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

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 tri-state 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 4-mm package
  L 9.7 mm × W 4.7 mm × H 4.0 mm
- 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 controller devices as e. g. TOIM4232
- Tri-state-Receiver Output, floating in shut down with a weak pull-up
- Lead (Pb)-free device
- Qualified for lead (Pb)-free and Sn/Pb processing (MSL4)
- Device in accordance with RoHS 2002/95/EC and WEEE 2002/96EC

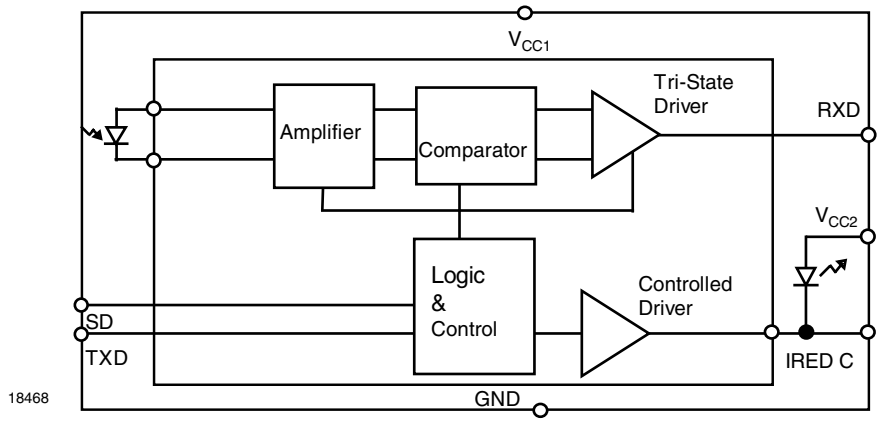
Applications

- 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

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



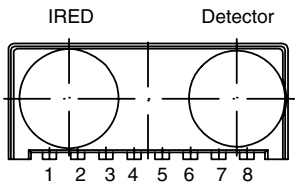
Pin Description

Pin Number	Function	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 µs (max 300 µs).	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 kΩ (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 BabyFace (Universal)



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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	- 0.3 V < V_{CC2} < 6.0 V	V_{CC1}	- 0.5		6.0	V
Supply voltage range, transmitter	- 0.5 V < V_{CC1} < 6.0 V	V_{CC2}	- 0.5		6.0	V
Voltage at RXD	- 0.5 V < V_{CC1} < 6.0 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		6.0	V
Input currents	For all Pins, Except IRED Anode Pin				10	mA
Output sinking current					25	mA
Power dissipation	See Derating Curve	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 µs, t_{on} < 20 %	I_{IRED} (RP)			400	mA

Eye safety information

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
Virtual source size	Method: EN ISO 11146	d	2.6			mm
Maximum Intensity for Class 1	IEC60825-1 or EN60825-1, edition Jan. 2001 operating below the absolute maximum ratings	I_e			*) (500)**)	mW/sr

*) Due to the internal limitation measures the device is a "class1" device under all conditions

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

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 the physical layer standard 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.

Note: We apologize to use sometimes in our documentation the abbreviation LED and the word Light Emitting Diode instead of Infrared Emitting Diode (IRED) for IR-emitters. That is by definition wrong; we are here following just a bad trend.

Typical values are for design aid only, not guaranteed nor subject to production testing and may vary with time.

