at 25 °C
- Operates from 2.4 V to 5.5 V within specification over full temperature range from -30 °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
- Qualified for lead (Pb)-free and Sn/Pb processing (MSL4)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### DESIGN SUPPORT TOOLS AVAILABLE



### DESCRIPTION

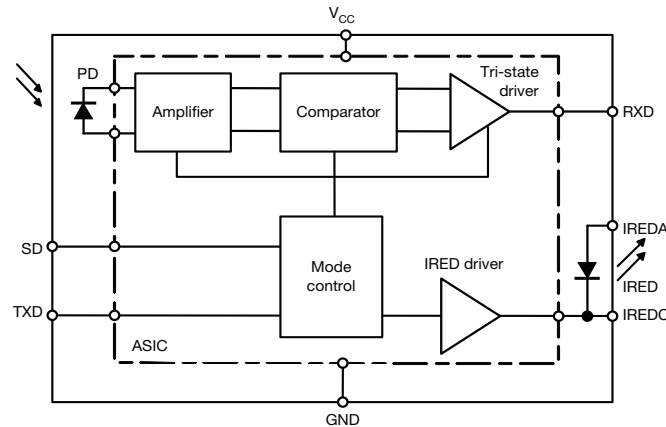
The TFBS4650 is one of the smallest IrDA® compliant transceivers available. It supports data rates up to 115 kbit/s. The transceiver consists of a PIN photodiode, infrared emitter, and control IC in a single package.

### APPLICATIONS

- Mobile phone
- PDAs

| PRODUCT SUMMARY |                    |                                     |                   |                       |                          |
|-----------------|--------------------|-------------------------------------|-------------------|-----------------------|--------------------------|
| PART NUMBER     | DATA RATE (kbit/s) | DIMENSIONS H x L x W (mm x mm x mm) | LINK DISTANCE (m) | OPERATING VOLTAGE (V) | IDLE SUPPLY CURRENT (mA) |
| TFBS4650        | 115.2              | 1.6 x 6.8 x 2.8                     | 0 to ≥ 0.3        | 2.4 to 5.5            | 0.075                    |

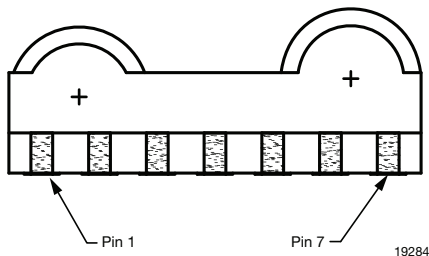
| PARTS TABLE  |   |          |
|--------------|---|----------|
| PART         | DESCRIPTION   | QTY/REEL |
| TFBS4650-TR1 | Oriented in carrier tape for side view surface mounting | 1000 pcs |
| TFBS4650-TR3 | Oriented in carrier tape for side view surface mounting | 2500 pcs |
| TFBS4650-TR4 | Oriented in carrier tape for side view surface mounting | 6000 pcs |
| TFBS4650-TT3 | Oriented in carrier tape for top view surface mounting  | 2500 pcs |

**FUNCTIONAL BLOCK DIAGRAM**


19283

| PIN DESCRIPTION |          |   |     |        |
|-----------------|----------|---|-----|--------|
| PIN NUMBER      | SYMBOL   | DESCRIPTION   | I/O | ACTIVE |
| 1               | IREDA    | IRED anode, connected via a current limiting resistor to $V_{CC2}$ . A separate unregulated power supply can be used.   |     |        |
| 2               | IREDC    | IRED 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 100 $\mu$ 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       | Shutdown. 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

**Definitions:**

In the Vishay transceiver datasheets 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.



