METER

HYDROS 21
GEN 2

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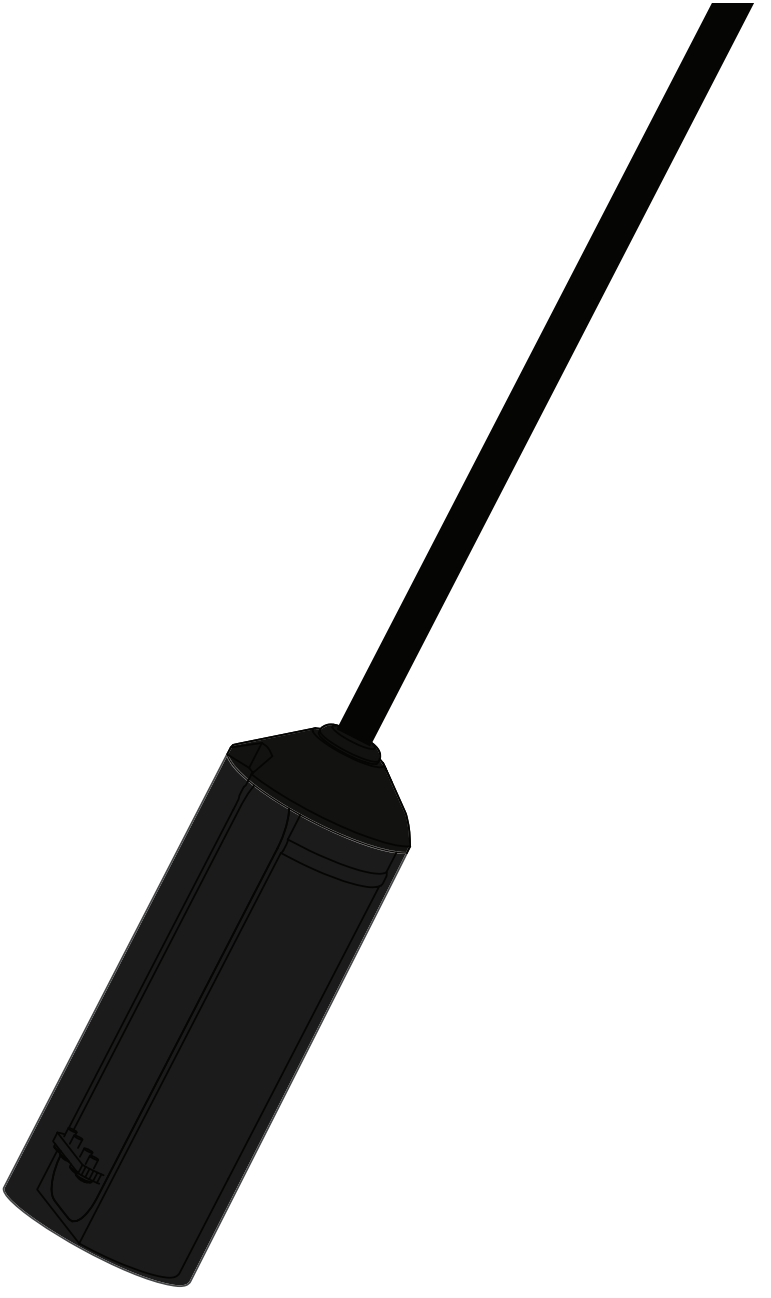


1. INTRODUCTION

Thank you for choosing the HYDROS 21 Gen 2 Water Depth, Temperature, and Electrical Conductivity (EC) sensor from METER Group.

The HYDROS 21 is designed for groundwater monitoring wells or piezometers, surface water monitoring, and wetland monitoring. The sensor cable is vented to remove the effects of barometric pressure changes on measurements. The sensor also features a precision thermistor to measure temperature. The integrated four-electrode EC transducer accurately senses EC up to 120 dS/m.

Prior to use, verify the sensor arrived in good condition.

