

Infrared Transceiver Module (SIR, 115.2 kbit/s) for IrDA® Applications


RoHS
COMPLIANT

DESIGN SUPPORT TOOLS AVAILABLE



DESCRIPTION

The TFDU4101 transceiver is an infrared transceiver module compliant to the latest IrDA® physical layer standard for fast infrared data communication, supporting IrDA speeds up to 115.2 kbit/s (SIR), and carrier based remote control modes. Integrated within the transceiver module are a photo pin diode, an infrared emitter (IRED), and a low-power control IC to provide a total front-end solution in a single package. This device covers the full IrDA range of more than 1 m using the internal intensity control. With one external current control resistor the current can be adjusted for shorter ranges saving operating current operating in IrDA low power mode. This Vishay SIR transceiver is using the lead frame technology.

The receiver output pulse duration is independent of the optical input pulse duration and recovers always a fixed pulse duration optimum for compatibility to standard Endecs and interfaces. TFDU4101 has a tristate output and is floating in shutdown mode with a weak pull-up.

FEATURES

- Operates from 2.4 V to 5.5 V within specification over full temperature range from -30 °C to +85 °C
- Split power supply, transmitter and receiver can be operated from two power supplies with relaxed requirements saving costs, US - patent no. 6,157,476
- Low power consumption (< 0.12 mA supply current in receive mode, no signal)
- Power shutdown mode (< 4 µA shutdown current in full temperature range, up to 85 °C, < 10 nA at 25 °C)
- Surface-mount package (L x W x H in mm): 9.7 × 4.7 × 4
- High efficiency emitter
- Low profile (universal) package capable of surface mount soldering to side and top view orientation
- Directly Interfaces with various super I/O and encoder / decoder devices
- Tri-state-receiver output, floating in shut down with a weak pull-up
- Qualified for lead (Pb)-free and Sn/Pb processing (MSL4)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

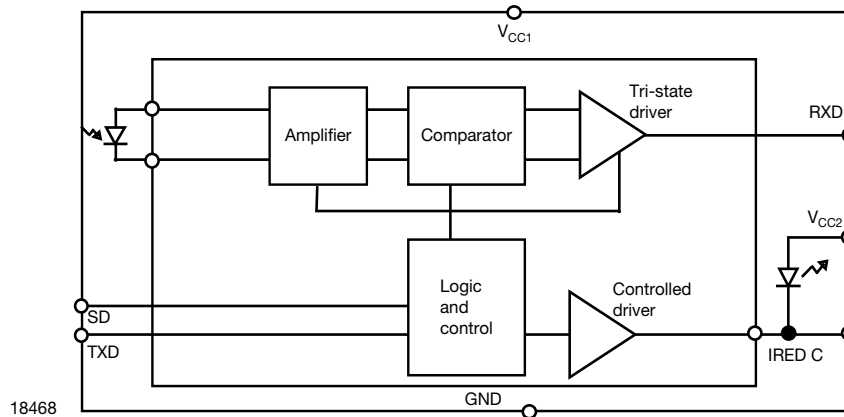
- Printers, fax machines, photocopiers, screen projectors
- Internet TV boxes, video conferencing systems
- Medical data collection
- Diagnostic systems
- Notebook computers, desktop PCs, palmtop computers (Win CE, Palm PC), PDAs
- Internet TV boxes, video conferencing systems
- External infrared adapters (dongles)
- Data loggers
- GPS
- Kiosks, POS, point and pay devices
- Industrial applications

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) |
|-------------|--------------------|-------------------------------------|-------------------|-----------------------|--------------------------|
| TFDU4101 | 115.2 | 4 x 9.7 x 4.7 | 0 to ≥ 1 | 2.4 to 5.5 | 0.07 |

PARTS TABLE

| PART | DESCRIPTION | QTY/REEL |
|--------------|---|----------|
| TFDU4101-TR3 | Oriented in carrier tape for side view surface mounting | 1000 pcs |
| TFDU4101-TT3 | Oriented in carrier tape for top view surface mounting | 1000 pcs |

FUNCTIONAL BLOCK DIAGRAM


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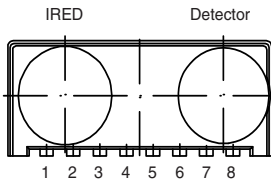
| PIN DESCRIPTION | | | | |
|-----------------|-------------------------|--|-----|--------|
| PIN NUMBER | SYMBOL | DESCRIPTION | I/O | ACTIVE |
| 1 | V_{CC2} IRED anode | IRED anode to be externally connected to V_{CC2} . An external resistor is only necessary for controlling the IRED current when a current reduction below 300 mA is intended to operate in IrDA low power mode. This pin is allowed to be supplied from an uncontrolled power supply separated from the controlled V_{CC1} - supply. | | |
| 2 | IRED cathode | IRED cathode, internally connected to driver transistor | | |
| 3 | TXD | This Schmitt-Trigger input is used to transmit serial data when SD is low. An on-chip protection circuit disables the LED driver if the TXD pin is asserted for longer than 50 μ s (max. 300 μ s). | I | High |
| 4 | RXD | Received data output, push-pull CMOS driver output capable of driving standard CMOS or TTL loads. During transmission the RXD output is active (echo-on). No external pull-up or pull-down resistor is required. Floating with a weak pull-up of 500 k Ω (typ.) in shutdown mode. | O | Low |
| 5 | SD | Shutdown | I | High |
| 6 | V_{CC1} | Supply voltage | | |
| 7 | NC | No internal connection | I | |
| 8 | GND | Ground | | |



