AquaMetrix AM-ES-TX

Toroidal Conductivity Sensor with Analog and Digital Output

Installation and Operation Manual

Contents

1. Introduction

The AquaMetrix AM-ES-TX series electrodeless conductivity sensors are used in processes where conventional contacting sensors may foul or corrode. (The terms “electrodeless” and “toroidal” are used interchangeably for this type of conductivity sensor.) Toroidal sensors are the heavyweights of the conductivity world. Also known as non-contacting or electrodeless, their sensing elements are encased in a hard polymer, so they are almost impossible to foul.

The AM-ES-TX consists of an ES1 sensor and an ES-BT. The ES-BT is the blind transmitter box potion of the ES-TX. The AM-ES-BT is the smart blind transmitter that provides accurate conductivity readings across the sensor's wide range, 4-400,000 µS/cm!

The AM-ES-BT outputs analog (4-20mA) in a customizable range or an optimized digital output.

The AM-ES1 uses a glass-filled polypropylene body engineered to expand and contract at roughly the same rate as the stainless steel insert, thus minimizing cracking from temperature swings that afflict more toroidal sensors. An embedded RTD temperature element enables automatic temperature compensation.

The AquaMetrix AM-ES1 sensor can be mounted in a flow-through configuration or submersion mounted in a tank or open vessel. Toroidal conductivity sensors are constructed of two wire wound toroids encapsulated in a potting compound and encased in a plastic body. One toroid acts as a transmitter and the other as a receiver. An electric current is induced between the toroids through the process solution. This current is directly proportional to the conductivity of the process solution. The generously sized toroids give the probe an industry-leading cell constant of 1.6 for maximum sensitivity, Toroidal conductivity sensors typically measure conductivity values greater than 100 µS/cm. However, the AM-ES-TX can measure levels as low as 4 µS/cm. No other probe-analyzer combination comes close.

2. Safety

⚠ WARNING

Electrical hazard: Do not install the probe unless you have electrical training and you have read the instruction manual. The probes and blind transmitter use a 24V power supply and improper installation and handling can result in injury or damage to surrounding equipment including this probe.

⚠ WARNING

Electrical hazard: Do not open or operate while open the ES-BT (blind transmitter box) when connected to a live power source. The probes and blind transmitter use a 24V power supply and improper installation and handling can result in injury or damage to surrounding equipment including this probe.

NOTICE

The probe should only be installed, stored and serviced in the manner described in this manual. Improper handling may result in damage to the unit and surrounding equipment and may void the warranty.

3. AM-ES-TX Sensor and Specifications

3.1. System Description

The AM-ES-TX consists of an ES1 sensor and an ES-BT. The ES-BT is the blind transmitter box potion of the ES-TX. These two will have matching start ends of the serial number and these pairs should be maintained, as they are calibrated together. The output for this sensor can either be 4-20mA Analog or Digital over RS485 (Cli commands only, Modbus pending). These connections are outlined in sections 4.1 and 4.2 respectively. Connections of the output wiring and ES1 sensor wiring to the ES-BT are noted in section 4.3.

3.2. Getting Started

3.2.1. The ES1 Sensor It should be completely immersed in the sample when taking measurements.

3.2.1.1. There should be a minimum of 2in of clearance for the ES1 from any other surfaces. If not possible refer to the calibration section to adjust accordingly.

