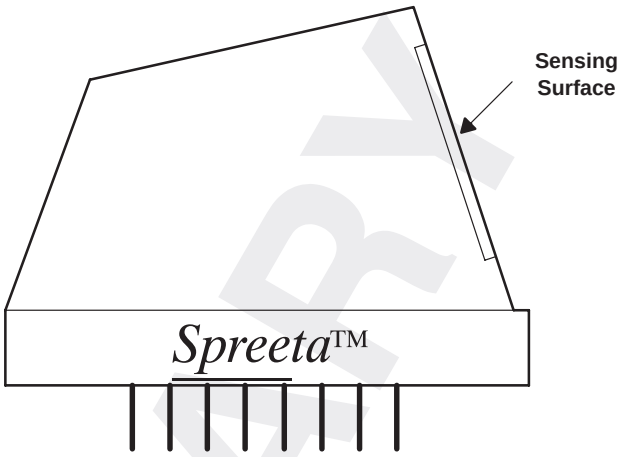
TSPR1A150100
Spreeta™ Liquid Sensor
Microcomponents Technology Center

SLYS009 – MARCH 1999

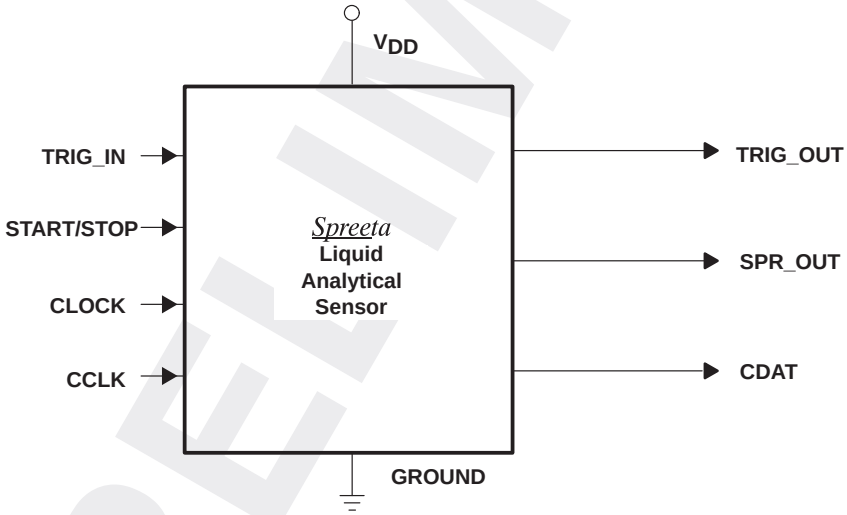
- **Real-Time Sensing**
- **Quantitative Analysis†**
- **Internal Fault Detection†**
- **On-Board Factory Set Calibration**
- **Robust Affordable Packaging**
- **Small and Lightweight**
- **Variety of Applications**
  - **Refractometry**
  - **Diagnostics**
  - **Quality Control**
  - **Distributed Process Control**



description

The Texas Instruments (TI™) TSPR1A150100 *Spreeta*™ liquid analytical sensor allows you to measure the refractive index of liquids that come in contact with the sensing surface. This measurement is obtained using an ultrasensitive physical principle known as surface plasmon resonance (SPR). Electrical connections are made via pins that protrude from the bottom of the device. The pin configuration is similar to a standard 16-pin dual in-line device. The following sections provide detailed information.

functional block diagram



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.

† When used in conjunction with processor board and *Spreeta* software

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Terminal Functions

TERMINAL NO.	TERMINAL NAME	I/O	DESCRIPTION
1	NC		No internal connection
2	NC		No internal connection
3	CDAT	O	Factory set calibration data output
4	NC		No internal connection
5	CLOCK	I	Clocks the measurement and output cycles
6	GROUND		Device ground
7	SPR_OUT	O	SPR information output (analog) (See Note 1)
8	SPR_OUT	O	SPR information output (analog) (See Note 1)
9	NC		No internal connection
10	NC		No internal connection
11	VDD		Device power
12	NC		No internal connection
13	START/STOP	I	Initiates measurement and output cycle
14	CCLK	I	Clocks calibration data out
15	TRIG_OUT	O	Trigger output (See Figure 2)
16	TRIG_IN	I	Trigger input; starts measurement cycle (See Figure 2)

NOTES: 1. Pins 7 and 8 are connected together internally.

detailed description

The *Spreeta* sensor uses a physical principal called surface plasmon resonance (SPR) to measure the refractive index of liquids in contact with the surface of the sensor. When a liquid comes in contact with the sensor and the appropriate signals are applied to the pins, the sensor provides an output that corresponds with the refractive index of the liquid. Detailed information on surface plasmon resonance can be found at http://www.ti.com/spreeta.

