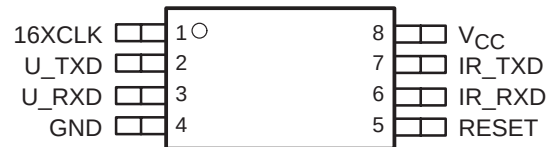


TIR1000, TIR1000I STANDALONE IrDA™ ENCODER AND DECODER

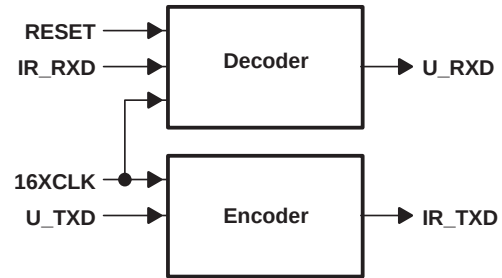
SLLS228F – DECEMBER 1995 – REVISED JULY 1999

- Adds Infrared (IR) Port to Universal Asynchronous Receiver Transmitter (UART)
- Compatible With Infrared Data Association (IrDA™) and Hewlett Packard Serial Infrared (HPSIR)
- Provides 1200 bps to 115 kbps Data Rate
- Operates From 2.7 V to 5.5 V
- Provides Simple Interface With UART
- Decodes Negative or Positive Pulses
- Available in Two 8-Terminal Plastic Small Outline Packages (PSOP), PS Package Has Slightly Larger Dimensions Than PW Package

PS OR PW PACKAGE
(TOP VIEW)



functional block diagram



description

The TIR1000 serial infrared (SIR) encoder/decoder is a CMOS device which encodes and decodes bit data in conformance with the IrDA specification.

A transceiver device is needed to interface to the photo-sensitive diode (PIN) and the light emitting diode (LED). A UART is needed to interface to the serial data lines.

Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
16XCLK	1	I	Clock signal. 16XCLK should be set to 16 times the baud rate. The highest baud rate for IrDA is 115.2 kbps for which the clock frequency equals 1.843 MHz (this terminal is tied to the BAUDOUT of a UART).
GND	4		Ground
IR_RXD	6	I	Infrared receiver data. IR_RXD is an IrDA-SIR-modulated input from an optoelectronics transceiver whose input pulses should be 3/16 of the baud rate period.
IR_TXD	7	O	Infrared transmitter data. IR_TXD is an IrDA-SIR-modulated output to an optoelectronics transceiver.
RESET	5	I	Active high reset. RESET initializes an IrDA-SIR-decode/encode state machine (this terminal is tied to a UART reset line).
U_RXD	3	O	Receiver data. U_RXD is decoded (demodulated) data from IR_RXD according to the IrDA specification (this terminal is tied to SIN of a UART).
U_TXD	2	I	Transmitter data. U_TXD is encoded (modulated) data and output data as IR_TXD (this terminal is tied to SOUT from a UART).
V _{CC}	8		Supply voltage



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

IrDA is a registered trademark of the Infrared Data Association.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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TIR1000, TIR1000I STANDALONE IrDA™ ENCODER AND DECODER

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

Supply voltage range, V_{CC} (see Note 1)	–0.5 V to 6 V
Input voltage range at any input, V_I	–0.5 V to $V_{CC} + 0.5$ V
Output voltage range, V_O	–0.5 V to $V_{CC} + 0.5$ V
Operating free-air temperature range, T_A , TIR1000	0°C to 70°C
T_A , TIR1000I	–40°C to 85°C
Storage temperature range, T_{stg}	–65°C to 150°C
Case temperature for 10 seconds: SOP package	260°C

[†] Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage levels are with respect to GND.

recommended operating conditions over recommended operating free-air temperature range

low voltage (3 V nominal)

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		2.7	3	3.3	V
High-level input voltage, V_{IH}		0.7 V_{CC}			V
Low-level input voltage, V_{IL}				0.2 V_{CC}	V
Operating free-air temperature, T_A	TIR1000	0		70	°C
	TIR1000I	–40		85	

standard voltage (5 V nominal)

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level input voltage, V_{IH}		0.7 V_{CC}			V
Low-level input voltage, V_{IL}				0.2 V_{CC}	V
Operating free-air temperature, T_A	TIR1000	0		70	°C
	TIR1000I	–40		85	