| ABSOLUTE MAXIMUM RATINGS               |   |                        |      |      |                       |      |
|--|---|------------------------|------|------|-----------------------|------|
| PARAMETER                              | TEST CONDITIONS                                     | SYMBOL                 | MIN. | TYP. | MAX.                  | UNIT |
| Supply voltage range, transceiver      | 0 V < V <sub>CC2</sub> < 6 V                        | V <sub>CC1</sub>       | -0.5 | -    | 6                     | V    |
| Supply voltage range, transmitter      | 0 V < V <sub>CC1</sub> < 6 V                        | V <sub>CC2</sub>       | -0.5 | -    | 6                     | V    |
| Voltage at RXD                         | All states  | V <sub>IN</sub>        | -0.5 | -    | V <sub>CC</sub> + 0.5 | V    |
| Input voltage range, transmitter TXD   | Independent of V <sub>CC1</sub> or V <sub>CC2</sub> | V <sub>IN</sub>        | -0.5 | -    | 6                     | V    |
| Input currents                         | For all pins, except IRED anode pin                 |                        | -40  | -    | 40                    | mA   |
| Output sinking current                 |   |                        | -    | -    | 20                    | mA   |
| Power dissipation                      |   | P <sub>D</sub>         | -    | -    | 250                   | mW   |
| Junction temperature                   |   | T <sub>J</sub>         | -    | -    | 125                   | °C   |
| Ambient temperature range (operating)  |   | T <sub>amb</sub>       | -30  | -    | +85                   | °C   |
| Storage temperature range              |   | T <sub>stg</sub>       | -40  | -    | +100                  | °C   |
| Soldering temperature <sup>(1)</sup>   | See section "Recommended Solder Profile"            |                        | -    | -    | -                     | °C   |
| Repetitive pulse output current        | < 90 μs, t <sub>on</sub> < 20 %                     | I <sub>IRED</sub> (RP) | -    | -    | 500                   | mA   |
| Average output current (transmitter)   |   | I <sub>IRED</sub> (DC) | -    | -    | 100                   | mA   |
| Thermal resistance junction-to-ambient | JESD51  | R <sub>thJA</sub>      | -    | 300  | -                     | K/W  |

Notes

- Reference point pin, ground unless otherwise noted
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
- <sup>(1)</sup> Sn/lead (Pb)-free soldering. The product passed Vishay's standard convection reflow profile soldering test

| EYE SAFETY INFORMATION  |                |
|---|----------------|
| STANDARD  | CLASSIFICATION |
| IEC/EN 60825-1 (2007-03), DIN EN 60825-1 (2008-05) "SAFETY OF LASER PRODUCTS - Part 1: equipment classification and requirements", simplified method  | Class 1        |
| IEC 62471 (2006), CIE S009 (2002) "Photobiological Safety of Lamps and Lamp Systems"  | Exempt         |
| DIRECTIVE 2006/25/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 <sup>th</sup> April 2006 on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation) (19 <sup>th</sup> individual directive within the meaning of article 16(1) of directive 89/391/EEC) | Exempt         |

Note

- Vishay transceivers operating inside the absolute maximum ratings are classified as eye safe according the above table



| <b>ELECTRICAL CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , $V_{CC} = 2.4\text{ V to }3.6\text{ V}$ unless otherwise noted) |  |            |                     |      |                      |                    |
|--|--|------------|---------------------|------|----------------------|--------------------|
| PARAMETER  | TEST CONDITIONS  | SYMBOL     | MIN.                | TYP. | MAX.                 | UNIT               |
| <b>TRANSCEIVER</b>   |  |            |                     |      |                      |                    |
| Supply voltage range   |  | $V_{CC}$   | 2.4                 | -    | 5.5                  | V                  |
| Dynamic supply current   |  |            |                     |      |                      |                    |
| Idle, dark ambient   | SD = low (< 0.8 V),<br>$E_{eamb} = 0\text{ klx}$ ,<br>$E_e < 4\text{ mW/m}^2$ ,<br>$-25\text{ }^{\circ}\text{C} \leq T \leq +85\text{ }^{\circ}\text{C}$ | $I_{CC}$   | -                   | 90   | 130                  | $\mu\text{A}$      |
| Idle, dark ambient   | SD = low (< 0.8 V),<br>$E_{eamb} = 0\text{ klx}$ ,<br>$E_e < 4\text{ mW/m}^2$ ,<br>$T = +25\text{ }^{\circ}\text{C}$                                     | $I_{CC}$   | -                   | 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<br>( $> V_{CC} - 0.5\text{ V}$ ),<br>$T = 25\text{ }^{\circ}\text{C}$ , $E_e = 0\text{ klx}$   | $I_{SD}$   | -                   | -    | 0.1                  | $\mu\text{A}$      |
| Shutdown supply current, dark ambient  | SD = high<br>( $> V_{CC} - 0.5\text{ V}$ ),<br>$-25\text{ }^{\circ}\text{C} \leq T \leq +85\text{ }^{\circ}\text{C}$                                     | $I_{SD}$   | -                   | -    | 1                    | $\mu\text{A}$      |
| Operating temperature range  |  | $T_A$      | -30                 | -    | +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                    | 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   | $V_{CC} = 2.4\text{ V to }3.6\text{ V}$<br>$C_{LOAD} = 15\text{ pF}$   | $V_{OL}$   | -0.5                | -    | $V_{CC} \times 0.15$ | V                  |
| Output voltage high  | $V_{CC} = 2.4\text{ V to }3.6\text{ V}$<br>$C_{LOAD} = 15\text{ pF}$   | $V_{OH}$   | $V_{CC} \times 0.8$ | -    | $V_{CC} + 0.5$       | V                  |
| RXD to $V_{CC}$ pull-up impedance  | SD = $V_{CC}$<br>$V_{CC} = 2.4\text{ V to }5\text{ V}$   | $R_{RXD}$  | -                   | 500  | -                    | $\text{k}\Omega$   |
| Input capacitance (TXD, SD)  |  | $C_I$      | -                   | -    | 6                    | pF                 |