PINOUT

TFDU4101
Weight 200 mg

"U" Option Baby Face (universal)



17087

| ABSOLUTE MAXIMUM RATINGS | | | | | | |
|---|--|-----------------|------|------|-----------------|------|
| PARAMETER | TEST CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| Supply voltage range, transceiver | $-0.3\text{ V} < V_{CC2} < 6\text{ V}$ | V_{CC1} | -0.5 | - | 6 | V |
| Supply voltage range, transmitter | $-0.5\text{ V} < V_{CC1} < 6\text{ V}$ | V_{CC2} | -0.5 | - | 6 | V |
| Voltage at RXD | $-0.5\text{ V} < V_{CC1} < 6\text{ V}$ | V_{RXD} | -0.5 | - | $V_{CC1} + 0.5$ | V |
| Voltage at all inputs and outputs | $V_{in} > V_{CC1}$ is allowed | V_{in} | -0.5 | - | 6 | V |
| Input currents | For all pins, except IRED anode pin | | - | - | 10 | mA |
| Output sinking current | | | - | - | 25 | mA |
| Power dissipation | | P_D | - | - | 250 | mW |
| Junction temperature | | T_J | - | - | 125 | °C |
| Ambient temperature range (operating) | | T_{amb} | -30 | - | +85 | °C |
| Storage temperature range | | T_{stg} | -30 | - | +85 | °C |
| Soldering temperature | See "Recommended Solder Profile" | | - | - | 260 | °C |
| Average output current, pin 1 | | $I_{IRED} (DC)$ | - | - | 80 | mA |
| Repetitive pulse output current, pin 1 to pin 2 | $< 90\ \mu s, t_{on} < 20\ %$ | $I_{IRED} (RP)$ | - | - | 400 | mA |
| Thermal resistance junction-to-ambient | JESD51 | R_{thJA} | - | 300 | - | K/W |

Note

- Reference point pin, GND unless otherwise noted. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing

| 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 th April 2006 on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation) (19 th 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



| ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = 2.4\text{ V to } 5.5\text{ V}$ unless otherwise noted) | | | | | | |
|--|---|-----------|----------------------|------|-----------------------|--------------------|
| PARAMETER | TEST CONDITIONS/PINS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| TRANSCEIVER | | | | | | |
| Supply voltage | | V_{CC1} | 2.4 | - | 5.5 | V |
| Dynamic supply current | SD = low, $E_{\theta} = 1\text{ klx}^{(1)}$, $T_{amb} = -25\text{ }^{\circ}\text{C to } +85\text{ }^{\circ}\text{C}$ $V_{CC1} = V_{CC2} = 2.4\text{ V to } 5.5\text{ V}$ | I_{CC1} | 40 | 90 | 130 | μA |
| Dynamic supply current | SD = low, $E_{\theta} = 1\text{ klx}^{(1)}$, $T_{amb} = 25\text{ }^{\circ}\text{C}$ $V_{CC1} = V_{CC2} = 2.4\text{ V to } 5.5\text{ V}$ | I_{CC1} | 40 | 75 | - | μA |
| Average dynamic supply current, transmitting | $I_{RED} = 300\text{ mA}$, 25 % duty cycle | I_{CC} | - | 0.65 | 2.5 | mA |
| Shutdown supply current | SD = high, $T = 25\text{ }^{\circ}\text{C}$, $E_{\theta} = 0\text{ klx}$ no signal, no resistive load | I_{SD} | - | 0.01 | 0.1 | μA |
| | SD = high, $T = 70\text{ }^{\circ}\text{C}$ no signal, no resistive load | I_{SD} | - | - | 1 | μA |
| | SD = high, $T = 85\text{ }^{\circ}\text{C}$ no signal, no resistive load | I_{SD} | - | - | 1 | μA |
| Operating temperature range | | T_A | -30 | - | +85 | $^{\circ}\text{C}$ |
| Output voltage low, RXD | $C_{load} = 15\text{ pF}$ | V_{OL} | -0.5 | - | $0.15 \times V_{CC1}$ | V |
| Output voltage high, RXD | $I_{OH} = -500\text{ }\mu\text{A}$, $C_{Load} = 15\text{ pF}$ | V_{OH} | $0.8 \times V_{CC1}$ | - | $V_{CC1} + 0.5$ | V |
| | $I_{OH} = -250\text{ }\mu\text{A}$, $C_{Load} = 15\text{ pF}$ | V_{OH} | $0.9 \times V_{CC1}$ | - | $V_{CC1} + 0.5$ | V |
| RXD to V_{CC1} impedance | | R_{RXD} | 400 | 500 | 600 | $\text{k}\Omega$ |
| Input voltage low (TXD, SD) | SD = high | V_{IL} | -0.5 | - | 0.5 | V |
| Input voltage high (TXD, SD) | | V_{IH} | $V_{CC1} - 0.5$ | - | 6 | V |
| Input leakage current (TXD, SD) | $V_{in} = 0.9 \times V_{CC1}$ | I_{ICH} | -2 | - | +2 | μA |
| Controlled pull down current $0 < V_{in} < 0.15 V_{CC1}$ $V_{in} > 0.7 V_{CC1}$ | SD, TXD = "0" or "1" | I_{ITX} | -1 | 0 | +150 | μA |
| | | | - | - | 1 | μA |
| Input capacitance (TXD, SD) | | C_I | - | - | 5 | pF |