The TSPR1A150100 *Spreeta* liquid sensor has a dynamic range of 1.320 to 1.368 refractive index units (RIU) with a resolution of 5×10^{-6} RIU.

The physical dimensions of the *Spreeta* sensor are shown in Figure 7 on page 8.

The output of the *Spreeta* sensor is a series of analog pulses, one per clock cycle, from which the refractive index of the liquid is derived when the voltages are digitized and processed with the proper algorithm.

sensor operation

Using the *Spreeta* sensor to measure a refractive index requires the proper application of signals to the pins. A START pulse initiates an internal reset and the measurement cycle. The measurement cycle continues until the device receives the STOP pulse. To ensure a valid measurement, the STOP pulse must not be issued until at least 129 clock pulses after the START pulse.

Simultaneously, a TRIG_IN pulse must be provided with the START pulse to initiate the measurement cycle. The TRIG_IN pulse must go high at the same time as START and must remain high until STOP.

After STOP is received, the output cycle, SPR_OUT, begins and continues for the next 129 clock pulses.

NOTE:
The measurement cycle must be a minimum of 129 CLOCK pulses, but it can be much longer.

To ensure that the measurement and output cycles are valid, START and STOP pulses must go high before the rising edge of the CLOCK and must go low before the next rising edge of CLOCK.

calibration data read

The TSPR1A150100 *Spreeta* sensor has been factory tested and calibrated and the initial calibration data is stored onboard. To perform calibration, you must access this data using the calibration clock line (CCLK) and the calibration data line (CDAT). See Figure 3 through Figure 6 for timing diagrams that can assist you in this access.

care, handling, and cleaning

The *Spreeta* sensor is sensitive to high voltages, such as those produced by static electrical discharges. Normal handling is generally not a problem if you are properly grounded prior to handling the sensor.

Since the *Spreeta* sensing region that sustains the surface plasmon resonance is only a few hundred Angstroms thick, handling of this surface must be done with care to avoid scratching and damaging.

The integrated nature of the *Spreeta* sensor makes it rugged and shock resistant, but damage to the sensor can result from excessive bending of the pins, dropping the sensor, and exposure to excessive temperature changes.

active-sensing region

The active-sensing region is an area of thin gold film that is actively used in liquid sensing. It is approximately 14.0 mm long by 1.0 mm wide on the face of the sensor (see Figure 1).