2. OPERATION

Please read all instructions before operating the HYDROS 21 to ensure it performs to its full potential.

⚠ PRECAUTION

METER sensors are built to the highest standards, but misuse, improper protection, or improper installation may damage the sensor and possibly void the manufacturer's warranty. Before integrating HYDROS 21 into a system, make sure to follow the recommended installation instructions and have the proper protections in place to safeguard sensors from damage.

2.1 INSTALLATION

The two most common installation methods for the HYDROS 21 are (1) groundwater well installation and (2) surface water installation. Hydrology studies using monitoring wells or piezometers are only as good as the well installation design. It is important to use properly designed wells to obtain accurate data and for proper sensor operation.

While installing the HYDROS 21, accommodate for the following considerations:

- Biofouling can affect sensor performance. One way to mitigate the accumulation of microorganisms, plants, and algae is to wrap the sensor with a copper mesh. Inspect and clean the sensor more frequently in these conditions.
- Buildup of sedimentation or debris around the sensor will cause inaccurate measurements and potential damage. Ensure the sensor installation is high enough to avoid becoming buried in sediment.
- If the sensor is in water, it must not experience temperatures below 0 °C (32 °F). If water freezes in the pressure transducer cavity, the pressure transducer will be permanently and catastrophically damaged by the ice formation. Freezing is not generally a problem in deep underground well installations but might be an issue in surface water wells and underground installations above the frost depth.

⚠ WARNING

Exposing the HYDROS 21 sensor to freezing temperatures with water in the pressure transducer cavity voids the sensor warranty.

Follow the steps listed in Table 1 to set up the HYDROS 21 and start collecting data.

Table 1 Installation

Tools Needed	**Zip ties** **Folding rule** **Reference document on well design** **Kellem grip for well installation (included)** **Slotted well screen or other sensor protection**

Table 1 Installation (continued)

Groundwater Well Installation

Suspend HYDROS 21 in Well

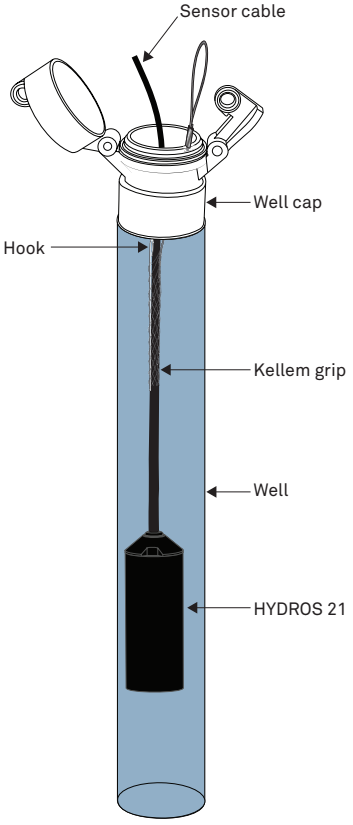
Ensure the well has been properly installed, consulting additional resources as necessary (e.g., Sprecher, 2008). The well must be 3.5 cm (1.38 in) in diameter or larger.

NOTE: Well design depends on the desired measurement, such as groundwater flow, quality, level, or pressure head.

Use the Kellem grip to set the desired installation depth. Set the installation depth based on the zero point for the pressure transducer (Figure 4, Sec. 3.2).

NOTE: the zero point offset is 15 mm. See Figure 4

Lower the sensor down the well and use the hook on the Kellem grip to suspend the sensor in its final position.



Sensor in groundwater well

Cap the well. Ensure the well is able to vent to atmospheric pressure.