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{OH} High-level output voltage	$I_{OH} = -4$ mA $V_{CC} = 5$ V	$V_{CC} - 0.8$			V
	$I_{OH} = -1.8$ mA $V_{CC} = 3$ V	$V_{CC} - 0.55$			
V_{OL} Low-level output voltage	$I_{OL} = +4$ mA $V_{CC} = 5$ V			0.5	V
	$I_{OL} = +1.8$ mA $V_{CC} = 3$ V			0.5	
I_I Input current	$V_I = 0$ to V_{CC} , All other pins floating			± 3	μ A
I_{CC} Supply current	$V_{CC} = 5.25$ V, $T_A = 25^\circ\text{C}$, All inputs at 0.2 V, 16XCLK at 2 MHz, No load on outputs			1	mA
$C_i(16XCLK)$ Clock input capacitance			5		pF
$f(16XCLK)$ Clock frequency				2	MHz



switching characteristics

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_r	Output rise time	$C_{(LOAD)} = 15 \text{ pF}$ (10% to 90%)		1.3		ns
t_f	Output fall time	$C_{(LOAD)} = 15 \text{ pF}$ (90% to 10%)		1.8		ns

† Typical values are at $T_A = 25^\circ\text{C}$.

APPLICATION INFORMATION

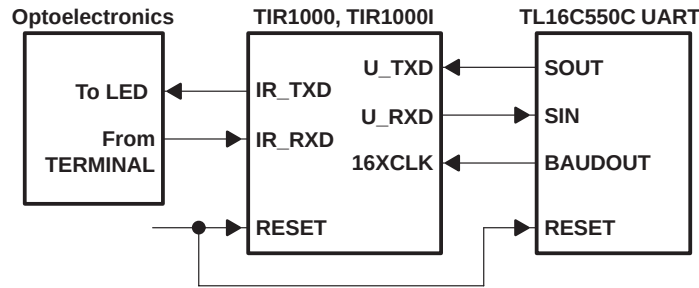


Figure 1. Typical application of the TIR1000, TIR1000I

PRINCIPLES OF OPERATION

IrDA overview

The Infrared Data Association (IrDA) defines several protocols for sending and receiving serial infrared data, including rates of 115.2 kbps, 0.576 Mbps, 1.152 Mbps, and 4 Mbps. The low rate of 115.2 kbps was specified first and the others must maintain downward compatibility with it. At the 115.2 kbps rate, the protocol implemented in the hardware is fairly simple. It primarily defines a serial infrared data *word* to be surrounded by a start bit equal to 0 and a stop bit equal to 1. Individual bits are encoded or decoded the same whether they are start, data, or stop bits. The TIR1000 and TIR1000I evaluate only single bits and only follow the 115.2 kbps protocol. The 115.2 kbps rate is a maximum rate. When both ends of the transfer are set up to a lower but matching speed, the protocol (with the TIR1000 and TIR1000I) still works. The clock used to code or sample the data is 16 times the baud rate, or 1.843 Mhz maximum. To code a 1, no pulse is sent or received for 1-bit time period, or 16 clock cycles. To code a 0, one pulse is sent or received within a 1-bit time period, or 16 clock cycles. The pulse must be at least 1.6 μs wide and 3 clock cycles long at 1.843 Mhz. At lower baud rates the pulse can be 1.6 μs wide or as long as 3 clock cycles. The transmitter output, IR_TXD, is intended to drive a LED circuit to generate an infrared pulse. The LED circuits work on positive pulses. A terminal circuit is expected to create the receiver input, IR_RXD. Most, but not all, PIN circuits have inversion and generate negative pulses from the detected infrared light. Their output is normally high. The TIR1000 and TIR1000I can decode either negative or positive pulses on IR_RXD.

TIR1000, TIR1000I STANDALONE IrDA™ ENCODER AND DECODER

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PRINCIPLES OF OPERATION

IrDA encoder function

Serial data from a UART is encoded to transmit data to the optoelectronics. While the serial data input to this block (U_TXD) is high, the output (IR_TXD) is always low, and the counter used to form a pulse on IR_TXD is continuously cleared. After U_TXD resets to 0, IR_TXD rises on the falling edge of the seventh 16XCLK. On the falling edge of the tenth 16XCLK pulse, IR_TXD falls, creating a 3-clock-wide pulse. While U_TXD stays low, a pulse is transmitted during the seventh to tenth clocks of each 16-clock bit cycle.

