

# Data Sheet

## True TDR-305N Soil Water-Temperature-BEC Sensor



### Description:

The TDR-305N is a 5cm waveguide version of the TDR-310N. The shorter waveguide allows this sensor to make very shallow measurements and to be used in significantly higher conductivity environments. It also has a much higher amplitude waveform than the H-series sensors, which consumes more power but makes it very effective in taking measurements in challenging soil environments. Being part of the Soil Smart Series means that its advanced waveform analysis works with all mineral soil types. It is a complete integrated time domain reflectometer that combines ultra-fast waveform generating and digitizing functions with a precision 5 pico-second resolution time base and highly sophisticated waveform digitizing and analyzing firmware that provides true time domain analysis of soil-propagated waveforms.

Its form factor is designed for easy vertical installation in an augered hole using a 34 mm flat-bottomed auger. It mates with a 1" schedule 40 PVC pipe that acts as a handle in its installation to any desired depth. It provides reading data through a 3-wire SDI-12 interface and is compatible with any data recorder that is compliant with SDI-12 version 1.4 and earlier.

### Features:

- Housing designed for easy bore hole installation at any depth
- Shorter waveguides are great for "check and go" type applications such as mobile readings on golf greens, other turf management, or limited space environments
- Ideal for high conductivity environments
- Soil Smart analysis works with all mineral soil types
- Incident Wave Amplitude: 2.3 V
- 20% to 80% Incident Wave Rise Time: 300 ps
- Waveform Digitizing Resolution: 5 ps
- SDI-12 Interface
- 3-element 5 cm stainless steel waveguide
- 5m or 10m 3-conductor waterproof cable (standard)
- Waterproof Epoxy-filled Housing

### Measurement Functions:

Volumetric Water Content:	0% to 100%
Medium Permittivity:	1 to 85
Medium Bulk Electrical Conductivity:	0 to 6000 $\mu\text{S}/\text{cm}$
Medium Temperature:	-40 to +55 degrees C
Pore Water EC (Hilhorst Model):	0 to 55000 $\mu\text{S}/\text{cm}$

### Measurement Performance:

Parameter	Min	Max	Units
<b>RELATIVE PERMITTIVITY</b>			
Range	1	85	-
Resolution	0.1		-
Repeatability (RMS deviation)	0.21		-
Accuracy	-4	+4	%FS <sup>1</sup>
Stability with Bulk Electrical Conductivity (0-6000 $\mu\text{S}/\text{cm}$ )	-1	+1	-
<b>VOLUMETRIC WATER CONTENT (VWC)</b>			
Range <sup>2</sup>	0	100	%
Resolution	0.1		%
Repeatability (RMS deviation)	0.5		%
Accuracy	-5	+5	%FS
Stability with Bulk Electrical Conductivity (0-6000 $\mu\text{S}/\text{cm}$ )	-1	+1	%FS
<b>TEMPERATURE<sup>4</sup></b>			
Range	-40	+55	$^{\circ}\text{C}$
Resolution	0.1		$^{\circ}\text{C}$
Repeatability (RMS deviation)	0.01		$^{\circ}\text{C}$
Accuracy (+5 to +35 $^{\circ}\text{C}$ )	-0.25	+0.25	$^{\circ}\text{C}$
Accuracy (-15 to +55 $^{\circ}\text{C}$ )	-0.5	+0.5	$^{\circ}\text{C}$
<b>BULK ELECTRICAL CONDUCTIVITY (BEC)</b>			
Range	0	6000	$\mu\text{S}/\text{cm}$
Resolution	1		$\mu\text{S}/\text{cm}$
Repeatability (RMS deviation)	3		$\mu\text{S}/\text{cm}$
Accuracy (0 – 1000 $\mu\text{S}/\text{cm}$ )	-25	+25	$\mu\text{S}/\text{cm}$
Accuracy (1000 – 2500 $\mu\text{S}/\text{cm}$ )	-2.5	+2.5	%
Accuracy (2500 – 6000 $\mu\text{S}/\text{cm}$ )	-5	+5	%

<sup>1</sup> Percent Full scale, i.e., +/- 2 percentage points

<sup>2</sup> VWC is calculated based on relative permittivity using the formula derived by Topp with minor modifications to allow readings in slurries and pure water. The relative permittivity of water varies with temperature, so to see a reading near 100%, the sensor must be fully immersed in water long enough to equilibrate temperature with the water. The water should be at 20.5C with at least 4cm of water around the rods on all sides, beyond the tips of the rods, and at least 1cm of the sensor body immersed. VWC readings higher than 100% are possible when the permittivity is higher than 80.

<sup>4</sup> The temperature sensing element is located next to one of the outer waveguide electrodes.

### Absolute Maximum Ratings:

Stresses beyond those specified below may cause permanent damage to the sensor. These are stress ratings only and operation at these levels is not implied.

Parameter	Min	Max	Units
Supply Voltage (Measured between the red and white wires)	-16	+16	Volts
SDI-12 Data Voltage (Blue-White wires)	-16	+16	Volts
External Voltage Applied to sensor rod	-0.3	+4	Volts
Electrostatic discharge, center rod	IEC 61000-4-2 (ESD)		
Storage Temperature	-40	+60	°C
	-40	+140	°F

### Operating Conditions:

Parameter	Min	Max	Units
Operating Supply Voltage	+4.2	+15	Volts
	Prior to 2H 2022 +6.5		
Operating Temperature (VWC errors due to ice)	-30	+55	°C
Operating Temperature (VWC accurate, no ice allowed)	0	+55	°C
<b>POWER CONSUMPTION</b>			
Idle Current (sensor powered but inactive, 20 °C)	< 10		uA
Idle Current (-35 to +50 °C)	< 50		uA
Sensor read time	0.4 typical		sec
Sensor read current (Supply Voltage = 12V)	118 typical		mA
Sensor read current (Supply Voltage = 7V)	150 typical		mA
Sensor communications current	6 typical		mA

### SDI-12 Data Line Electrical Characteristics:

Parameter	Min	Max	Units
<b>INPUT (when sensor is idle or receiving data)</b>			
Resistance to GND	160k	175k	Ohms
VIL (required input voltage in “marking” state)	-1	1.3	V
VIH (required input voltage in “spacing” state)	3.2	6	V
<b>OUTPUT (when sensor is transmitting data)</b>			
Output impedance	1000	1250	Ohms
VOL (output voltage in “marking” state)	0	0.25	V
VOH (output voltage in “spacing” state)	4.7	5.2	V

### Physical Characteristics:

Dimensions (without cable)	15 cm x 3.3 cm
Weight (without cable)	121 g
Cable weight	32.7 g/m
Composition	316 Stainless Steel, Epoxy, ABS Plastic
Cable	3 copper conductor, 22 Ga., waterproof and UV resistant PVC jacket, 4.8mm overall diameter
Communication Protocol	SDI-12 Version 1.4