Notes

- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
- (1) Standard illuminant A
- (2) The typical threshold level is $0.5 \times V_{CC1}$. It is recommended to use the specified min./max. values to avoid increased operating current



| OPTOELECTRONIC CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = 2.4\text{ V to } 5.5\text{ V}$ unless otherwise noted) | | | | | | |
|---|---|----------------------|------------------|-----------|----------------------------|---|
| PARAMETER | TEST CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| RECEIVER | | | | | | |
| Minimum irradiance E_e in angular range ⁽²⁾ SIR mode | 9.6 kbit/s to 115.2 kbit/s $\lambda = 850\text{ nm to } 900\text{ nm}$; $\alpha = 0^{\circ}, 15^{\circ}$ | $E_{e, min.}$ | 4 (0.4) | 20 (2) | 35 ⁽¹⁾ (3.5) | mW/m ² ($\mu\text{W/cm}^2$) |
| Maximum irradiance E_e in angular range ⁽³⁾ | $\lambda = 850\text{ nm to } 900\text{ nm}$ | $E_{e, max.}$ | 5 (500) | - | - | kW/m ² (mW/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 | Input pulse length $> 1.2\text{ }\mu\text{s}$ | t_{PW} | 1.65 | 2.2 | 3 | μs |
| Leading edge jitter | Input irradiance = 100 mW/m ² , $\leq 115.2\text{ kbit/s}$ | | - | - | 250 | ns |
| Standby/shutdown delay, receiver startup time | After shutdown active or power-on | | - | 100 | 500 | μs |
| Latency | | t_L | - | 100 | 150 | μs |
| TRANSMITTER | | | | | | |
| IRED operating current, switched current limiter | No external resistor for current limitation ⁽⁴⁾ | I_D | 250 | 300 | 350 | 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 | | I_{IRED} | -1 | - | 1 | μA |
| Output radiant intensity | $\alpha = 0^{\circ}, 15^{\circ}$ TXD = high, SD = low | I_e | 48 | 65 | 150 | mW/sr |
| Output radiant intensity | $V_{CC1} = 5\text{ V}$, $\alpha = 0^{\circ}, 15^{\circ}$ TXD = low or SD = high (receiver is inactive as long as SD = high) | I_e | - | - | 0.04 | mW/sr |
| Output radiant intensity, angle of half intensity | | α | - | ± 24 | - | deg |
| Peak - emission wavelength ⁽⁵⁾ | | λ_p | 880 | - | 900 | nm |
| Spectral bandwidth | | $\Delta\lambda$ | - | 45 | - | nm |
| Optical rise time, optical fall time | | t_{ropt}, t_{fopt} | 10 | - | 300 | ns |
| Optical output pulse duration | Input pulse width $1.6\text{ }\mu\text{s} < t_{TXD} < 20\text{ }\mu\text{s}$ | t_{opt} | $t_{TXD} - 0.15$ | - | $t_{TXD} + 0.15$ | μs |
| Optical output pulse duration | Input pulse width $t_{TXD} \geq 20\text{ }\mu\text{s}$ | t_{opt} | - | 20 | 300 | μs |
| Optical overshoot | | | - | - | 25 | % |

Notes

- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
- (1) IrDA specification is 40 mW/m². Specification takes a window loss of 10 % into account
- (2) 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
- (3) 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
- (4) Using an external current limiting resistor is allowed and recommended to reduce IRED intensity and operating current when current reduction is intended to operate at the IrDA low power conditions. E.g. for $V_{CC2} = 3.3\text{ V}$ a current limiting resistor of $R_S = 56\text{ }\Omega$ will allow a power minimized operation at IrDA low power conditions
- (5) Due to this wavelength restriction compared to the IrDA spec of 850 nm to 900 nm the transmitter is able to operate as source for the standard remote control applications with codes as e.g. Phillips RC5/RC6[®] or RECS 80

For more definitions see the document "Symbols and Terminology" on the Vishay website.

RECOMMENDED CIRCUIT DIAGRAM

Operated with a clean low impedance power supply the TFDU4101 needs no additional external components. However, depending on the entire system design and board layout, additional components may be required (see figure 1). That is especially the case when separate power supplies are used for bench tests. When using compact wiring and regulated supplies as e. g. in phone applications in most cases no external components are necessary.