**Note**

- Typical values are for design aid only, not guaranteed nor subject to production testing



| <b>OPTOELECTRONIC CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , $V_{CC} = 2.4\text{ V}$ to $3.6\text{ V}$ unless otherwise noted) |  |                            |            |           |             |   |
|--|--|----------------------------|------------|-----------|-------------|---|
| PARAMETER  | TEST CONDITIONS  | SYMBOL                     | MIN.       | TYP.      | MAX.        | UNIT  |
| <b>RECEIVER</b>  |  |                            |            |           |             |   |
| Sensitivity: minimum irradiance $E_e$ in angular range <sup>(1)(2)</sup>   | 9.6 kbit/s to 115.2 kbit/s<br>$\lambda = 850\text{ nm}$ to $900\text{ nm}$   | $E_e$                      | -          | 40<br>(4) | 81<br>(8.1) | $\text{mW}/\text{m}^2$<br>( $\mu\text{W}/\text{cm}^2$ ) |
| Maximum irradiance $E_e$ in angular range  | $\lambda = 850\text{ nm}$ to $900\text{ nm}$   | $E_e$                      | 5<br>(500) | -         | -           | $\text{kW}/\text{m}^2$<br>( $\text{mW}/\text{cm}^2$ )   |
| No receiver output input irradiance <sup>(3)</sup>   | According to IrDA IrPHY 1.4, appendix A1, fluorescent light specification  | $E_e$                      | 4<br>(0.4) | -         | -           | $\text{mW}/\text{m}^2$<br>( $\mu\text{W}/\text{cm}^2$ ) |
| Rise time of output signal   | 10 % to 90 %, $C_L = 15\text{ pF}$   | $t_{r(RXD)}$               | 20         | -         | 100         | ns  |
| Fall time of output signal   | 90 % to 10 %, $C_L = 15\text{ pF}$   | $t_{f(RXD)}$               | 20         | -         | 100         | ns  |
| RXD pulse width of output signal, 50 % <sup>(4)</sup>  | Input pulse width<br>1.63 $\mu\text{s}$  | $t_{PW}$                   | 1.7        | 2         | 2.9         | $\mu\text{s}$   |
| Receiver start up time   | Power on delay   |                            | -          | 100       | 150         | $\mu\text{s}$   |
| Latency  |  | $t_L$                      | -          | 50        | 200         | $\mu\text{s}$   |
| <b>TRANSMITTER</b>   |  |                            |            |           |             |   |
| IRED operating current, current controlled   | The IRED current is internally controlled but also can be reduced by an external resistor R1   | $I_D$                      | 200        | 300       | 400         | mA  |
| Forward voltage of built-in IRED   | $I_F = 300\text{ mA}$  | $V_F$                      | 1.4        | 1.8       | 1.9         | V   |
| Output leakage IRED current  | $T_{amb} = 85\text{ }^{\circ}\text{C}$   | $I_{IRED}$                 | -          | -         | 1           | $\mu\text{A}$   |
| Output radiant intensity <sup>(5)</sup>  | $a = 0^{\circ}, 15^{\circ}$ , TXD = high, SD = low, $V_{CC1} = 3\text{ V}$ , $V_{CC2} = 3\text{ V}$ , $R1 = 30\text{ }\Omega$ (resulting in about 50 mA drive current) | $I_e$                      | 5          | 10        | 25          | $\text{mW}/\text{sr}$                                   |
| Output radiant intensity <sup>(5)</sup>  | $a = 0^{\circ}, 15^{\circ}$ , TXD = high, SD = low, $V_{CC1} = 3\text{ V}$ , $V_{CC2} = 3\text{ V}$ , $R1 = 0\text{ }\Omega$ , $I_F = 300\text{ mA}$                   | $I_e$                      | 30         | 65        | 150         | $\text{mW}/\text{sr}$                                   |
| Output radiant intensity <sup>(5)</sup>  | $V_{CC1} = 5\text{ V}$ , $a = 0^{\circ}, 15^{\circ}$<br>TXD = low or SD = high<br>(receiver is inactive as long as SD = high)  | $I_e$                      | -          | -         | 0.04        | $\text{mW}/\text{sr}$                                   |
| Saturation voltage of IRED driver  | $V_{CC} = 3\text{ V}$ , $I_F = 50\text{ mA}$   | $V_{CEsat}$                | -          | 0.4       | -           | V   |
| Peak - emission wavelength   |  | $\lambda_p$                | 880        | 886       | 900         | nm  |
| Spectral bandwidth   |  | $\Delta\lambda$            | -          | 45        | -           | nm  |
| Optical rise time, optical fall time   |  | $t_{ropt}$ ,<br>$t_{fopt}$ | 20         | -         | 100         | ns  |
| Optical output pulse duration  | Input pulse width $t < 30\text{ }\mu\text{s}$<br>Input pulse width $t \geq 30\text{ }\mu\text{s}$  | $t_{opt}$<br>$t_{opt}$     | 30         | t<br>50   | 300         | $\mu\text{s}$<br>$\mu\text{s}$                          |
| Optical output pulse duration  | Input pulse width $t = 1.63\text{ }\mu\text{s}$  | $t_{opt}$                  | 1.45       | 1.61      | 2.2         | $\mu\text{s}$   |
| Optical overshoot  |  |                            | -          | -         | 20          | %   |