3.2.1.2. There should be no “air bubbles” in the or on the sensor, as these may affect readings.

3.2.2. The ES1 and the ES-BT should be connected as per section 4.3 and powered (24±4 VDC)

3.2.3. The AM-ES-TX comes calibrated out of the box, so you are ready to go once connected to a controller or PLC.

3.2.3.1. To optimize performance a site calibration is always beneficial, but not required.

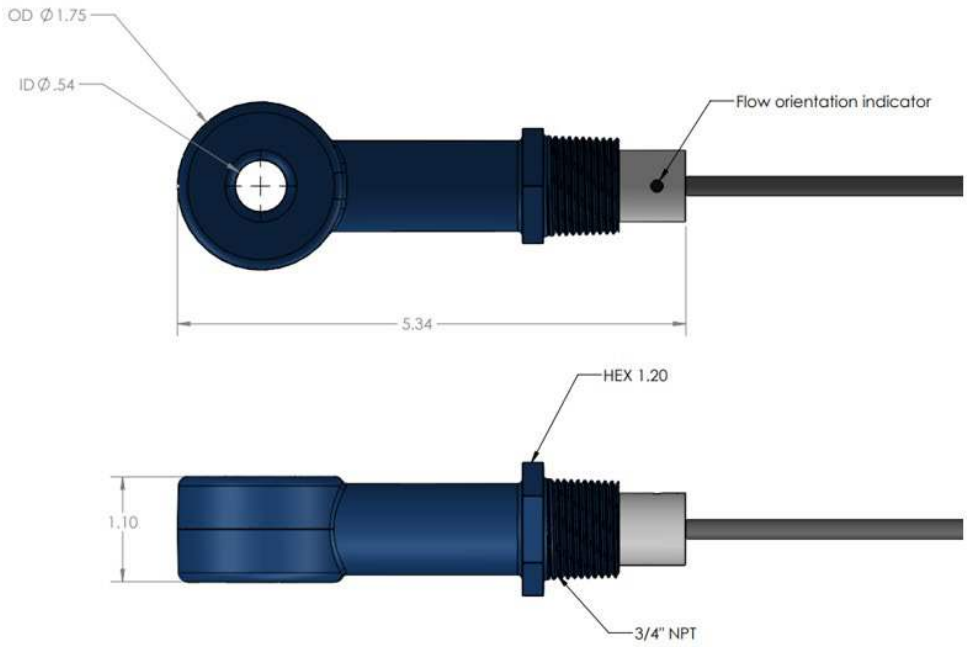
3.3. Specifications

Probe Parameters	
Parameters	Toroidal Conductivity Sensor
Data Transmission	Analog (4-20mA) Conductivity Digital (RS485) Conductivity, Temp
Range	4 – 400,000 µS/cm @ 25°C
Accuracy Digital	+/- 5% of scale 4-200 µS/cm@ 25°C
	+/- 5% of indication 200-400,000 µS/cm @ 25°C
Resolution Digital, Cond	0.01 µ/cm
Resolution Digital, Temp	0.1°C
Resolution Analog	0.04mA
Response Time, Cond	T90<3m, 4-200 µ/cm
	T90<60s, 200-400,000 µS/cm
Response Time, Temp	5min/°C
Units, Cond	µS/cm, mS/cm
Range, Temp.	0°C to 70°C (32°F to 158°F)
Units, Temp	Celsius, Fahrenheit
Temperature Compensation	Automatic via standard PT1000Ω RTD (Temperature compensation can be turned off by Digital Protocol)
Calibration	1 points via RS485 Connection OR multipoint at local controller
Calibration Time	~3 min (for each point), 4-200 µS/cm
	~1 min (for each point), 200-400,000 µS/cm
Physical	
Sensor	
Mounting	¾ threaded connection
Flow Rate (max)	3 m/sec (10 ft/sec). Flow should be as low as possible in water with low conductivity water or suspended solids
Maximum Load	450 Ω
Pressure Limits	100 psig @ 65 °C,
Power Supply Limit	24±4 VDC,
Ingress Protection	IP68
Cleaning	Typical: Water and soft brush Biofilm: bleach soak ~20min Scaling: weak acid soak ~10min
Time between cleaning	~60 days (environment specific)
Wetted Materials	Glass filled Polypropylene (SS304 on cable if submerged)