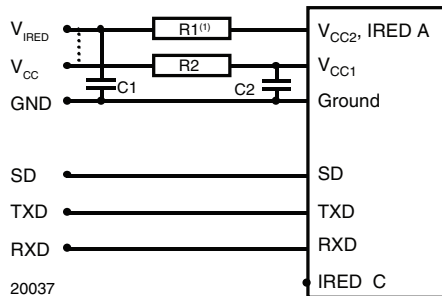


Fig. 1 - Recommended Test Circuit

Note

⁽¹⁾ R1 is optional when reduced intensity is used

The capacitor C1 is buffering the supply voltage and eliminates the inductance of the power supply line. This one should be a Tantalum or other fast capacitor to guarantee the fast rise time of the IRED current. The resistor R1 is the current limiting resistor, which may be used to reduce the operating current to levels below the specified controlled values for saving battery power.

Vishay's 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 shutdown input must be grounded for normal operation, also when the shutdown function is not used.

The inputs (TXD, SD) and the output RXD should be directly connected (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. R2, C1 and C2 are optional and dependent on the quality of the supply voltages V_{CC1} 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 extended wiring is used (bench tests!) the inductance of the power supply can cause dynamically a voltage drop at V_{CC2} . Often some power supplies are not able to follow the fast current rise time. In that case another 4.7 μ F (type, see table under C1) at V_{CC2} will be helpful.

Under extreme EMI conditions as placing an RF-transmitter antenna on top of the transceiver, we recommend to protect all inputs by a low-pass filter, as a minimum a 12 pF capacitor, especially at the RXD port. The transceiver itself withstands EMI at GSM frequencies above 500 V/m. When interference is observed, the wiring to the inputs picks it up. It is verified by DPI measurements that as long as the interfering RF - voltage is below the logic threshold levels of the inputs and equivalent levels at the outputs no interferences are expected.

One should 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, Winfield Hill, 1989, Cambridge University Press, ISBN: 0521370957.

TABLE 1 - RECOMMENDED TESTS AND APPLICATION CIRCUIT COMPONENTS

| COMPONENT | RECOMMENDED VALUE | VISHAY PART NUMBER |
|-----------|--|----------------------|
| C1 | 4.7 μ F, 16 V | 293D 475X9 016B |
| C2 | 0.1 μ F, ceramic | VJ 1206 Y 104 J XXMT |
| R1 | Depends on current to be adjusted, e. g. with $V_{CC2} = 3.3$ V 56 Ω is an option for minimum low power operation | |
| R2 | 47 Ω , 0.125 W | CRCW-1206-47R0-F-RT1 |

Figure 2 shows an example of a typical application with a separate supply voltage V_S and using the transceiver with the IRED anode connected to the unregulated battery V_{batt} . This method reduces the peak load of the regulated power supply and saves therefore costs. Alternatively all supplies can also be tied to only one voltage source. R1 and C1 are not used in this case and are depending on the circuit design in most cases not necessary.

In Fig. 2 an option is shown to operate the transmitter at two different power levels to switch for long range to low power mode for e.g. saving power for IrDA application but use the full range specification for remote control. The additional components are marked in the figure.

For operating at RS232 ports TOIM4232 is recommended as ENDEC.

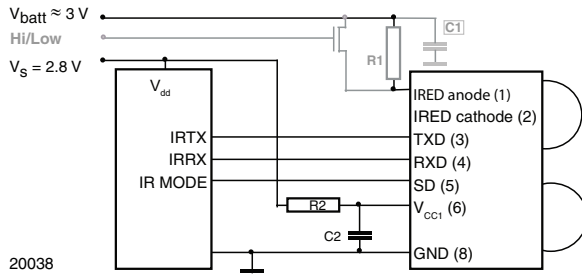


Fig. 2 - Typical Application Circuit
Grey: Optional for High/Low Switching

I/O AND SOFTWARE

In the description, already different I/Os are mentioned. Different combinations are tested and the function verified with the special drivers available from the I/O suppliers. In special cases refer to the I/O manual, the Vishay application notes, or contact directly Vishay Sales, Marketing or Application.

| TABLE 2 - TRUTH TABLE | | | | | |
|-----------------------|--------------|--|---|----------------|--|
| INPUTS | | | OUTPUTS | | REMARK |
| SD | TXD | OPTICAL INPUT IRRADIANCE mW/m ² | RXD | TRANSMITTER | OPERATION |
| High > 1 ms | x | x | Weakly pulled (500 kΩ) to V _{CC1} | 0 | Shutdown |
| Low | High < 50 μs | x | Low active | I _e | Transmitting |
| | High > 50 μs | x | High inactive | 0 | Protection is active |
| | Low | < 4 | High inactive | 0 | Ignoring low signals below the IrDA defined threshold for noise immunity |
| | Low | > min. irradiance E _e < max. irradiance E _e | Low (active) | 0 | Response to an IrDA compliant optical input signal |
| Low | Low | > max. irradiance E _e | Undefined | 0 | Overload conditions can cause unexpected outputs |