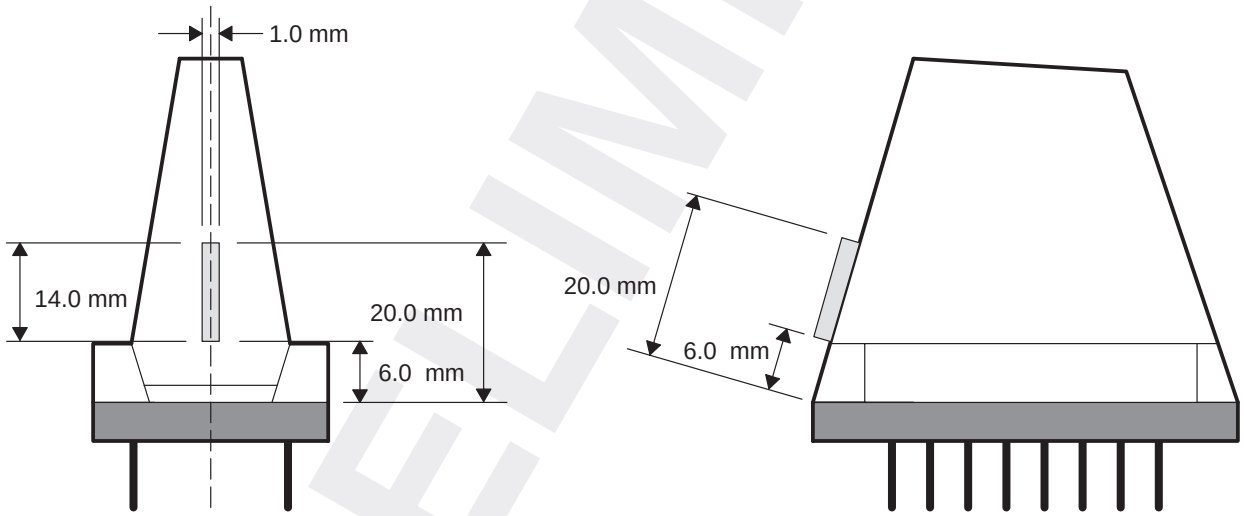

Figure 1. *Spreeta* **Sensor Active Sensing Region**

absolute maximum ratings†

Supply voltage, V_{DD} . . . . . 7 V
Digital input voltage range, V_I . . . . . –0.6 V to VDD+1.0 V
Digital input current range, I_I . . . . . –20 mA to 20 mA
Operating free-air temperature range, T_A . . . . . 0°C to 70°C
Storage temperature range, T_{stg} . . . . . –25°C to 85°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 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.

recommended operating conditions, T_A = 25°C (unless otherwise noted) (see Figure 3 and Figure 4)

General	**MIN**	**NOM**	**MAX**	**UNIT**
Supply voltage, V_{DD}	4.5	5.0	5.5	V
High-level input voltage, V_{IH}	$V_{DD} \times 0.7$			V
Low-level input voltage, V_{IL}	0		$V_{DD} \times 0.3$	V
Measurement and Output Cycle				
Trigger pulse width, t_W (See Notes 2 and 4)	TBD	5.0	TBD	ms
Trigger input current, V_I – Pulsed for 5 ms maximum (See Note 3 and 4)	25.0	100.0	TBD	mA
Start/Stop pulse setup time, $t_{su(ss)}$	0		t_W	ns
Hold time, start/stop pulse, $t_{h(ss)}$	20.0			ns
Clock frequency, f_{CLOCK}	5.0	25.0	2000	kHz
Measurement cycle time, SPR_M	TBD		TBD	ms
Output cycle time, SPR_O	TBD		TBD	ms
Calibration Data Access				
Calibration clock frequency, f_{CCLK}			100	kHz
Calibration clock high time, t_{HIGH}	4000			ns
Calibration clock low time, t_{LOW}	4700			ns
CDAT and CCLK rise time, , t_r	1000			ns
CDAT and CCLK fall time, t_f	300			ns
Start condition hold time, $t_{hd:STA}$	4000			ns
Start condition setup time, $t_{su:STA}$	4700			ns
Data input hold time, $t_{hd:DAT}$	0			ns
Data input setup time, $t_{su:DAT}$	250			ns
Stop condition setup time, $t_{su:STO}$	4700			ns
Output valid from CLOCK, t_{AA}			3500	ns
Bus free time, t_{buf}	4700			ns
Output fall time, t_{OF}			250	ns

NOTE 2: TRIG_IN must remain high during the period between START and STOP pulses.
NOTE 3: TRIG_IN current requirement depends on the measurement cycle time, clock frequency, and the TRIG_IN pullup value.
NOTE 4: See Figure 2 for a typical trigger circuit.

performance characteristics at T_A = 25°C (unless otherwise noted) (see Note 5)

PARAMETER	TEST CONDITIONS	MIN	NOM	MAX	UNIT
Refractive Index Range	TBD	1.320		1.368	RIU
Resolution	TBD		5×10^{-6}		RIU

NOTES: 5. Actual resolution varies depending upon the analog-to-digital (A/D) converter and algorithm used.