Electrical Characteristics

Transceiver

T_{amb} = 25 °C, V_{CC1} = V_{CC2} = 2.4 V to 5.5 V unless otherwise noted.
Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Parameter	Test Conditions/Pins	Symbol	Min	Typ.	Max	Unit
Supply voltage		V_{CC1}	2.4		5.5	V
Dynamic supply current	SD = Low, E_e = 1 klx*), Tamb = - 25 °C to + 85 °C V_{CC1} = V_{CC2} = 2.4 V to 5.5 V	I_{CC1}		90	130	µA
Dynamic supply current	SD = Low, E_e = 1 klx*), T_{amb} = 25 °C V_{CC1} = V_{CC2} = 2.4 V to 5.5 V	I_{CC1}		75		µA
Average dynamic supply current, transmitting	I_{IRED} = 300 mA, 25 % Duty Cycle	I_{CC}			0.65	mA
Shutdown supply current	SD = High, T = 25 °C, E_e = 0 klx No signal, no resistive load	I_{SD}			0.1	µA
	SD = High, T = 70 °C No signal, no resistive load	I_{SD}			3	µA
	SD = High, T = 85 °C No signal, no resistive load	I_{SD}			4	µA
Operating temperature range		T_A	- 30		+ 85	°C
Output voltage Low, RXD	C_{load} = 15 pF	V_{OL}	- 0.5		0.15 x V_{CC1}	V
Output voltage High, RXD	I_{OH} = - 500 µA, C_{Load} = 15 pF	V_{OH}	0.8 x V_{CC1}		V_{CC1} + 0.5	V
	I_{OH} = - 250 µA, C_{Load} = 15 pF	V_{OH}	0.9 x V_{CC1}		V_{CC1} + 0.5	V
RXD to V_{CC1} impedance		R_{RXD}	400	500	600	kΩ
Input voltage low (TXD, SD)		V_{IL}	- 0.5		0.5	V
Input voltage High (TXD, SD)	1.5 V ≤ V_{logic} ≤ 2.5 V**)	V_{IH}	0.8 x V_{CC1}		6	V
	V_{logic} > 2.5 V**)	V_{IH}	V_{CC1} - 0.5		6	V
Input leakage current (TXD, SD)	V_{in} = 0.9 x 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_{IrTX}	 - 1	 0	+ 150 1	µA µA
Input capacitance (TXD, SD)		C_I			5	pF

*) Standard Illuminant A

**) The typical threshold level is 0.5 x V_{CC1}. It is recommended to use the specified min/max values to avoid increased operating current.

Optoelectronic Characteristics

Receiver

T_{amb} = 25 °C, $V_{CC1} = V_{CC2}$ = 2.4 V to 5.5 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
Minimum irradiance E_e in angular range**) SIR mode	9.6 kbit/s to 115.2 kbit/s λ = 850 nm to 900 nm; α = 0°, 15°	E_e	4 (0.4)	20 (2)	35*) (3.5)	mW/m^2 (µW/cm^2)
Minimum irradiance E_e in angular range	λ = 850 nm to 900 nm	E_e	5 (500)			kW/m^2 (µW/cm^2)
Rise time of output signal	10 % to 90 %, C_L = 15 pF	$t_{r\ (RXD)}$	20		100	ns
Fall time of output signal	90 % to 10 %, C_L = 15 pF	$t_{f\ (RXD)}$	20		100	ns
RXD pulse width	input pulse length > 1.2 µs	t_{PW}	1.65	2.2	3.0	µs
Leading edge jitter	Input Irradiance = 100 mW/m^2, ≤ 115.2 kbit/s				250	ns
Standby /Shutdown delay, receiver startup time	After shutdown active or power-on				500	µs
Latency		t_L		100	150	µs

*) IrDA specification is 40 mW/m^2. Specification takes a window loss of 10 % into account.

) 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 power 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 (http://www.vishay.com/docs/82512/82512.pdf).

Optoelectronic Characteristics, continued

Transmitter

T_{amb} = 25 °C, V_{CC1} =V_{CC2} = 2.4 V to 5.5 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, switched current limiter	No external resistor for current limitation*)	I_D	250	300	350	mA
Forward voltage of built-in IRED	I_f = 300 mA	V_f	1.4	1.8	1.9	V
Output leakage IRED current		I_{IRED}	- 1		1	µA
Output radiant intensity	α = 0°, 15° TXD = High, SD = Low	I_e	48	65		mW/sr
Output radiant intensity	V_{CC1} = 5.0 V, α = 0°, 15° 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**)		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 µs < t_{TXD} < 20 µs	t_{opt}	t_{TXD} - 0.15		t_{TXD} + 0.15	µs
Optical output pulse duration	input pulse width $t_{TXD} \geq$ 20 µs	t_{opt}		20	300	µs
Optical overshoot					25	%

*) 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 V a current limiting resistor of R_s = 56 Ω will allow a power minimized operation at I_{rDA} low power conditions.

**) 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. Philips RC5/RC6® or RECS 80.

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.

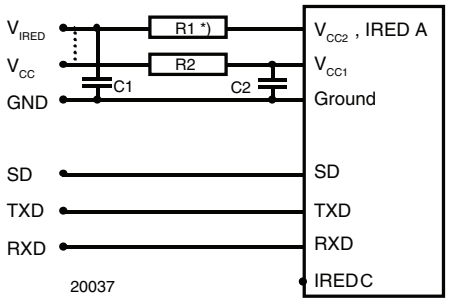


Figure 1. Recommended test circuit.
*) R1 is optional when reduced intensity is used.