RECOMMENDED SOLDER PROFILES

Solder Profile for Sn/Pb Soldering

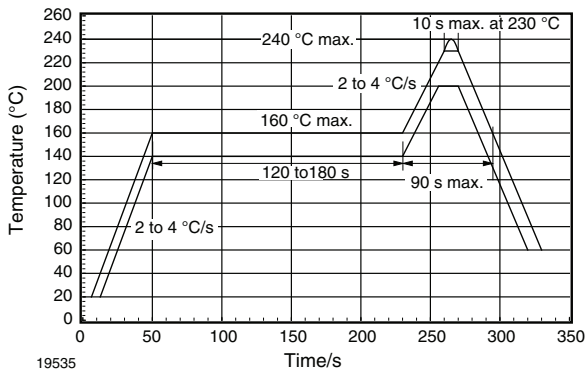


Fig. 3 - Recommended Solder Profile for Sn/Pb Soldering

Lead (Pb)-free, Recommended Solder Profile

The TFDU4101 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 5 and 6 are Vishay's recommended profiles for use with the TFDU4101 transceivers. For more details please refer to the application note "SMD Assembly Instructions". A ramp-up rate less than 0.9 °C/s is not recommended. Ramp-up rates faster than 1.3 °C/s could damage an optical part because the thermal conductivity is less than compared to a standard IC.

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 TFBSxxx) 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".