Table 1 Installation (continued)

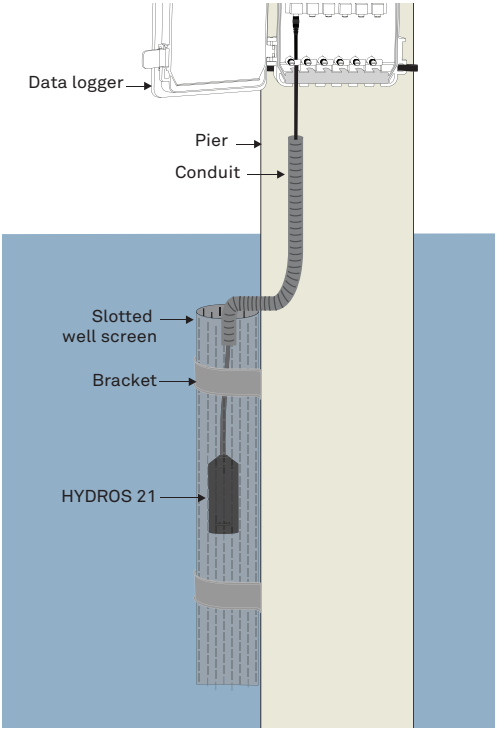
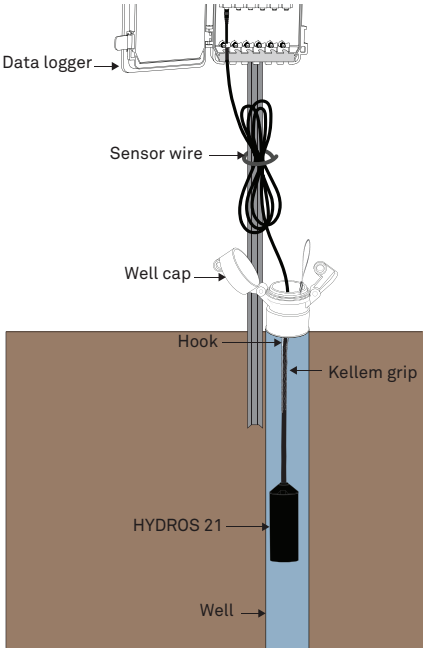
Surface Water Installation	**Suspend HYDROS 21 in Water Body** Select a secure location to mount the sensor, such as a bridge abutment or pier. If there is not an existing structure, drive a post into the stream bed. Install sensor protection. Protect the pressure sensor from water flow noise. For example, slotted well screens protect the sensor from debris and dampen the effect of stream current on the pressure measurement. Suspend sensor from mounting location.  **Sensor suspended in water body** Secure cable, accounting for higher flow conditions to protect sensor cable from higher currents and floating debris.

Table 1 Installation (continued)

Connecting	**Secure and Protect Cables** **NOTE: Improperly protected cables can lead to severed cables or disconnected sensors. Cabling issues can be caused by many factors such as rodent damage, driving over sensor cables, tripping over cables, not leaving enough cable slack during installation, or poor sensor wiring connections.** Install cables in conduit or plastic cladding when near the ground to avoid rodent damage. Gather and secure cables between the HYDROS 21 and the data logger to the mounting mast in one or more places.  **Cable management** **Connect to Data Logger** Plug the sensor into a data logger. Use the data logger to make sure the sensor is reading properly. Verify that these readings are within expected ranges. For more instructions on connecting to data loggers, refer to Section 2.2.

2.2 CONNECTING

The HYDROS 21 works seamlessly with METER data loggers. The HYDROS 21 can also be used with other data loggers, such as those from Campbell Scientific, Inc. For extensive directions on how to integrate the sensors into third-party loggers, refer to the HYDROS 21 Integrator Guide.

HYDROS 21 sensors require an excitation voltage in the range of 4.0 to 15.0 VDC and operate at a 4.0-VDC level for data communication. HYDROS 21 can be integrated using DDI Serial or SDI-12 protocol. See the HYDROS 21 Integrator Guide for details on interfacing with data acquisition systems.

HYDROS 21 sensors come with a 3.5-mm stereo plug connector (Figure 1) to facilitate easy connection with METER loggers. HYDROS 21 sensors may be ordered with stripped and tinned wires to facilitate connecting to some third-party loggers (Section 2.2.1).