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 µF (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 µF, 16 V	293D 475X9 016B
C2	0.1 µF, 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 figure 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.

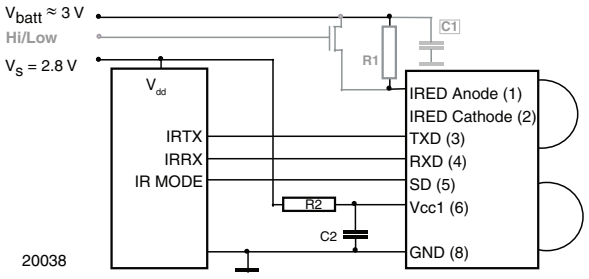


Figure 2. Typical application circuit.
Grey: Optional for Hi/Low switching.

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.

Current Derating Diagram

Figure 3 shows the maximum operating temperature when the device is operated without external current limiting resistor.

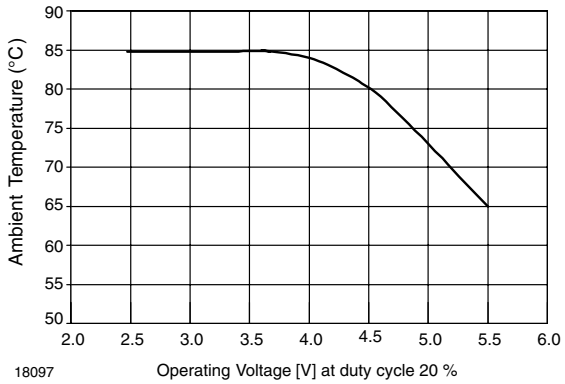


Figure 3. Current Derating Diagram

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	> Max. irradiance E_e	undefined	0	Overload conditions can cause unexpected outputs

Recommended Solder Profiles

Solder Profile for Sn/Pb Soldering

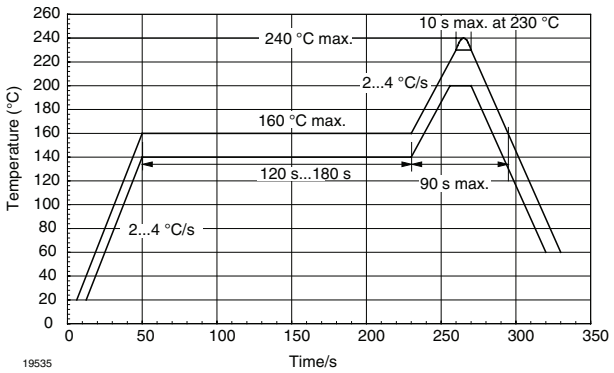


Figure 4. Recommended Solder Profile for Sn/Pb soldering

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”
(http://www.vishay.com/docs/82602/82602.pdf).

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"
(http://www.vishay.com/docs/82601/82601.pdf).