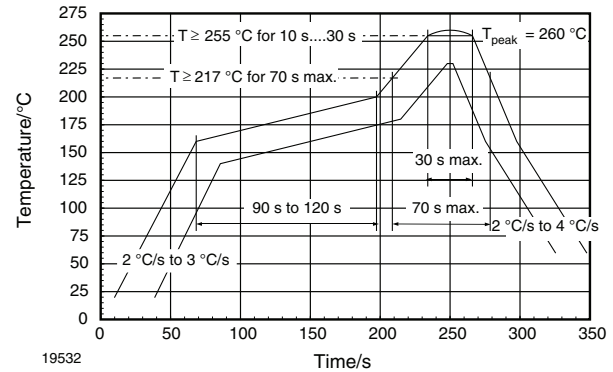


Fig. 4 - Solder Profile, RSS Recommendation

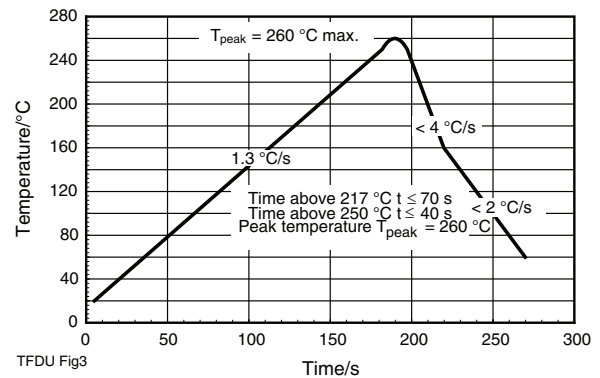


Fig. 5 - RTS Recommendation

PACKAGE DIMENSIONS in millimeters

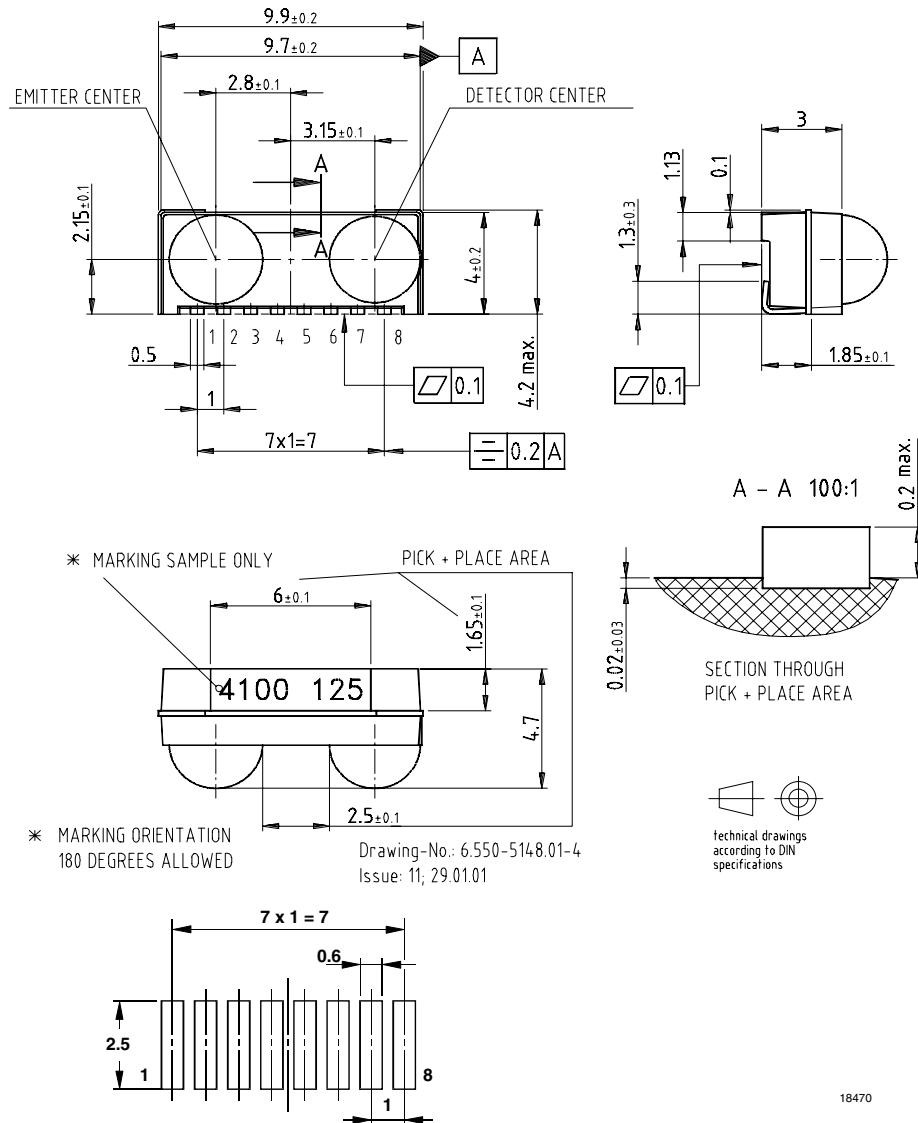


Fig. 6 - Package Drawing TFDU4101. Tolerance ± 0.2 mm if not otherwise mentioned

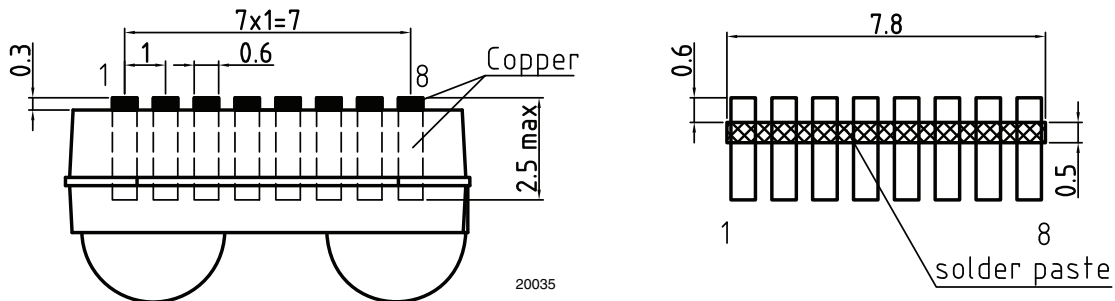


Fig. 7 - Recommended Footprint for Side View Applications and Solderpaste Mask

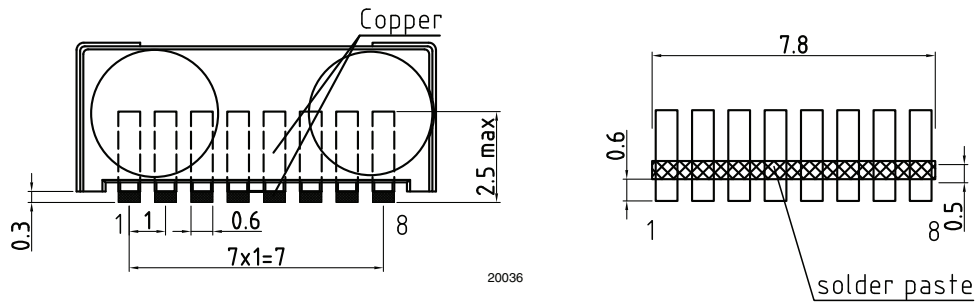
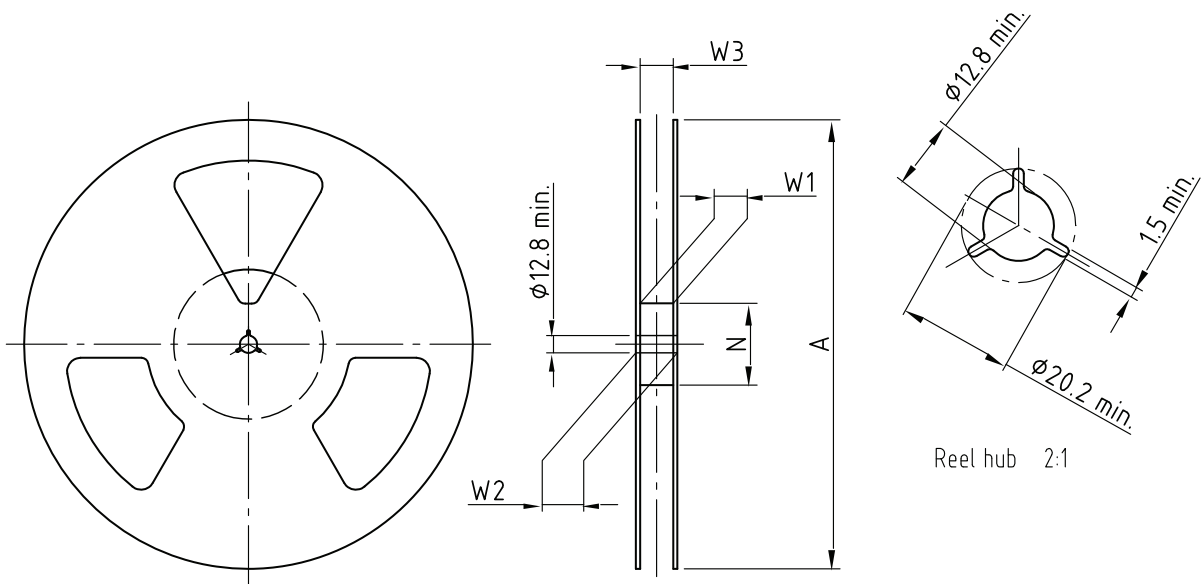