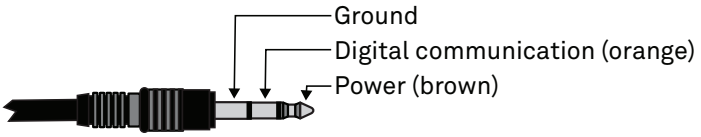


Figure 1 Stereo plug connector

The HYDROS 21 comes standard with a 10-, 20-, or 40-m cable. In some instances, the cable can be extended beyond 40 m by the user, but this is discouraged for a variety of reasons. Please contact Customer Support for more details before extending or splicing cables.

NOTE: The HYDROS 21 vents the pressure transducer through the cable to atmospheric pressure. Long cable lengths may cause a slow response to changes in atmospheric pressure; a maximum cable length of 40 m is recommended for optimal venting.

2.2.1 CONNECT TO METER DATA LOGGER

The HYDROS 21 works most efficiently with METER ZENTRA series data loggers. Check the HYDROS 21 Firmware Updater (metergroup.com/en/meter-environment/products/hydros-21/hydros-21-support) for the most recent data logger firmware. Logger configuration may be done using either ZENTRA Utility (desktop and mobile application) or ZENTRA Cloud (web-based application for cell-enabled data loggers).

1. Plug the stereo plug connector into one of the sensor ports on the logger.
2. Use the appropriate software application to configure the chosen logger port for the HYDROS 21. METER data loggers will automatically recognize HYDROS 21 sensors.
3. Set the measurement interval.

   METER data loggers measure the HYDROS 21 every minute and return the average of the 1-min data across the chosen measurement interval.

HYDROS 21 data can be downloaded from METER data loggers using either ZENTRA Utility or ZENTRA Cloud. Refer to the logger user manual for more information about these programs.

2.2.2 CONNECT TO NON-METER DATA LOGGER

The HYDROS 21 can be purchased for use with non-METER (third party) data loggers. Refer to the third-party logger manual for details on logger communications, power supply, and ground ports. The HYDROS 21 Integrator Guide also provides detailed instructions on connecting sensors to non-METER loggers.

HYDROS 21 sensors can be ordered with stripped and tinned (pigtail) wires for use with screw terminals. Refer to the third-party logger manual for details on wiring.

Connect the HYDROS 21 wires to the data logger as illustrated in Figure 2 and Figure 3, with the power supply wire (brown) connected to the excitation, the digital out wire (orange) connected to a digital input, and the bare ground wire connected to ground.

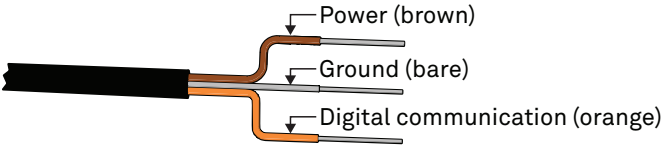


Figure 2 Pigtail wiring

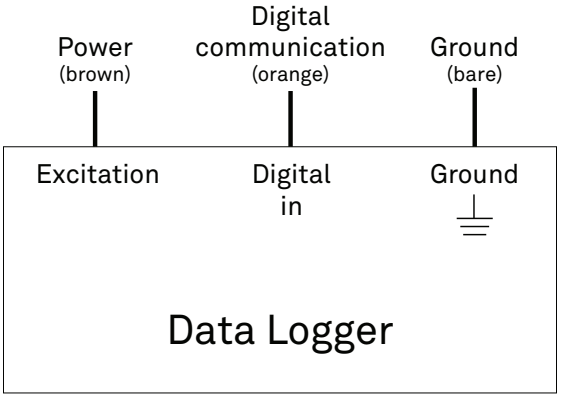


Figure 3 Wiring diagram

NOTE: The acceptable range of excitation voltages is from 4.0 to 15.0 VDC. To read HYDROS 21 sensors with Campbell Scientific data loggers, power the sensor from a switched 12-V port or a 12-V port if using a multiplexer.