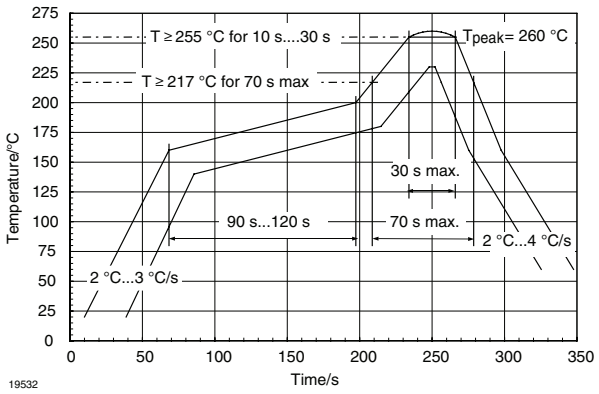


Figure 5. Solder Profile, RSS Recommendation

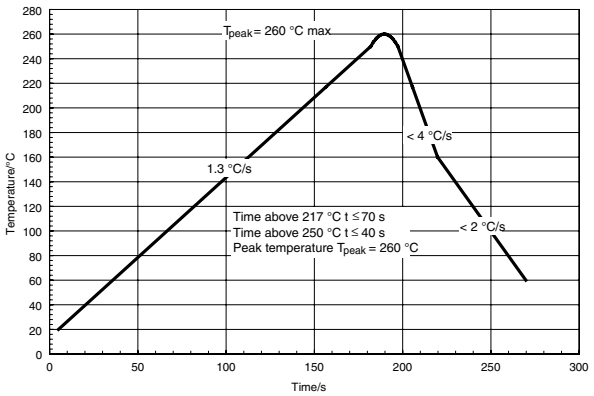


Figure 6. RTS Recommendation

Package Dimensions in mm

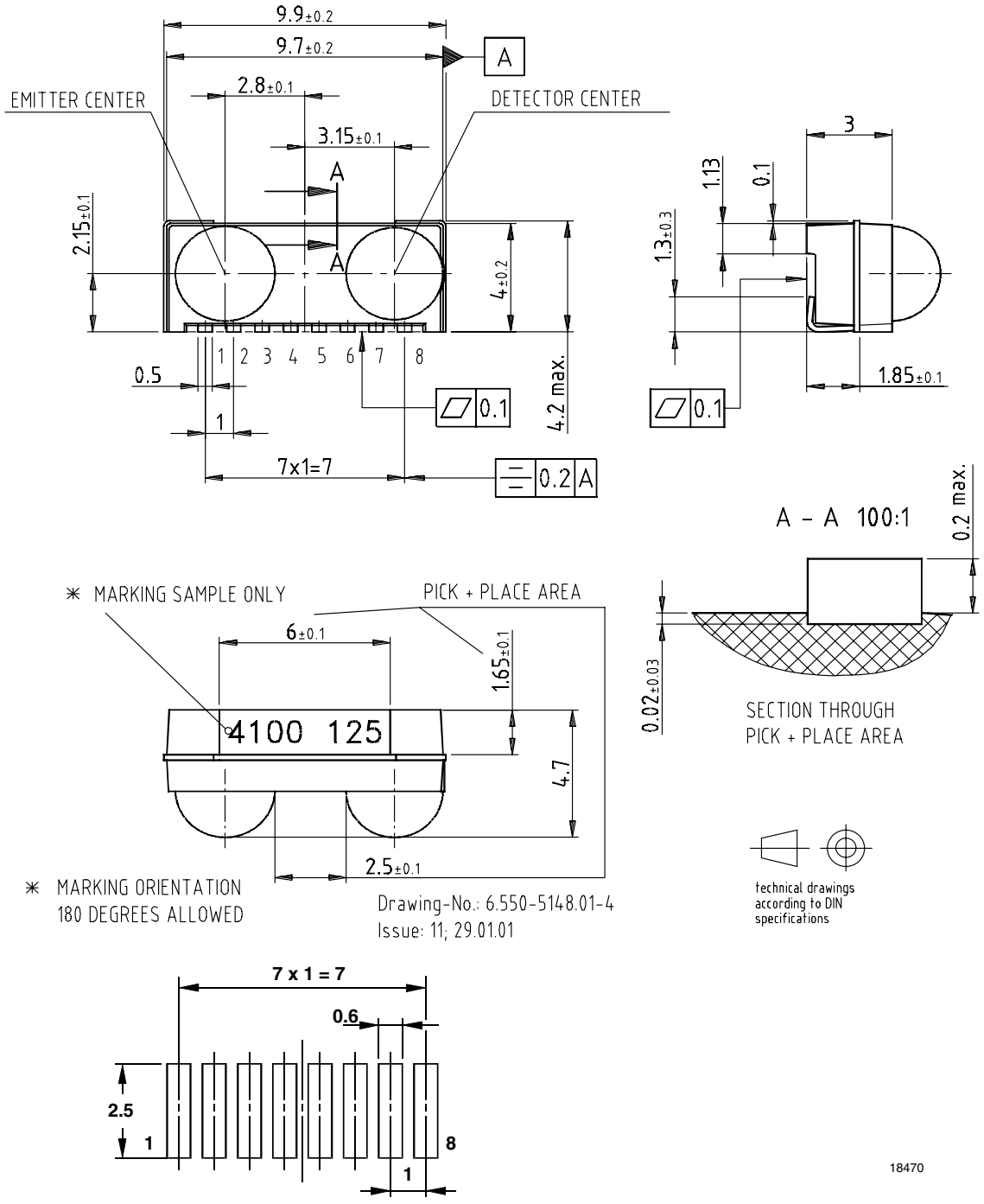


Figure 7. Package drawing TFDU6103, dimensions in mm, tolerance ± 0.2 mm if not otherwise mentioned