Fig. 8 - Recommended Footprint for Top View Applications and Solderpaste Mask

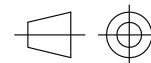
REEL DIMENSIONS in millimeters



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Issue: 1; 29.11.05
14017

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

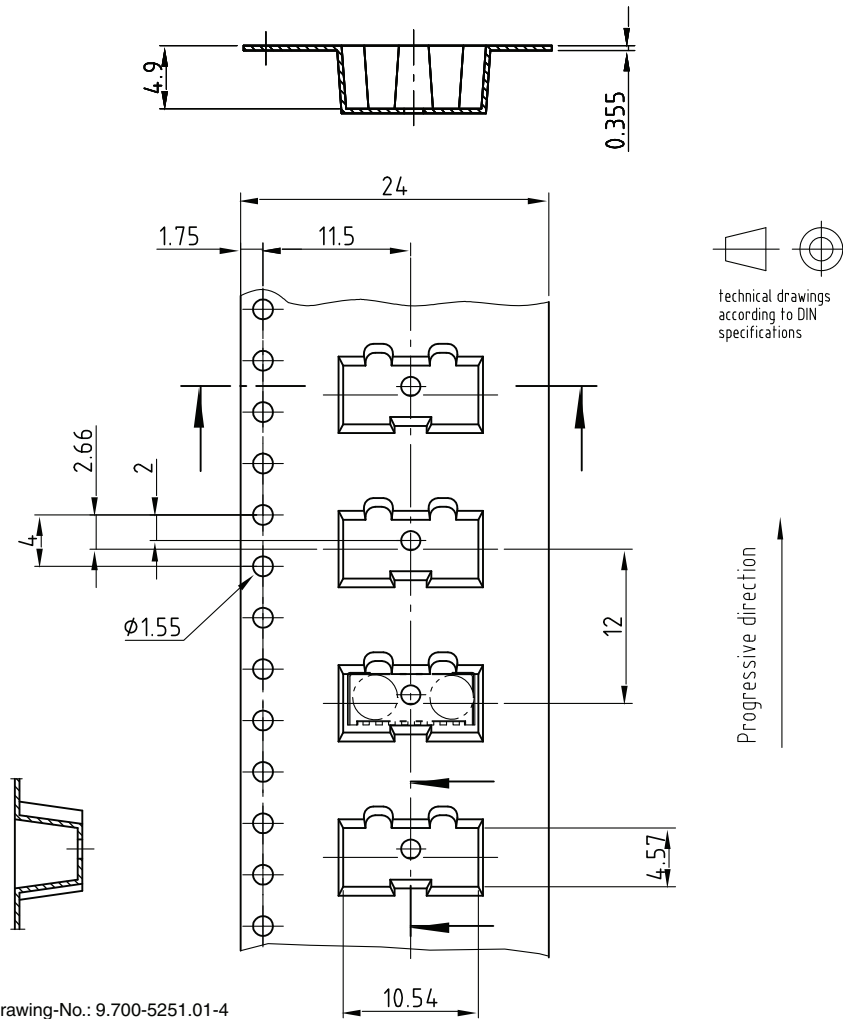
Dimension acc. to IEC EN 60 286-3



Technical drawings according to DIN specifications

| TAPE WIDTH (mm) | A MAX. (mm) | N (mm) | W ₁ MIN. (mm) | W ₂ MAX. (mm) | W ₃ MIN. (mm) | W ₃ MAX. (mm) |
|-----------------|-------------|--------|--------------------------|--------------------------|--------------------------|--------------------------|
| 24 | 330 | 60 | 24.4 | 30.4 | 23.9 | 27.4 |