If the HYDROS 21 cable has a standard stereo plug connector and needs to be connected to a non-METER data logger, use one of the following two options.

Option 1

1. Clip off the stereo plug connector on the sensor cable.
2. Strip and tin the wires.
3. Wire it directly into the data logger.

This option has the advantage of creating a direct connection and minimizes the chance of the sensor becoming unplugged. However, it then cannot be easily used in the future with a METER readout unit or data logger.

Option 2
Obtain an adapter cable from METER.

The adapter cable has a connector for the stereo plug connector on one end and three wires (or pigtail adapter) for connection to a data logger on the other end. The stripped and tinned adapter cable wires have the same termination as seen in Figure 3: the brown wire is excitation, the orange is output, and the bare wire is ground.

NOTE: Secure the stereo plug connector to the pigtail adapter connections using adhesive-lined heat shrink to ensure the sensor does not become disconnected during use.

2.3 COMMUNICATION

The HYDROS 21 communicates using two different methods:

- DDI Serial string
- SDI-12 communications protocol

To obtain detailed instructions, refer to the HYDROS 21 Integrator Guide.

The SDI-12 protocol requires that all sensors have a unique address. HYDROS 21 sensor factory default is an SDI-12 address of 0. To add more than one SDI-12 sensor to a bus, the sensor address can be changed using a ZSC Bluetooth® sensor interface and the ZENTRA Utility Mobile app as described below:

NOTE: The sensor SDI-12 address must be returned to 0 to work with ZENTRA loggers.

1. Using a mobile device, open the ZENTRA Utility Mobile app.
2. Connect the sensor to the ZSC.
3. Under Sensor Information, select the SDI Address dropdown.
4. Scroll through the options and select the desired SDI-12 address.

⚠ WARNING

Address options include 0-9, A-Z, and a-z.

Detailed information can also be found in the application note Setting SDI-12 addresses on METER digital sensors using Campbell Scientific data loggers and LoggerNet.

When using the sensor as part of an SDI-12 bus, excite the sensors continuously to avoid issues with initial sensor startup interfering with the SDI-12 communications.

3. SYSTEM

This section describes the HYDROS 21 Water Depth, Temperature, and EC (CTD) sensor.

3.1 SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Water Depth	
Range	0–10,000 mm
Resolution	1 mm
Accuracy	±0.25% of full scale at 20 °C
NOTE: Depth measurement accuracy assumes no abrupt temperature variations.	
Temperature	
Range	–40 to +60 °C
Resolution	0.1 °C
Accuracy	±1 °C
NOTE: The pressure transducer may be damaged or destroyed if frozen in ice. Remove the sensor if the water temperature could drop below 0 °C (32 °F).	
Electrical Conductivity (EC)	
Range	0–120 dS/m
Resolution	0.001 dS/m
Accuracy	±0.01 dS/m or ±10%, whichever is greater
NOTE: The EC measurement is corrected to a standard temperature of 25 °C.	

COMMUNICATION SPECIFICATIONS

Output
DDI Serial or SDI-12 communications protocol
Data Logger Compatibility
METER ZL6 data loggers and any data acquisition system capable of 4.0- to 15.0-VDC power and serial or SDI-12 communications

PHYSICAL SPECIFICATIONS

Dimensions	
Length	9.0 cm (3.5 in)
Diameter	3.4 cm (1.3 in)
Operating Temperature Range	
Minimum	0 °C
Maximum	60 °C

NOTE: The pressure transducer may be damaged or destroyed if frozen in ice. No damage will occur at subfreezing temperatures if the sensor is not in water. Contact Customer Support for assistance.