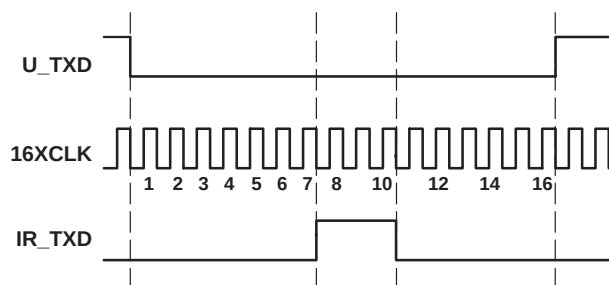


Figure 2. IrDA-SIR Encoding Scheme – Detailed Timing Diagram

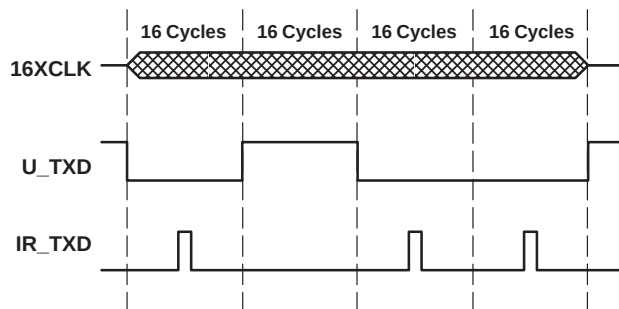


Figure 3. Encoding Scheme – Macro View

IrDA decoder function

After reset, U_RXD is high and the 4-bit counter is cleared. When a falling edge is detected on IR_RXD, U_RXD falls on the next rising edge of 16XCLK with sufficient setup time. U_RXD stays low for 16 cycles (16XCLK) and then returns to high as required by the IrDA specification. As long as no pulses (falling edges) are detected on IR_RXD, U_RXD remains high.

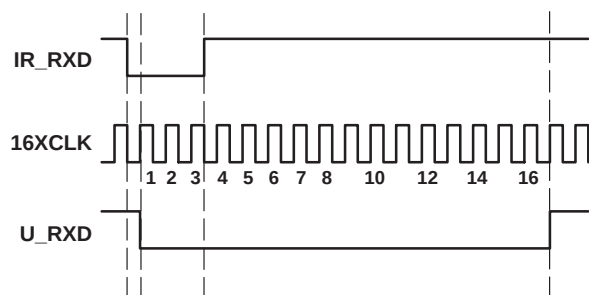


Figure 4. IrDA-SIR Decoding Scheme – Detailed Timing Diagram

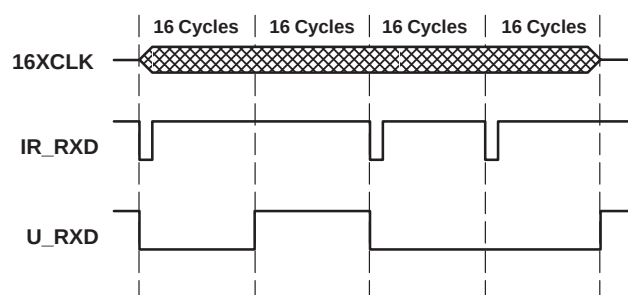


Figure 5. Decoding Scheme – Macro View

PRINCIPLES OF OPERATION

IrDA encoder function (continued)

It is possible for jitter or slight frequency differences to cause the next falling edge on IR_RXD to be missed for one 16XCLK cycle. In that case, a 1-clock-wide pulse appears on U_RXD between consecutive zeroes. It is important for the UART to strobe U_RXD in the middle of the bit time to avoid latching this 1-clock-wide pulse. The TL16C550C UART already strobes incoming serial data at the proper time. Otherwise, note that data is required to be framed by a leading zero and a trailing one. The falling edge of that first zero on U_RXD synchronizes the read strobe. The strobe occurs on the eighth 16XCLK pulse after the U_RXD falling edge and once every 16 cycles thereafter until the stop bit occurs.