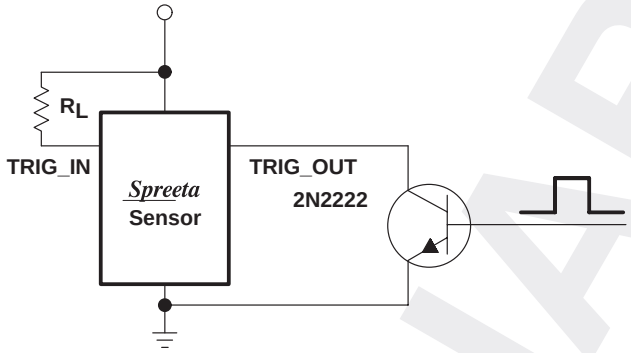

Figure 2. Typical Trigger Circuit

timing diagrams

Figure 3 through Figure 6 illustrate timing diagrams for the *Spreeta* sensor.

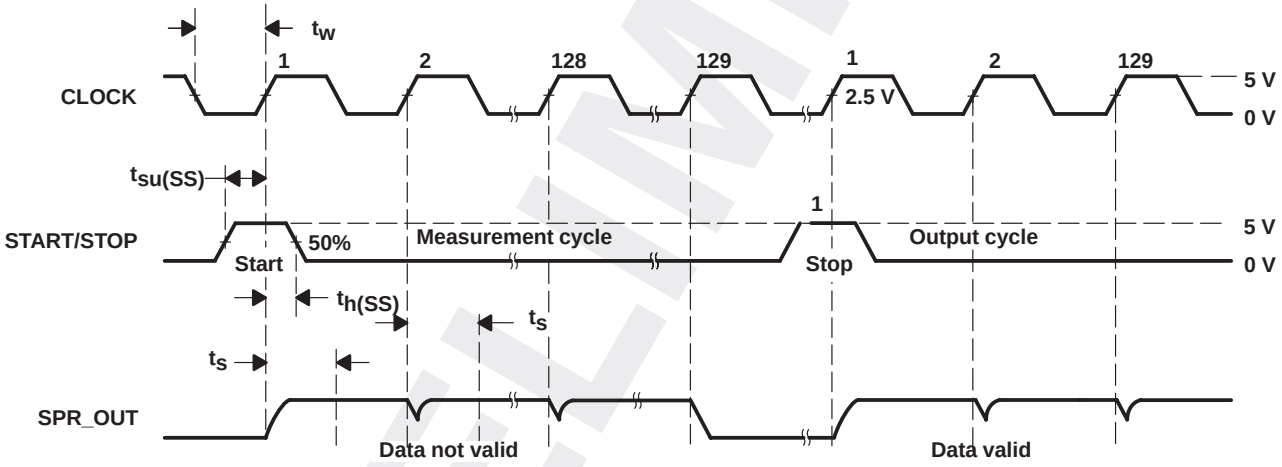

Figure 3. Measurement and Output Waveforms

timing diagrams (continued)