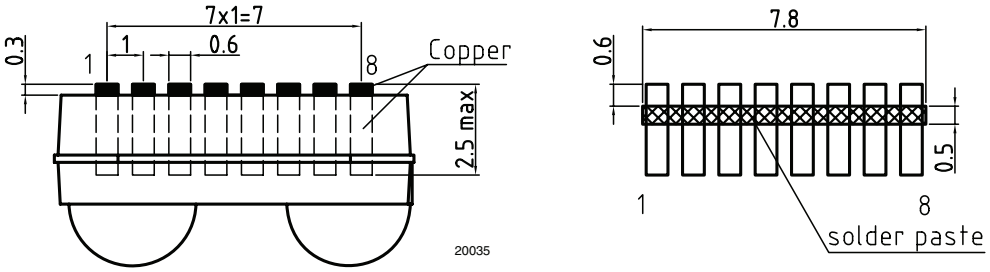


Figure 8. Recommended footprint for side view applications and solderpaste mask

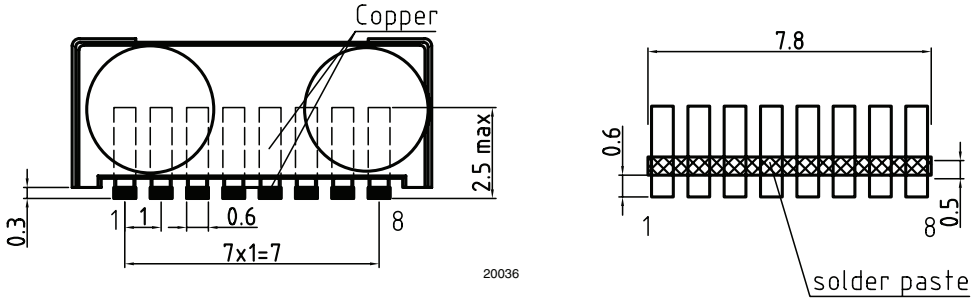
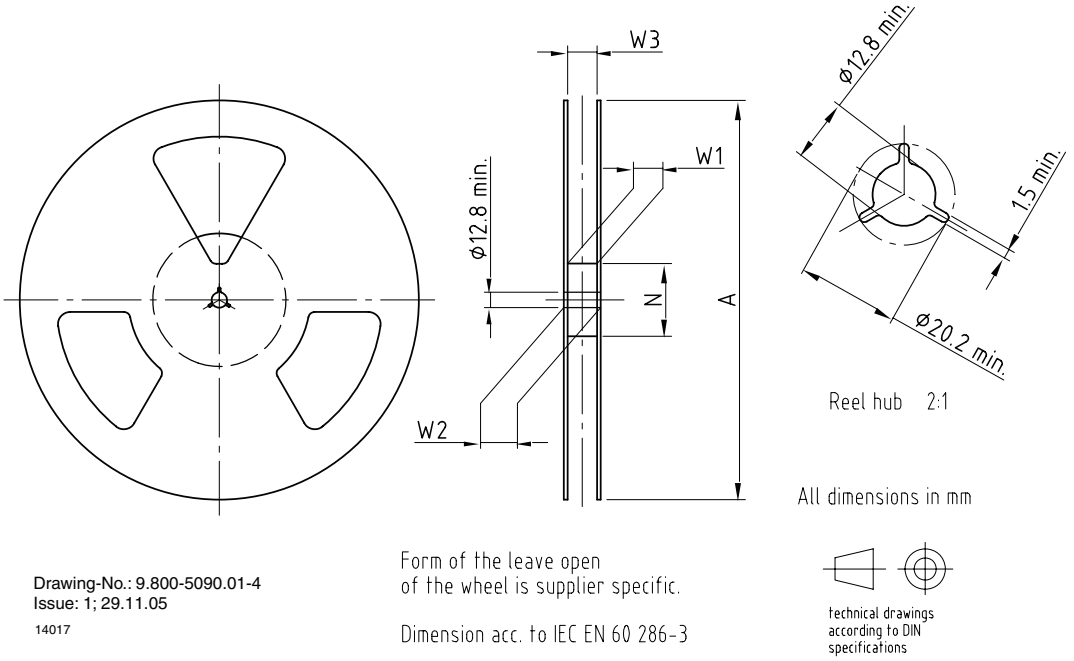


