



## Data Sheet

# True TDR-310N

## Soil Water-Temperature-BEC Sensor



### Description:

The TDR-310N is a replacement to the former Acclima TDR-310L. It has a high voltage waveform output, which makes it effective in taking measurements when the soil electrical conductivity is high. It also consumes more power than the TDR-310H. 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 augured 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:

SDI-12 Interface  
3-element 10 cm stainless steel waveguide  
5 m 3-conductor waterproof cable (standard)  
Waterproof Epoxy-filled Housing  
20% to 80% Incident Wave Rise Time: 300 ps  
Waveform Digitizing Resolution: 5 ps  
Incident Wave Amplitude: 2.3 V

### Measurement Functions:

Volumetric Water Content:	0% to 100%
Medium Permittivity:	1 to 100
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	100	-
Resolution	0.1		-
Repeatability (RMS deviation)	0.07		-
Accuracy	-2	+2	-
Stability with Bulk Electrical Conductivity (0-3000 uS/cm)	-1	+1	-
<b>VOLUMETRIC WATER CONTENT (VWC)</b>			
Range <sup>1</sup>	0	100	%
Resolution	0.1		%
Repeatability (RMS deviation)	0.07		%
Accuracy	-2	+2	%FS <sup>2</sup>
Stability with Bulk Electrical Conductivity (0-3000 uS/cm)	-1	+1	%FS
<b>TEMPERATURE<sup>3</sup></b>			
Range	-40	+60	°C
Resolution	0.1		°C
Repeatability (RMS deviation)	0.01		°C
Accuracy (+5 to +35 °C)	-0.25	+0.25	°C
Accuracy (-15 to +50 °C)	-0.5	+0.5	°C
<b>BULK ELECTRICAL CONDUCTIVITY (BEC)</b>			
Range	0	6000	uS/cm
Resolution	1		uS/cm
Repeatability (RMS deviation)	3		uS/cm
Accuracy (0 – 1000 uS/cm)	-25	+25	uS/cm
Accuracy (1000 – 2500 uS/cm)	-2.5	+2.5	%
Accuracy (2500 – 6000 uS/cm)	-5	+5	%

**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	+6.5	+15	Volts
Operating Temperature (VWC errors due to ice)	-30	+55	°C

<sup>1</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 of 100%, the sensor must be fully immersed in water at 20C with at least 2 cm of water around the rods on all sides and beyond the tips of the rods. VWC readings higher than 100% are possible when the permittivity is higher than 80.

<sup>2</sup> Percent Full scale, or +/- 2 percentage points

<sup>3</sup> The temperature sensing element is located next to one of the outer waveguide electrodes.



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	0.3 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)	20 cm x 3.3 cm
Weight (without cable)	132 g
Cable weight	32.7 g/m
Composition	304 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