Cable Length

10 m (standard)
20 m
40 m (maximum)

Cable Diameter

6.00 ±0.25 mm (0.240 ±0.010 in) with minimum jacket of 0.80 mm (0.031 in)

Connector Types

Stereo plug connector or stripped and tinned wires

Stereo Plug Connector Diameter

3.50 mm

Conductor Gauge

20-AWG signal and power / 21-AWG ground wire

ELECTRICAL AND TIMING CHARACTERISTICS

Supply Voltage (power to ground)	
Minimum	4.0 V
Typical	NA
Maximum	15.0 V
Digital Input Voltage (logic high)	
Minimum	2.8 V
Typical	3.6 V
Maximum	5.0 V

Digital Input Voltage (logic low)	
Minimum	–0.3 V
Typical	0.0 V
Maximum	0.8 V
Digital Output Voltage (logic low)	
Minimum	NA
Typical	3.6 V
Maximum	NA
Required Power Line Slew Rate	
Minimum	1.0 V/ms
Typical	NA
Maximum	NA
Current Drain (during measurement)	
Minimum	2.5 mA
Typical	3.5 mA
Maximum	8.0 mA
Current Drain (while asleep)	
Minimum	NA
Typical	0.35 mA
Maximum	NA
Power Up Time (DDI Serial)	
Minimum	52 ms
Typical	NA
Maximum	100 ms
Power Up Time (SDI-12)	
Minimum	NA
Typical	700 ms
Maximum	750 ms

Power Up Time (SDI-12, DDI Serial disabled)	
Minimum	NA
Typical	175 ms
Maximum	200 ms
Measurement Duration	
Minimum	NA
Typical	450 ms
Maximum	600 ms

COMPLIANCE

EM ISO/IEC 17050:2010 (CE Mark)

EN 55011:2016 / A1:2017 (GROUP 1, CLASS A) (RCM Mark)

3.2 COMPONENTS

The HYDROS 21 sensor monitors water level, temperature, and EC in both ground and surface water. The HYDROS 21 uses a vented ceramic peizoresistive differential pressure transducer to measure the pressure from the water column to determine water depth. The reference port of the pressure transducer is vented through the cable to atmospheric pressure, so no reference barometric pressure is required. A porous Teflon® vent near the data logger end of the cable provides the reference. The Teflon keeps liquid water out of the cable but allows air to enter and leave. This vent must be kept open to the same atmospheric pressure that is applied to the water whose depth is being measured. Since the cable is conducting reference air between the sensor and the atmosphere, it is extremely important that the cable be protected from any damage that would allow water to enter.

A thermistor in thermal contact with the probe provides water temperature, while the stainless steel screws on the surface of the sensor form a four-electrode array to measure EC. With a range of 0 to 120 dS/m, the HYDROS 21 has the ability to make accurate EC measurements in a broad range of applications. The HYDROS 21 has a compact 3.4-cm diameter body. The electronic circuitry is encapsulated in a marine-grade epoxy to protect the sensor in corrosive environments.