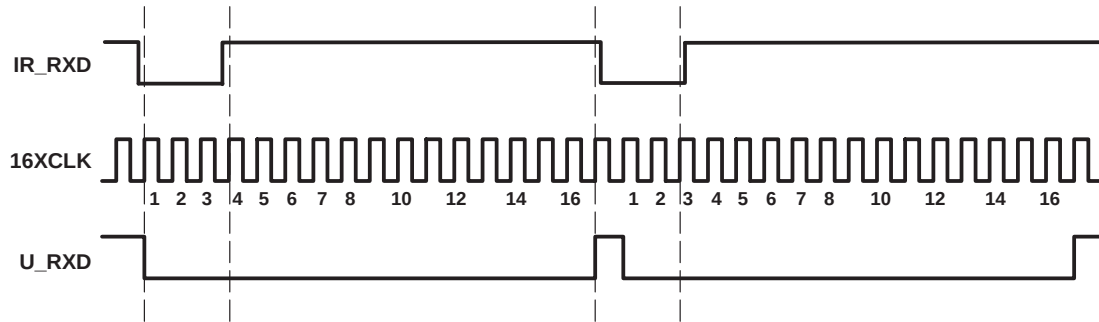


Figure 6. Timing Causing 1-clock-wide Pulse Between Consecutive Ones

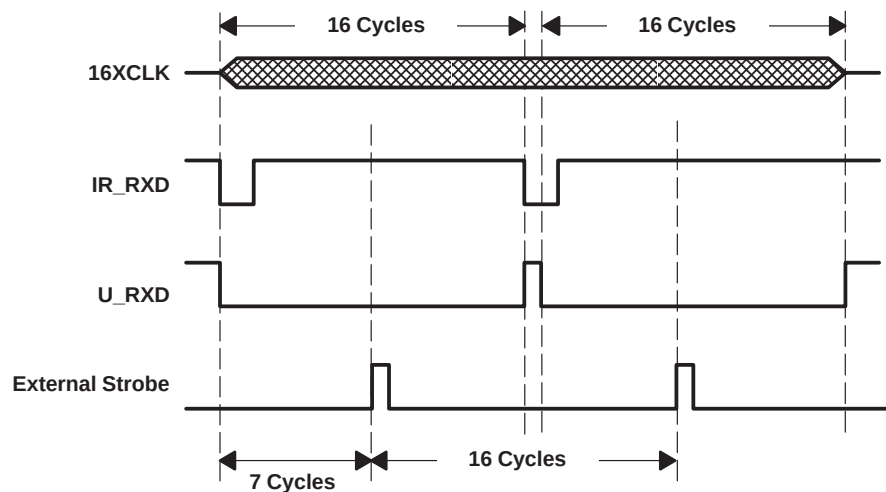


Figure 7. Recommended Strobing For Decoded Data

PRINCIPLES OF OPERATION

IrDA encoder function (continued)

The TIR1000 and TIR1000I can decode positive pulses on IR_RXD. The timing is different, but the variation is invisible to the UART. The decoder, which works from the falling edge, now recognizes a zero on the trailing edge of the pulse rather than on the leading edge. As long as the pulse width is fairly constant, as defined by the specification, the trailing edges should also be 16 clock cycles apart and data can readily be decoded. The zero appears on U_RXD after the pulse rather than at the start of it.

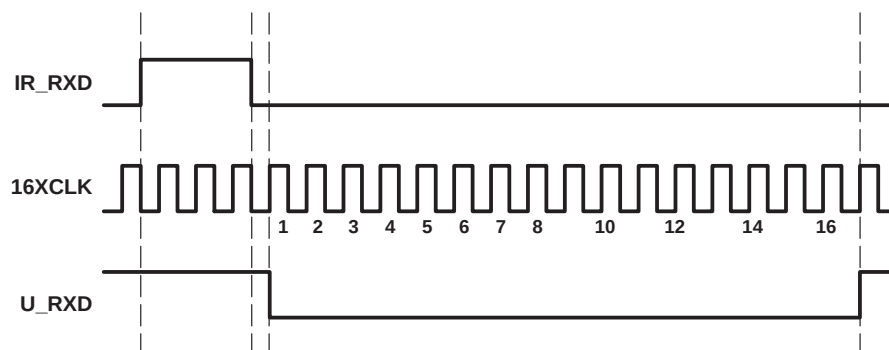


Figure 8. Positive IR_RXD Pulse Decode – Detailed View

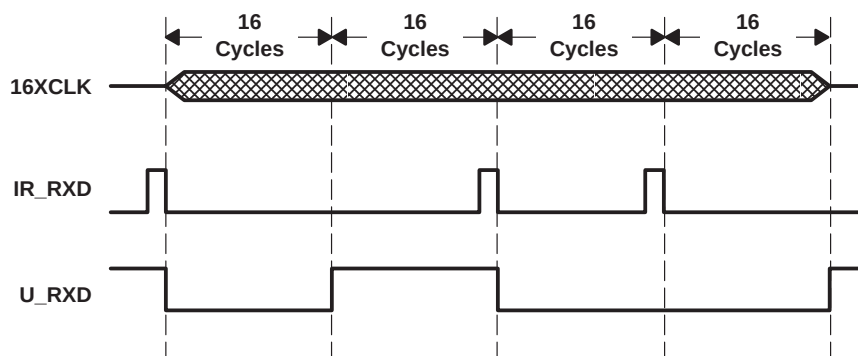


Figure 9. Positive IR_RXD Pulse Decode – Macro View

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
TIR1000IPS	ACTIVE	SO	PS	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	IR1000I	Samples
TIR1000IPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	IR1000I	Samples
TIR1000IPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R1000I	Samples
TIR1000IPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R1000I	Samples
TIR1000IPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R1000I	Samples
TIR1000IPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	R1000I	Samples
TIR1000PSLE	OBSOLETE	SO	PS	8		TBD	Call TI	Call TI	0 to 70		
TIR1000PSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	IR1000	Samples
TIR1000PSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	IR1000	Samples
TIR1000PWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI	0 to 70		
TIR1000PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	IR1000	Samples
TIR1000PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	IR1000	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