**Notes**

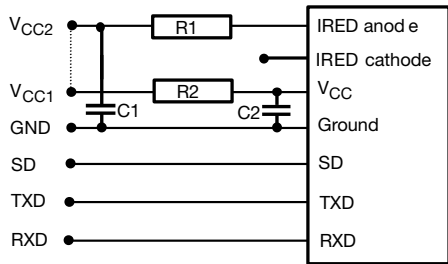
- Typical values are for design aid only, not guaranteed nor subject to production testing
- (2) This parameter reflects the backlight test of the IrDA physical layer specification to guarantee immunity against light from fluorescent lamps.
- (3) IrDA sensitivity definition: minimum irradiance  $E_e$  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-angular range at the maximum link length
- (4) 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. For more definitions see the document "Symbols and Terminology" on the Vishay website
- (5) 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
- (6) 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  $> 50\text{ cm}$  operation by increasing the current to  $> 200\text{ mA}$ , e.g. operating the transceiver without current control resistor (i.e.  $R1 = 0\text{ }\Omega$ ) and using the internal current control

| 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><br>< 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 Fig. 1). When long wires are used for bench tests, the capacitors are mandatory for testing rise / fall time correctly.



19286

Fig. 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 is 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.

**RECOMMENDED APPLICATION CIRCUIT COMPONENTS**

| COMPONENT | RECOMMENDED VALUE                                 |
|-----------|---|
| C1, C2    | 0.1 μF, Ceramic Vishay part# VJ 1206 Y 104 J XXMT |
| R1        | See table below                                   |
| R2        | 47 Ω, 0.125 W (V <sub>CC1</sub> = 3 V)            |

**RECOMMENDED RESISTOR R1 (Ω)**

| V <sub>CC2</sub> (V) | MINIMIZED CURRENT CONSUMPTION, IrDA LOW POWER COMPLIANT |
|----------------------|---|
| 2.7                  | 24  |
| 3                    | 30  |
| 3.3                  | 36  |