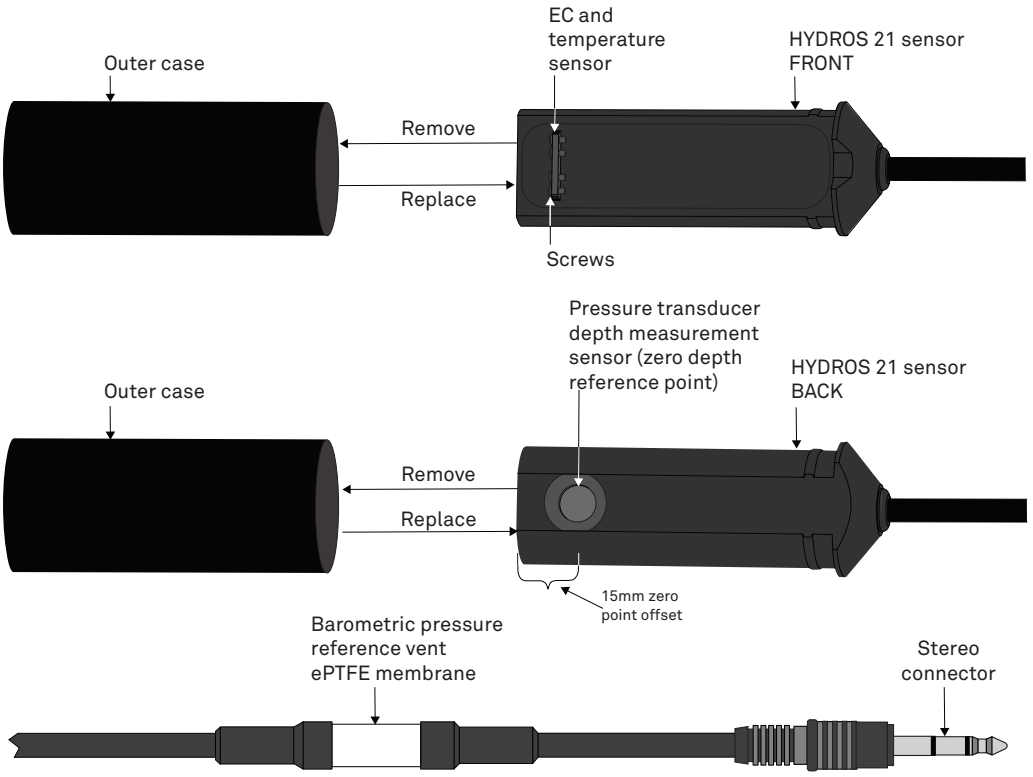


Figure 4 HYDROS 21 component diagram

3.3 THEORY

This section explains the theory of water depth, temperature, and electrical conductivity.

3.3.1 WATER DEPTH

The HYDROS 21 sensor uses a ceramic peizoresistive differential pressure transducer to measure the pressure applied by the water column above the sensor. The HYDROS 21 uses a direct relationship between pressure and water depth to output water depth. The reference port of the pressure transducer is vented through the cable to atmospheric pressure, so the HYDROS 21 does not require a reference barometric pressure. A porous Teflon vent near the data logger end of the cable provides the reference. The Teflon keeps liquid water out of the cable but allows air to enter and leave.

Keep the vent open to the same atmospheric pressure that applies to the water and out of the water. Since the cable conducts reference air between the sensor and the atmosphere, it is extremely important to protect the cable from any damage that allows water to enter.

3.3.2 TEMPERATURE

A thermistor near the EC sensor detects the temperature of the water. The HYDROS 21 uses the temperature to adjust the EC measurements to the 25 °C default value and provides the temperature output for the data stream.

3.3.3 ELECTRICAL CONDUCTIVITY

The HYDROS 21 EC can be used to determine the concentration of salts or dissolved solids in the water. The HYDROS 21 measures EC by applying an alternating electrical current to two electrodes, measuring the current flow through those electrodes, and then measuring voltage drop with a separate set of electrodes. The conductance is the ratio of current to voltage. The HYDROS 21 EC measurements are corrected to EC at 25 °C:

$$EC_{25} = \frac{EC_T}{\left[1 + 0.019(T - 25)\right]}$$

Equation 1

where EC_{25} is the normalized EC at 25 °C, EC_T is the EC measured by the probe at temperature T, and T is the temperature at the time of measurement.

Conductivity is conductance multiplied by a cell constant (obtained by using conductivity standards).

NOTE: A four-electrode sensor gives unpredictable readings in air because there is no connection between the voltage and current electrodes.

4. SERVICE

This section contains calibration and maintenance guidelines for the HYDROS 21. Troubleshooting solutions and customer support contact information are also provided.

4.1 CALIBRATION

METER factory calibrates the water depth and EC sensors to values stored internally in flash memory. The depth sensor is calibrated to known depths of water, and the EC sensor is calibrated using potassium chloride (KCl) solutions of known concentrations.

Table 2 relates EC at 25 °C for various concentrations of KCl, and these values can be used to verify the HYDROS 21 EC sensor performance. The value outputs from the HYDROS 21 are internally corrected to 25 °C.

