



# True TDR-305N

## Soil Water-Temperature-BEC Sensor

The TDR-305N is a modified version of the TDR-310N. The very short waveguide allows this sensor to make very shallow measurements and to be used in higher conductivity environments with a sacrifice in total measurement volume. 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-315H. It is a complete integrated time domain reflectometer that combines ultra-fast waveform generating and digitizing functions with a precision 5 picosecond 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 5 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 10000  $\mu\text{S/cm}$   
 Medium Temperature: -40 to +55 degrees C  
 Pore Water EC (Hilhorst Model): 0 to 55000  $\mu\text{S/cm}$

## 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 (0-6000 $\mu\text{S/cm}$ ) | -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> |

<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

|  |       |       |       |
|--|-------|-------|-------|
| Stability with Bulk Electrical Conductivity (0-6000 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     | 10000 | 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>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) | 15 cm x 3.3 cm   |
| Weight (without cable)     | 121 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   |