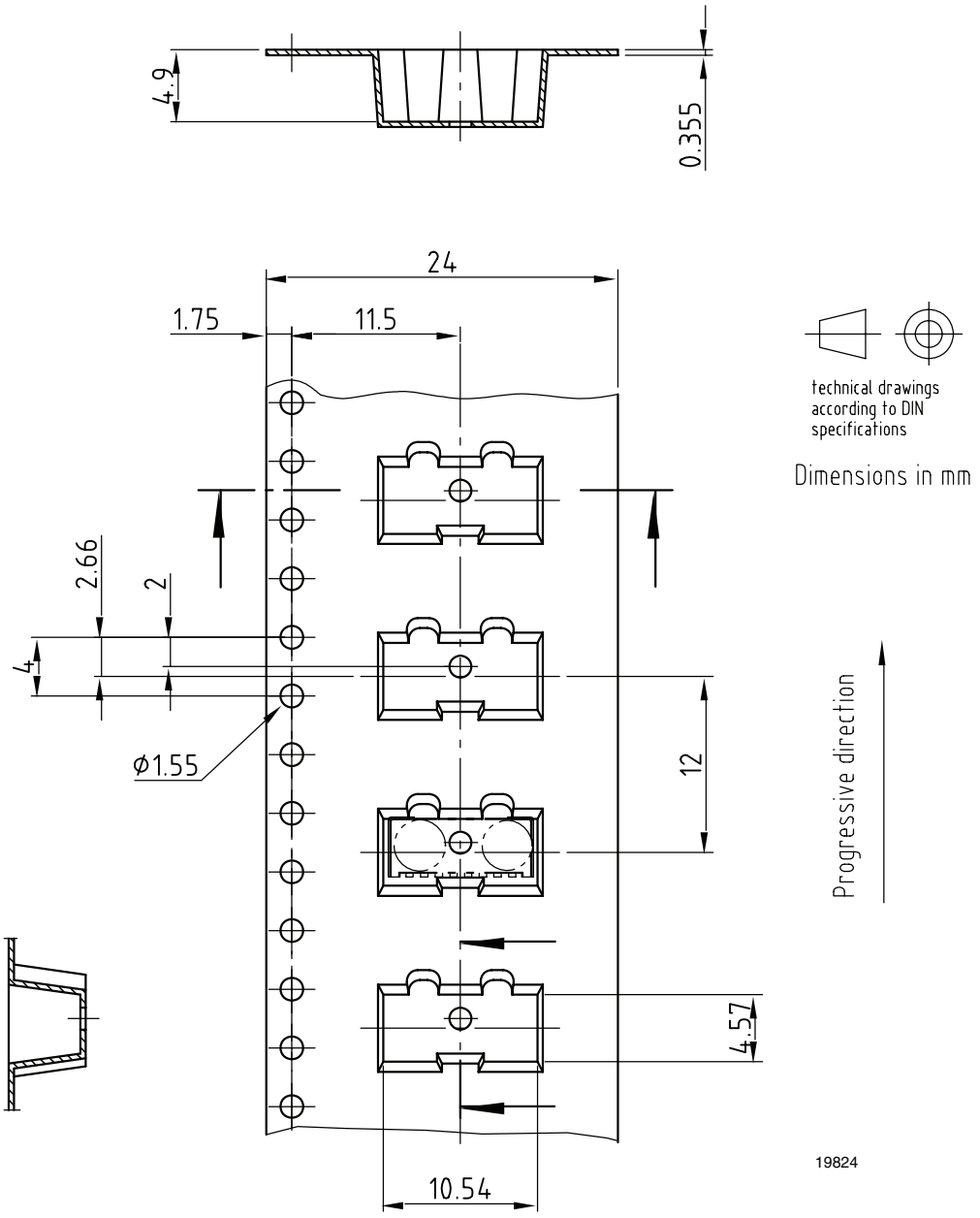
Figure 9. Recommended footprint for top view applications and solderpaste mask

Reel Dimensions



Tape Width	A max.	N	W_1 min.	W_2 max.	W_3 min.	W_3 max.
mm	mm	mm	mm	mm	mm	mm
24	330	60	24.4	30.4	23.9	27.4