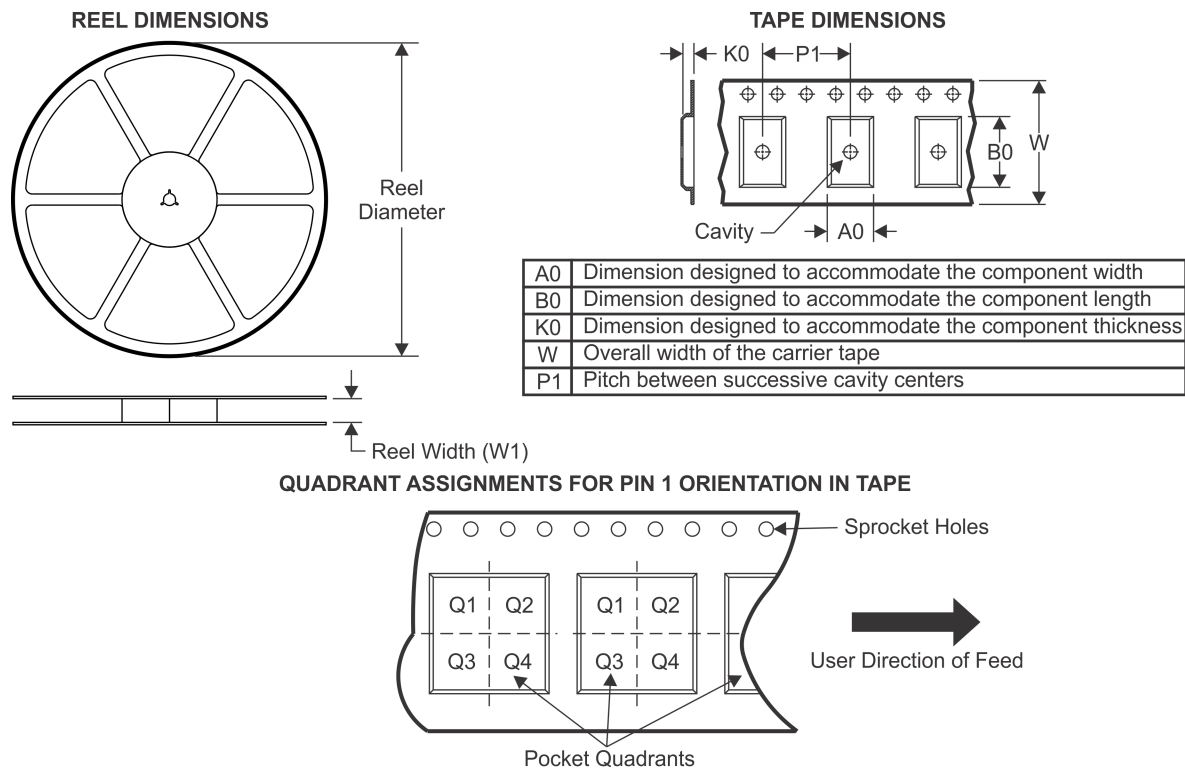
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

⁽⁴⁾ Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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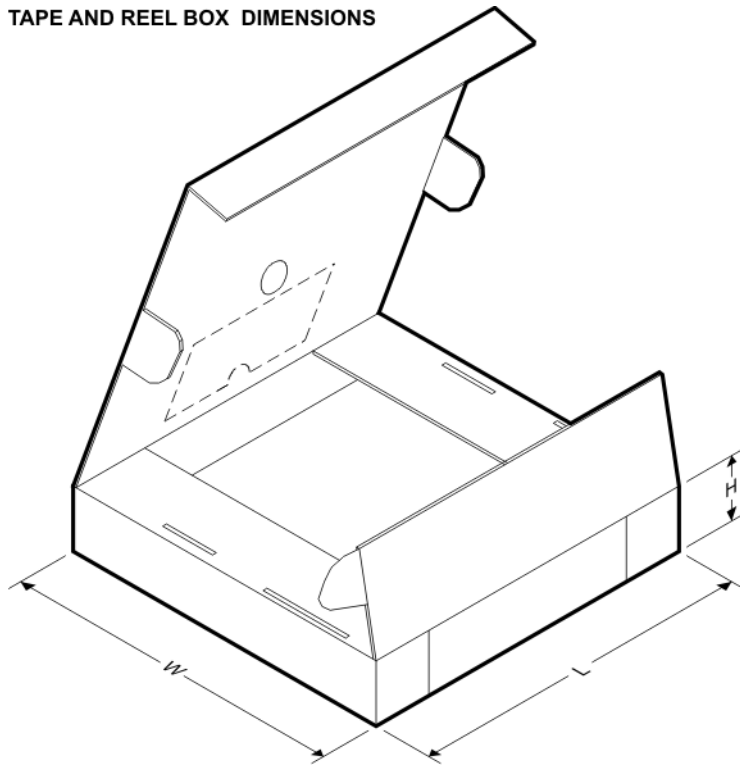
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TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TIR1000IPSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TIR1000IPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
TIR1000PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