**RECOMMENDED SOLDER PROFILES**

**Solder Profile for Sn/Pb Soldering**

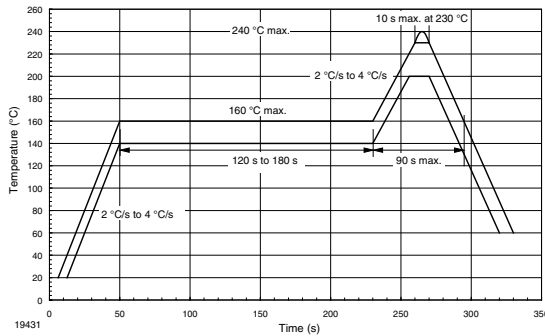


Fig. 2 - Recommended Solder Profile for Sn/Pb Soldering

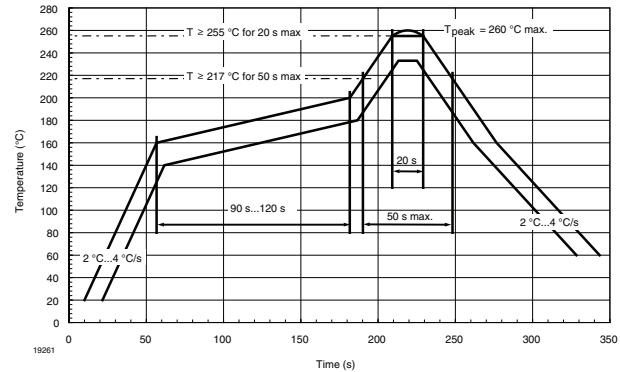


Fig. 3 - Solder Profile, RSS Recommendation

**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<sub>(3.0 - 4.0)</sub>Ag<sub>(0.5 - 0.9)</sub>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 in Fig. 3 is Vishay's recommended profiles for use with the TFBS4650 transceivers. For more details please refer to the application note "SMD Assembly Instructions".

**Wave Soldering**

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

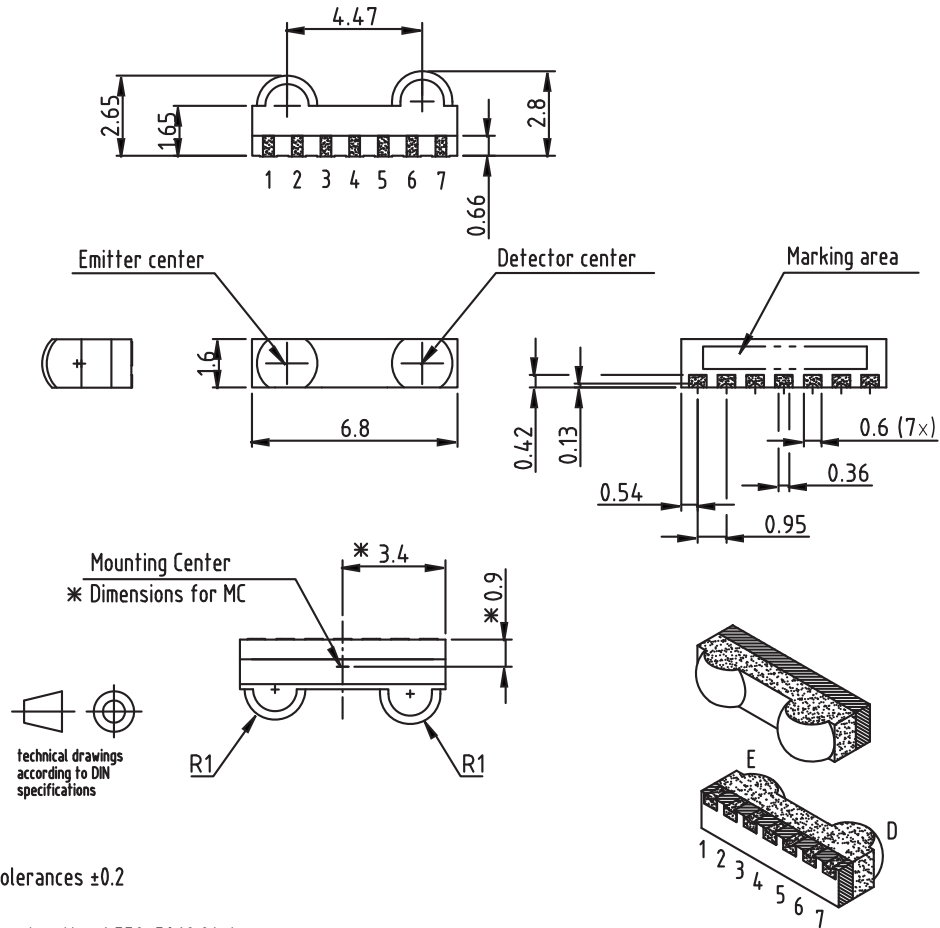
**Manual Soldering**

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".