Tape Dimensions



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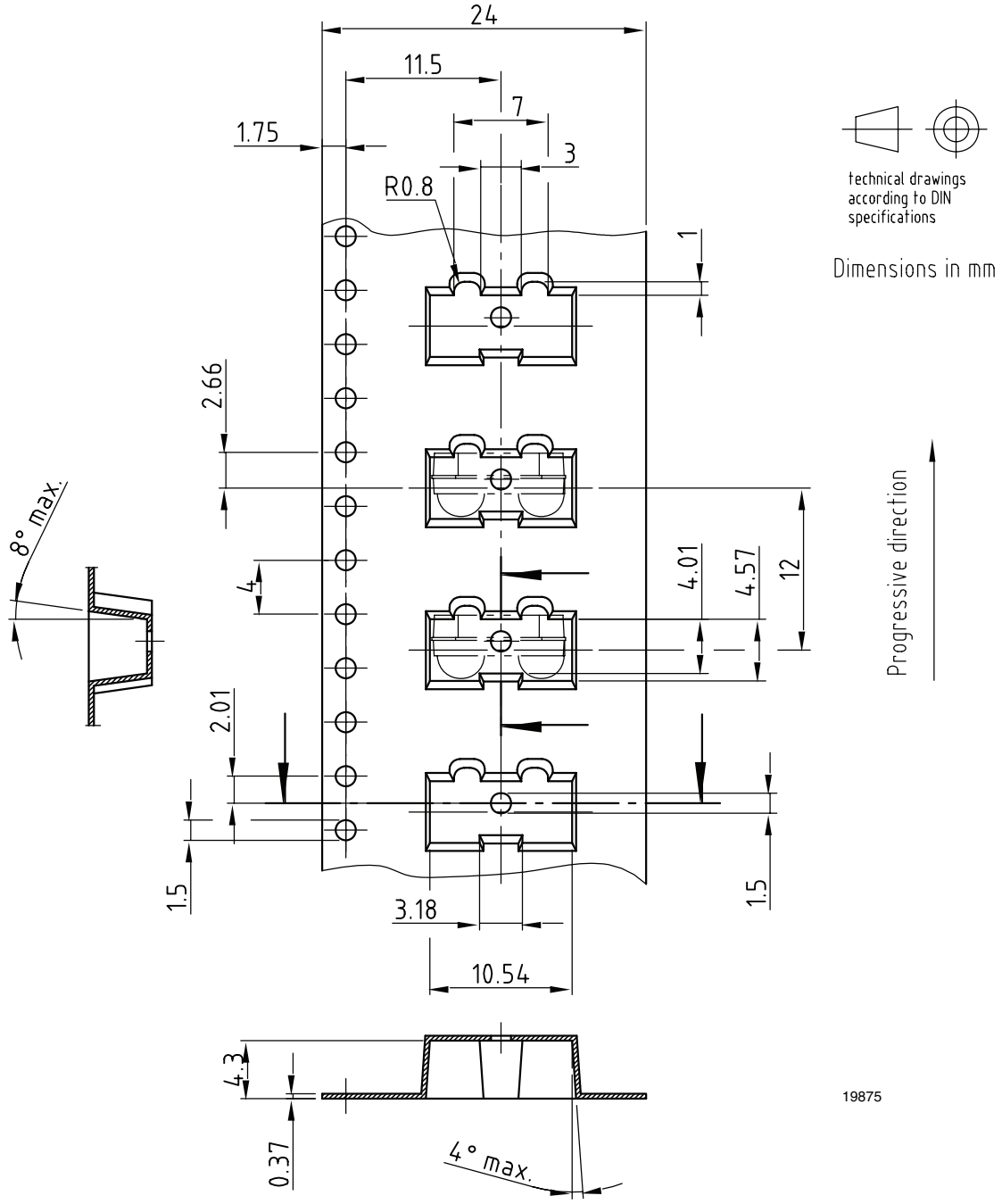
Issue: 3; 02.09.05

Figure 10. Tape drawing, TFDU6103 for top view mounting, tolerance ± 0.1 mm

Tape Dimensions



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Issue: 1; 04.08.05

Figure 11. Tape drawing, TFDU6103 for side view mounting, tolerance ± 0.1 mm

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.

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