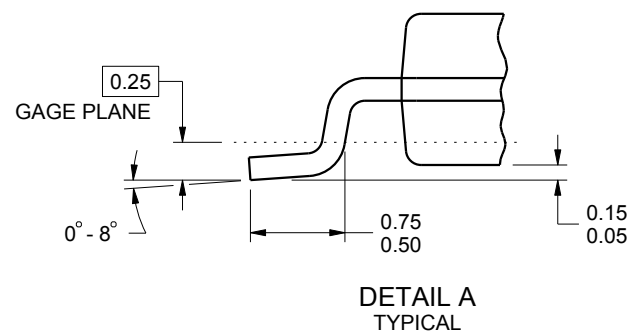
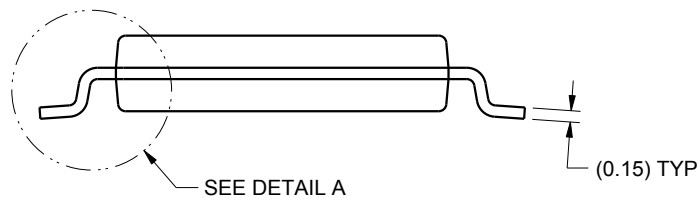
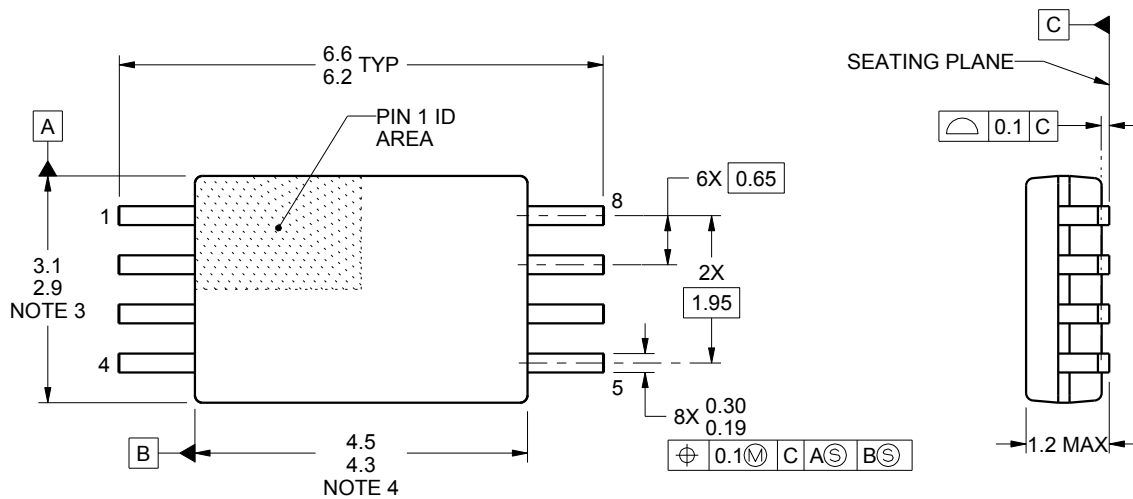
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TIR1000IPSR	SO	PS	8	2000	367.0	367.0	38.0
TIR1000IPWR	TSSOP	PW	8	2000	367.0	367.0	35.0
TIR1000PWR	TSSOP	PW	8	2000	367.0	367.0	35.0

PW0008A

PACKAGE OUTLINE

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

NOTES:

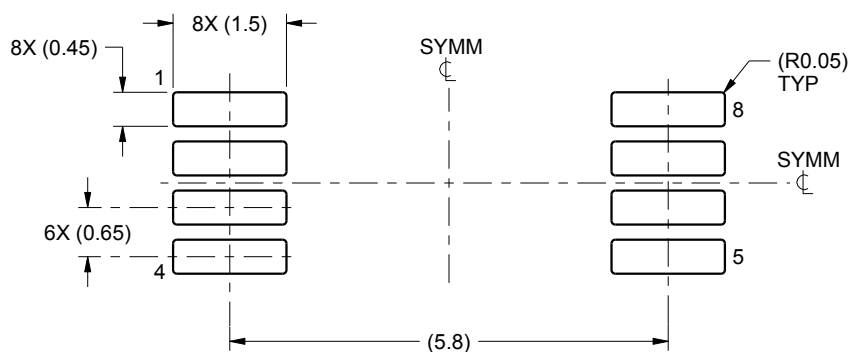
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