**PACKAGE DIMENSIONS** in millimeters



Tolerances ±0.2

Drawing-No.: 6.550-5268.01-4

Issue: 2; 06.03.06

19322

Fig. 4 - TFBS4650 Mechanical Dimensions, Tolerance ± 0.2 mm, if not otherwise mentioned

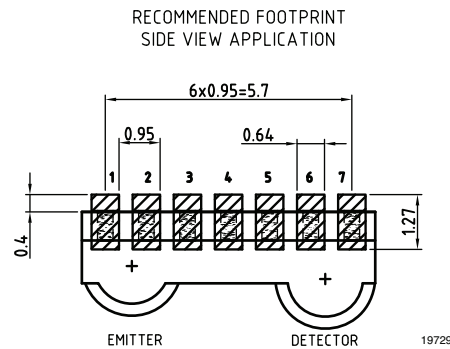
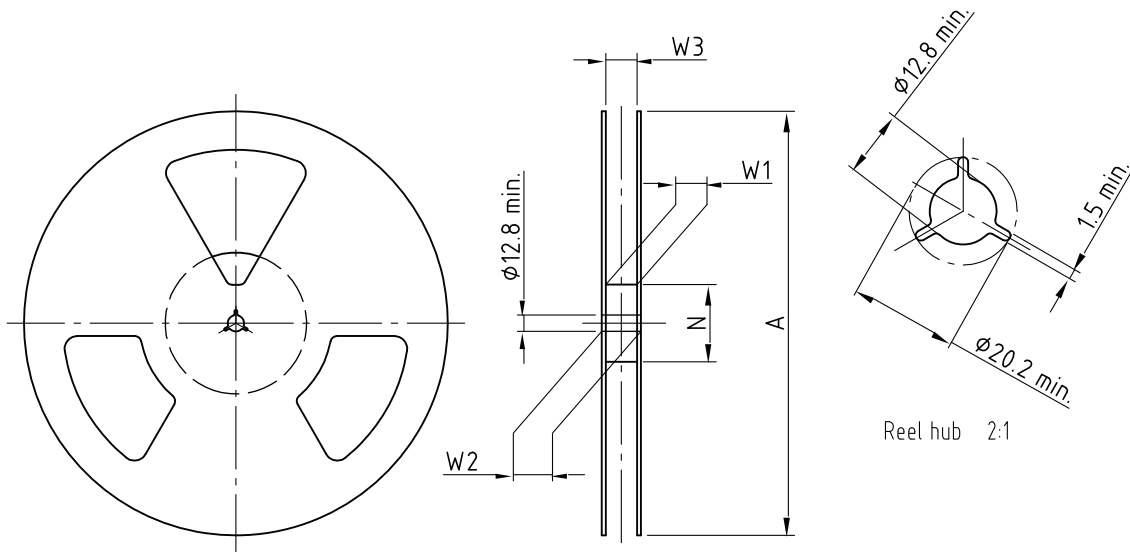


Fig. 5 - TFBS4650 Soldering Footprint, Tolerance ± 0.2 mm, if not otherwise mentioned





REEL DIMENSIONS in millimeters



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

Reel hub 2:1  
Technical drawings according to DIN specifications

| TAPE WIDTH (mm) | A MAX. (mm) | N (mm) | W <sub>1</sub> MIN. (mm) | W <sub>2</sub> MAX. (mm) | W <sub>3</sub> MIN. (mm) | W <sub>3</sub> MAX. (mm) |
|-----------------|-------------|--------|--------------------------|--------------------------|--------------------------|--------------------------|
| 16              | 330         | 50     | 16.4                     | 22.4                     | 15.9                     | 19.4                     |









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