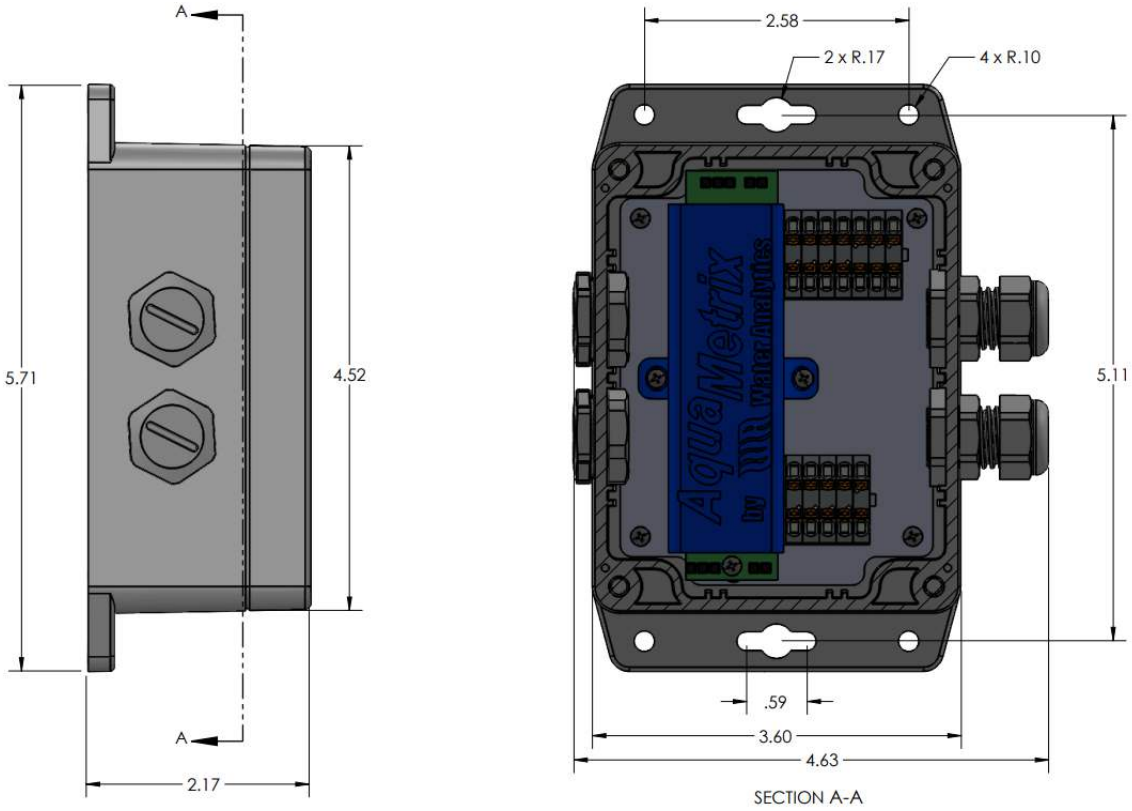
Enclosure	
Material	Flame retardant ABS thermoplastic
Mounting	2 or 4 screws
Dims	5.71” W 4.63” H 2.17”
Power Supply Limit	24±4 VDC,
Operating Temperature	40 F to 203 F
Rating	NEMA 4x, IP66

3.4. Dimensions

4.3.1 Sensor



4.3.2 Blind Transmitter



4.3.3 Cables

The cable connection between the ES1 and the ES-BT should not exceed 15ft. The Cable from the ES-BT to the controller or PLC can be up to 2000ft.

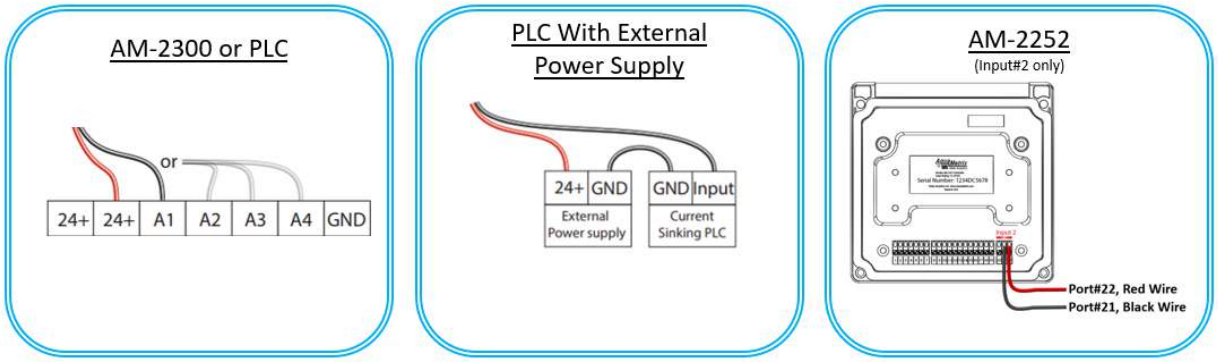
3.5. Connections to Power Supply and Controller

Wire color	Description
Red	Power (24±4 VDC)
Black	Analog Output 1 (mA mapping configured using RS485 connection) OR GND (if using RS485 connection only)
Clear	Shield/RS485 Ground
Green	RS 485 B (+)
White	RS 485 A (-)

1) The two RS485 wires can be cut, but should not be shorted, if the user does not need PC monitoring or firmware updates.
2) Power supply: 24±4VDC. Make sure to follow the wiring instructions above and provide the proper power. Connecting the probe to any power outside the normal range may result in damage and may void the warranty.