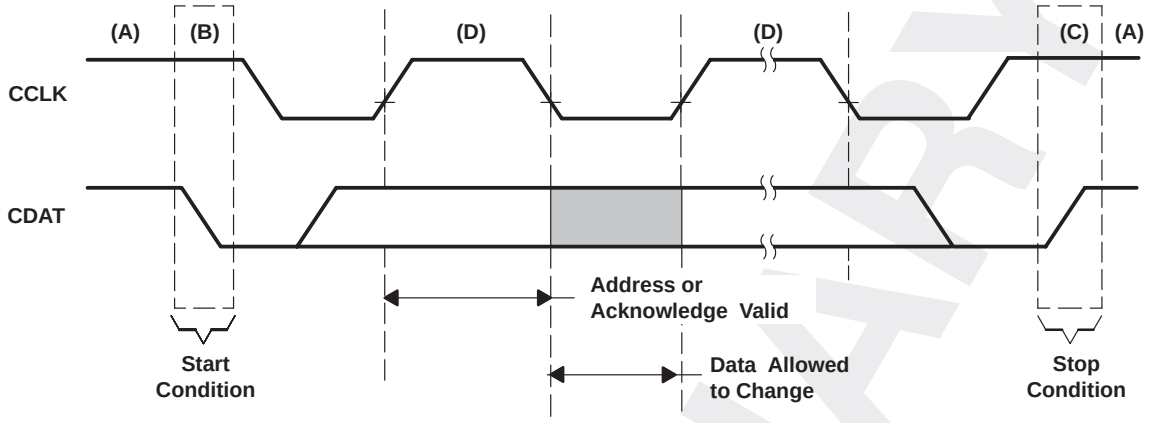

Figure 4. Calibration Data Transfer Sequence on the Serial Bus

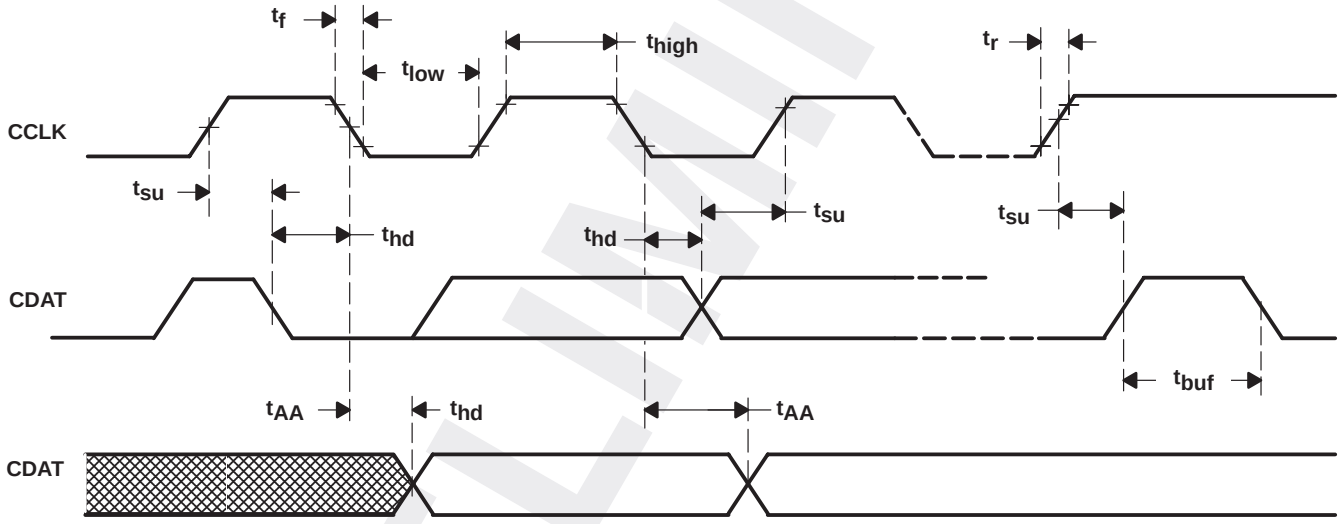

Figure 5. Bus Timing Data

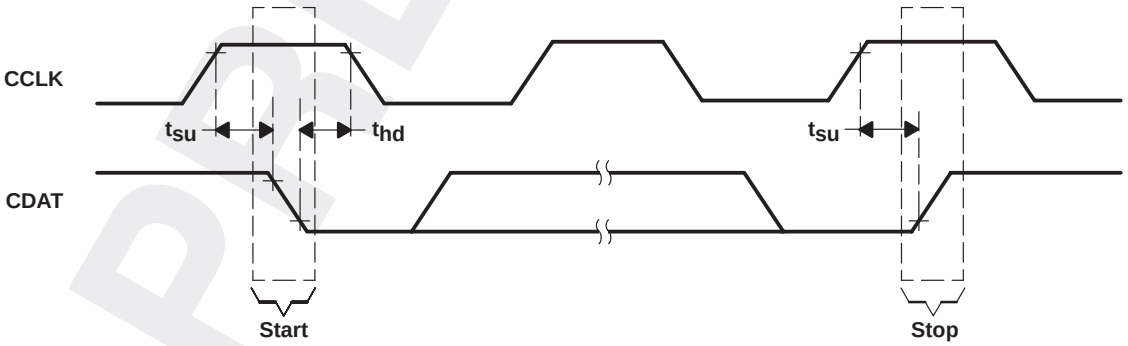

Figure 6. Bus Timing Start/Stop

ADDITIONAL INFORMATION

For details on the TI *Spreeta* liquid sensor and its components, see the *Spreeta* website at:

http://www.ti.com/spreeta

This website expands on the operation and application of the *Spreeta* liquid sensor, provides access to important documentation, and explains how you can order a *Spreeta* Evaluation Kit.