EXAMPLE BOARD LAYOUT

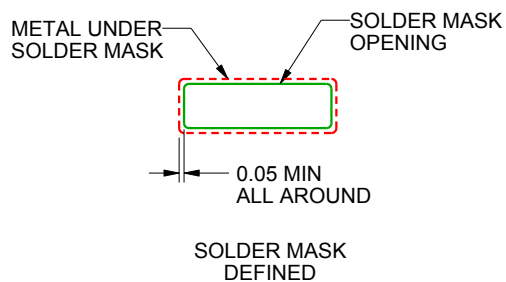
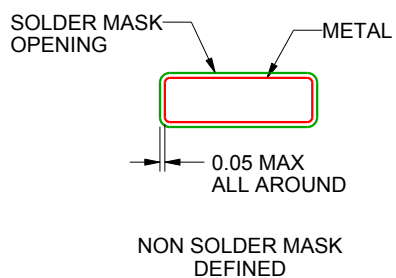
PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:10X



SOLDER MASK DETAILS
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

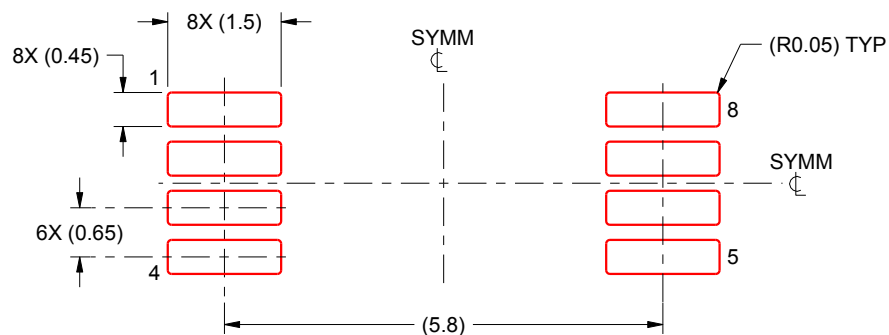
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:10X

4221848/A 02/2015

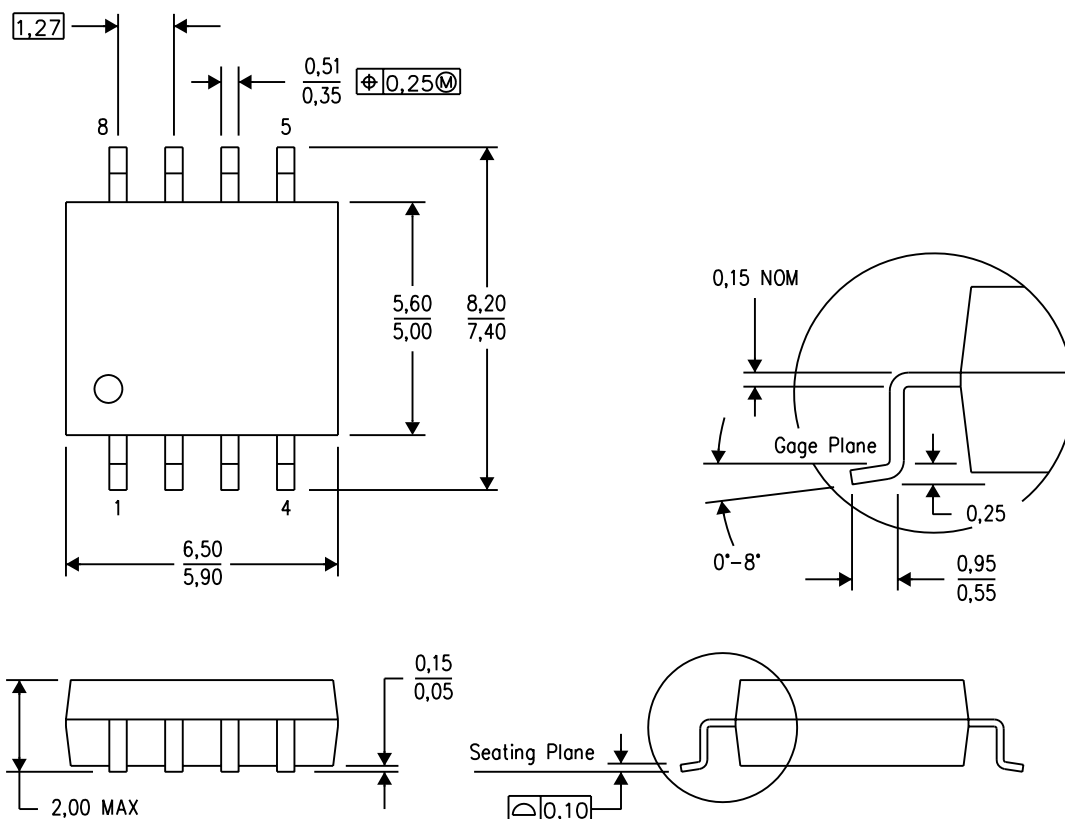
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