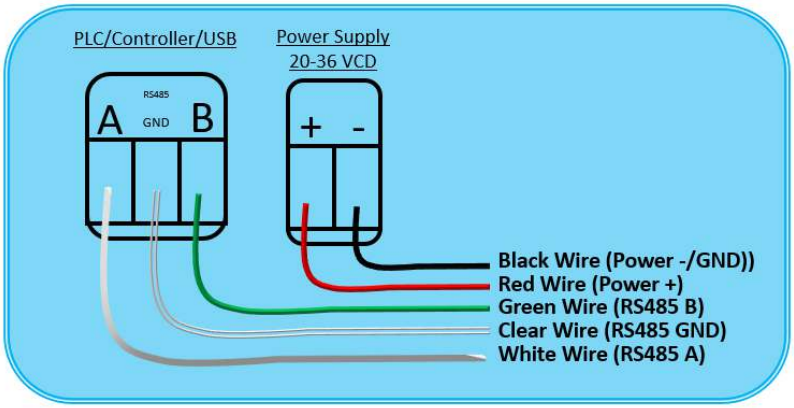
4. Installation

4.1. Analog Connections



Note: the 4-20mA mapping is defaulted to 0-400mS/cm. For custom ranges, use the Digital communication protocol or contact the Water Analytics Team.

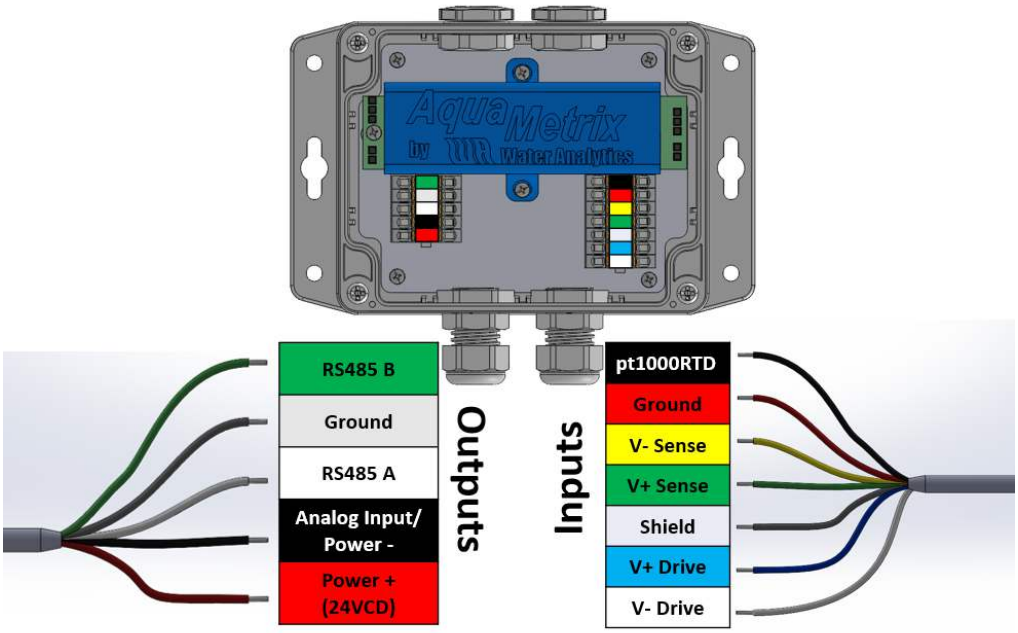
4.2. Digital (RS485) Connections



Note: Digital communication is currently available over RS485 and via CLI commands. The Modbus RTU protocol will be available in future releases.