Table 2 HYDROS 21 calibration values

Electrical Conductivity (µS/cm)	Concentration of KCl in Distilled Water (g/kg)
100	0.0446
200	0.0930
500	0.2456
1,000	0.5120
2,000	1.0673
5,000	2.8186
10,000	5.8758
20,000	12.2490

4.2 CLEANING

Maintaining the HYDROS 21 is essential for consistent sensor performance. Inspect and clean the HYDROS 21 frequently to prevent accumulation of microorganisms, plants, sedimentation, or other debris.

4.2.1 PRESSURE TRANSDUCER

The HYDROS 21 ceramic piezoresistive sensor must be protected from sediment and debris. If sediment or other debris build up on the pressure transducer, clean the membrane.

NOTE: Take care not to damage the pressure sensor.

Follow these steps to clean the HYDROS 21 pressure sensor:

1. Remove the cover.

   Figure 4 in Section 3.2 shows how to remove and replace the cover.
2. Run water over the sensor housing and pressure sensor to remove debris.
3. If the sediment is not completely removed with running water, soak the sensor in a mixture of water and dish soap for one hour.
4. Repeat step 2 and step 3.
5. Slide the outer cover back over the sensor.

4.2.2 ELECTRICAL CONDUCTIVITY SENSOR

The four-electrode conductivity measurement is less sensitive to sensor fouling than a two-electrode sensor, but contamination of the electrodes can still affect the measurement.

Follow these steps to clean the HYDROS 21 EC array:

1. Put on gloves.

   NOTE: Do not touch the screws without gloves or allow contact with any source of oil or other nonconducting residue.
2. Remove the outer cover.

   Figure 4 in Section 3.2 shows how to remove the cover.
3. Clean the screws using a mild detergent such as liquid dish soap and a nonabrasive sponge or cloth.

   NOTE: Avoid detergents that contain lotions or moisturizers.
4. Rinse the sensor and screws thoroughly with tap or distilled water.
5. Slide the outer cover back over the sensor.

4.3 TROUBLESHOOTING

Table 3 lists common problems and their solutions. If the problem is not listed or these solutions do not solve the issue, contact Customer Support.

Table 3 Troubleshooting the HYDROS 21

Problem	Possible Solutions
Sensor not responding	Ensure sensor is installed correctly. Check power to the sensor. Check sensor cable and stereo plug connector integrity. Check data logger wiring to ensure brown is power supply, orange is digital out, and bare is ground.

Table 3 Troubleshooting the HYDROS 21 (continued)

Problem	Possible Solutions
Sensor is not logging readings	Ensure the data logger batteries are not dead or weakened. Check configuration of the data logger in ZENTRA Utility to ensure the HYDROS 21 is selected. Ensure the most recent software and firmware are installed from metergroup.com.
Inaccurate pressure readings	Check pressure sensor to ensure it is clean and free of sediment or other debris (Section 4.2). Check for anything interfering with the opening of the vent.
Inaccurate EC readings	Check the four electrode array and ensure it is clean and free of sediment or other debris (Section 4.2). Ensure stainless steel cover is on the bottom of the sensor housing. Contact Customer Support for a replacement if missing.

4.4 CUSTOMER SUPPORT

NORTH AMERICA

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7:00 am to 5:00 pm Pacific time.

Email: support.environment@metergroup.com
sales.environment@metergroup.com
Phone: +1.509.332.5600
Fax: +1.509.332.5158
Website: metergroup.com

EUROPE

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8:00 to 17:00 Central European time.

Email: support.europe@metergroup.com
sales.europe@metergroup.com
Phone: +49 89 12 66 52 0
Fax: +49 89 12 66 52 20
Website: metergroup.com

If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

4.5 TERMS AND CONDITIONS

By using METER instruments and documentation, you agree to abide by the METER Group, Inc. Terms and Conditions. Please refer to metergroup.com/terms-conditions for details.

REFERENCES

Sprecher, S.W. 2008. Installing Monitoring Wells in Soils (Version 1.0). National Soil Survey Center, Natural Resources Conservation Service, USDA, Lincoln, NE.

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