If you have questions or comments, please contact us through our website feedback form or email us at:

spreeta@ti.com

MECHANICAL INFORMATION

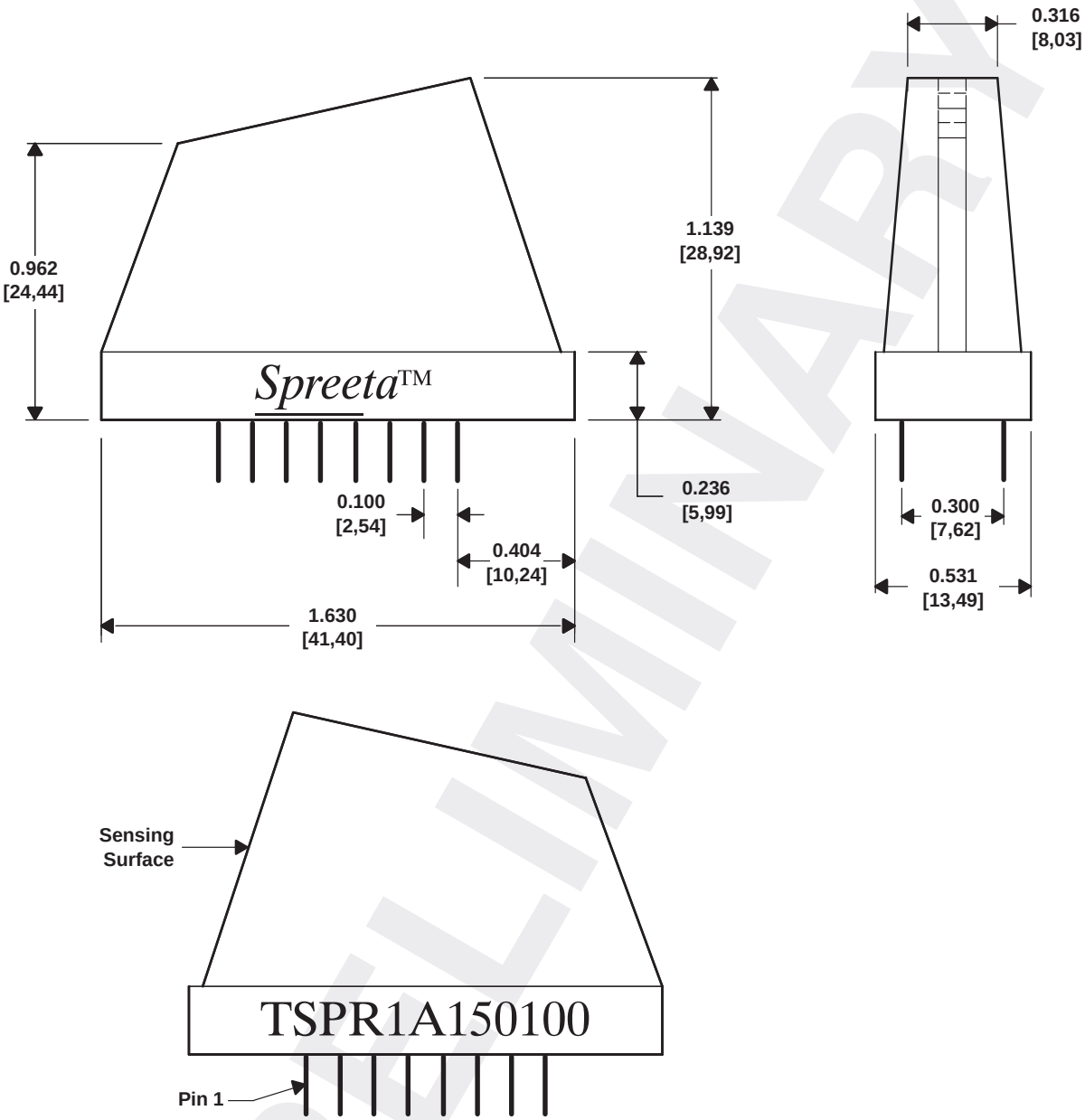

Figure 7. *Spreeta* Sensor Dimensions

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