TAPE DIMENSIONS in millimeters

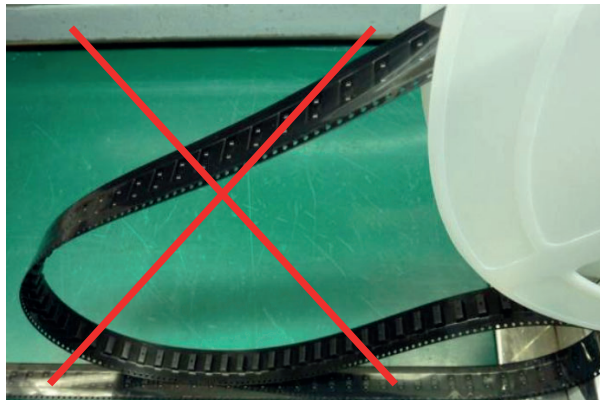


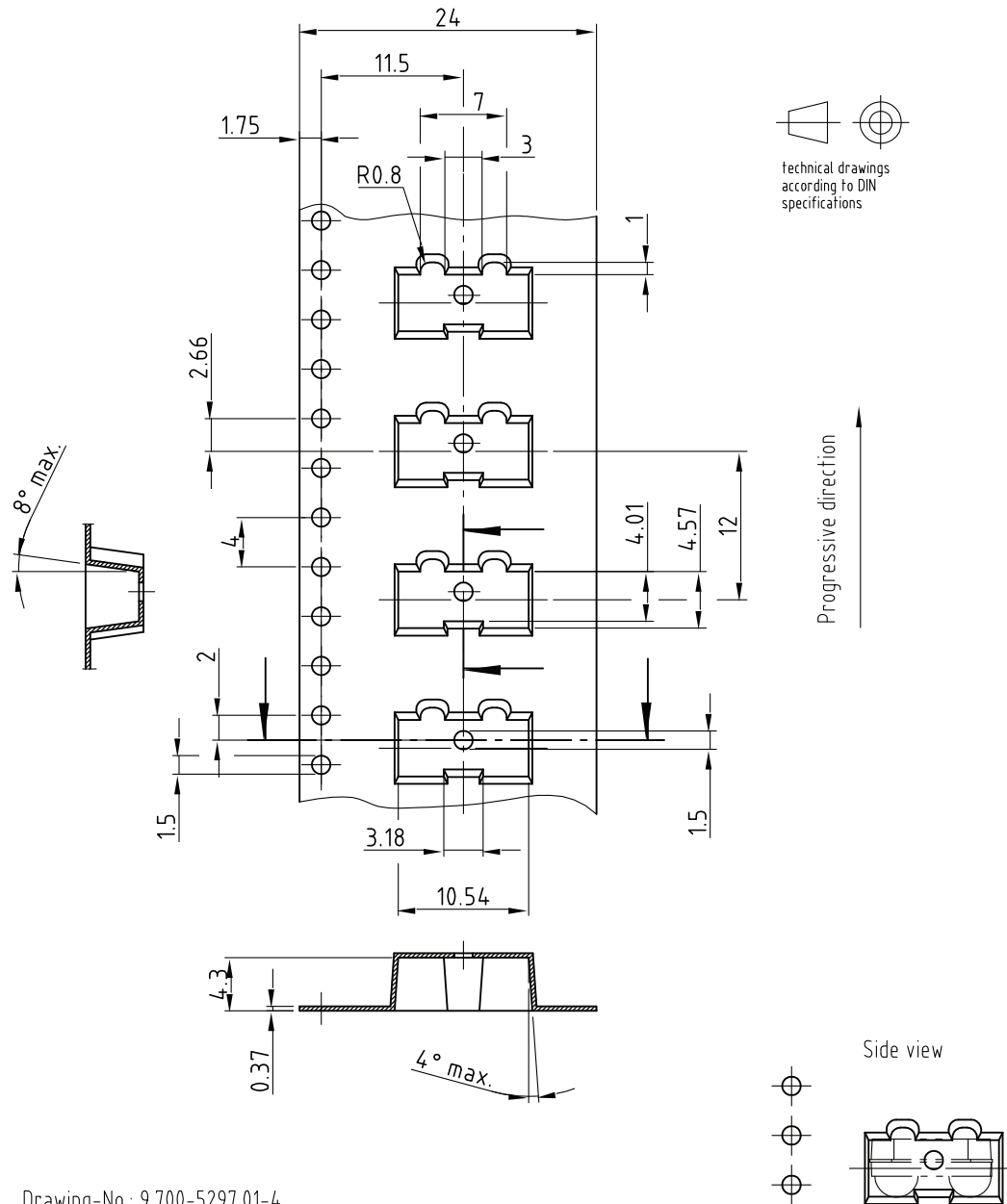
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 Issue: 3; 02.09.05
 19824

Fig. 9 - Tape Drawing, TFDU4101 for Top View Mounting, Tolerance ± 0.1 mm

HANDLING PRECAUTION

Sagging of carrier tape may cause some units to rotate and will result to pick-and-place problem. Do not allow carrier tape to sag as shown in picture below.





Drawing-No.: 9.700-5297.01-4
 Issue: 3; 21.12.05
 19875

Fig. 10 - Tape Drawing, TFDU4101 for Side View Mounting, Tolerance ± 0.1 mm



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