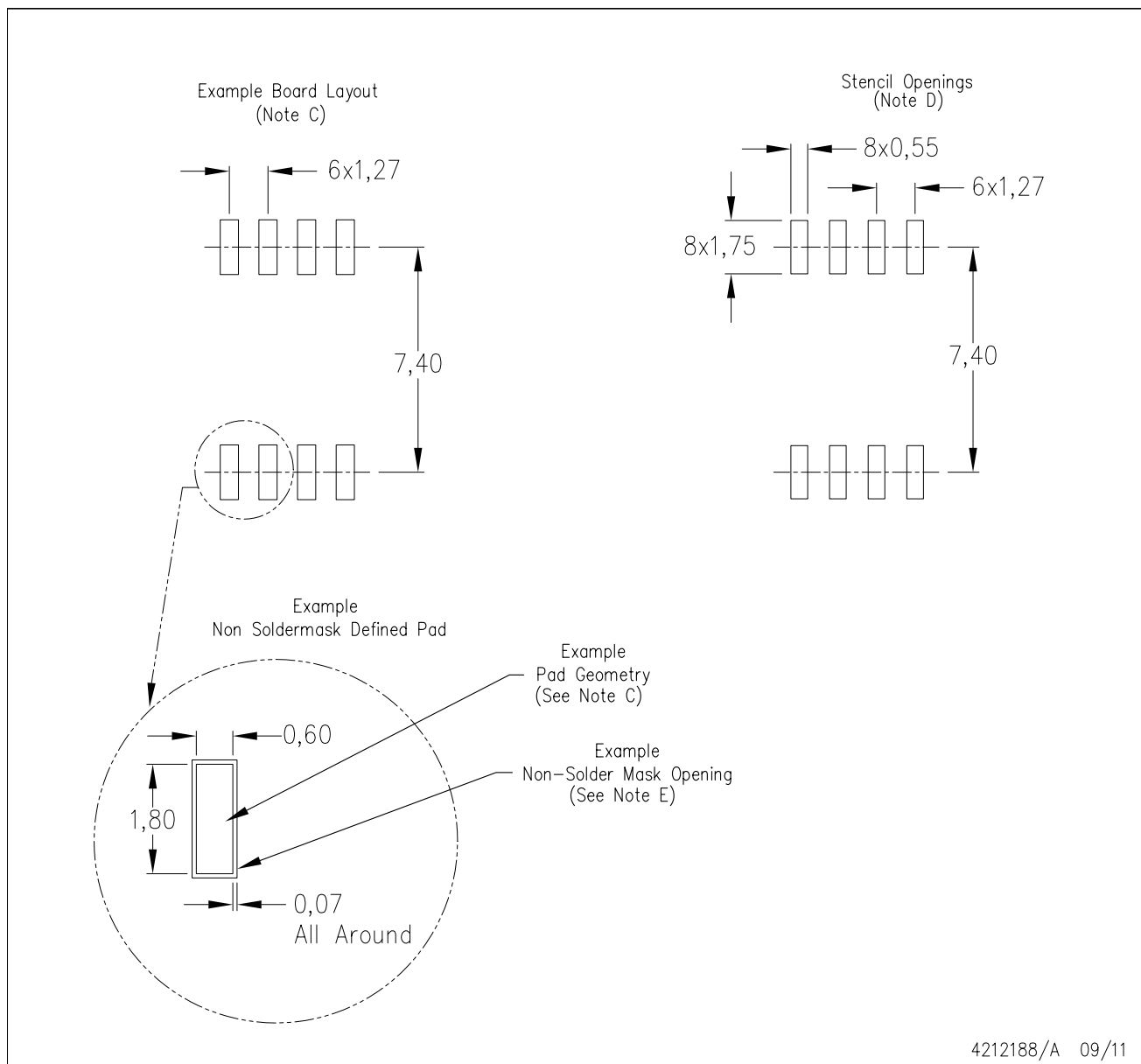


4040063/C 03/03

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PS (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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