4.3. ES-BT Connections

The ES-BT comes pre-wired with the PCB board wired to the jumper connections. To simplify the wiring process when connecting the ES1 sensor and the output cable (Analog and Digital) all one must simply do is match the wire colors. As a reference here is the wiring for the ES-BT:



NOTES:

- The ES-TX can work with the AM-2252 controller or AM-2300 controller, as well as most third-party PLC controllers. Contact AquaMetrix to confirm compatibility.
- The length of cable from the ES1 sensor to the ES-BT should not be altered, as this may cause a change in performance.
- If the PCB wires become disconnected, please consult with the manufacturer.

5. Digital Communication PC Configuration:

5.1. Getting Started

5.1.1. Download and install any terminal emulator that supports serial port (we recommend Tera Term or Docklight, but feel free to use your own)

5.1.2. Make sure the USB-RS485 ModBus Converter is plugged into the USB port of your PC.

5.1.3. Open terminal emulator and then select Serial and identify the correct USB port

5.1.4. For emulators like Tera Term, we recommend turning on “Local Echo” in the settings.

5.2. Port Configuration:

a. Speed – 9600
b. Data – 8 bit
c. Parity – none
d. Stop bite – 1 bit

5.3. Supported Commands

Please note all of these commands are (cAsE sEnSiTiVe):

Commands	Description
Cond	Returns the present conductivity in µS/cm.
Info	return information about the transmitter: FW version, FW date, and all user-calibrated data. (If this command is given via debug Uart, all the calibrated data including factory calibrated data will be shown)
Help	return list of user CLI commands.
TempCoeff	Returns the present temperature coefficient
TempCoeff:2	Set temperature coefficient to 2 (user can choose any value between 0 and 10%/°C with up to 2 decimal points). Default is 2
Temp	Returns the present temperature in °C.
Point20	Returns conductivity value set for 20mA output
Point20:xxxxx	Set conductivity for 20mA point (where xxxxx is conductivity in µS/cm) (user can choose any value between 0 and 400,000 µS/cm with up to 2 decimal points). Default is 400,000
Point4	Returns conductivity value set for 4mA output
Point4:xxxxx	Set conductivity for 4mA point (where xxxxx is conductivity in µS/cm) (user can choose any value between 0 and 400,000 µS/cm with up to 2 decimal points) Default is 0
TempCal:xx	Set the reference temperature to xx degrees (°C) and start the single point temperature calibration routine. Prints the measured temperature and asks user to select the stable temperature value to set the offset . **TempOffset = Measured_Temperature - Reference_Temperature** (User can choose any standard Ref temperature for calibration).
TempCalClear	Clear the single point temperature calibration.
CondCal:xxxxx	Set the reference conductivity to xxxxx (where xxxxx is conductivity in µS/cm) and start the single point conductivity calibration routine, prints the measured conductivity and asks the user to select the stable conductivity value to set the offset. **CondOffset = Measured_Conductivity - Reference_Conductivity** (User can choose any standard reference conductivity for calibration up to 400,000).
CondCalClear	Removes previously saved one-point conductivity user calibration.
UserCalClear	Clears all the User calibrations(Toroidal zero offset calibration, single point conductivity calibration, temperature calibration).
SwitchAnalog	Turn OFF the Rs485 and update the 4-20

6. Calibration

The ES-TX sensor comes with a factory calibration and is ready to use as is. The ES-TX has a mA output that is linear with default values of 4 mA = 0 µS/cm and 20 mA = 400,000 µS/cm (if custom ordered, this range may be different for you, please refer to the label in the ES-BT, sales order or by confirming in a terminal emulator). To improve the error at any specific point within the range, it is recommended that the user perform a user calibration at the point of interest. Doing so will not modify the factory calibration, but will change the resulting output conductivity value thus reducing the error at the user-specified point to allow for a more accurate reading. However, the user should be aware that doing so may sacrifice the accuracy of the sensor at other points. The further away from the user-specified point of interest, the greater the error. It is also possible for the user to increase the range using the RS485, but as the range is increased the accuracy of the sensor will decrease. Please note that the mA output is temperature compensated at 2% / °C by default. This value can be changed by using the RS485 command. Calibration can be done by one of the following methods, please note the more points used the better the accuracy will be across the desired range of measurement:

- Two-point or multipoint calibration at the Controller or PLC
- One-point via RS485 commands

6.1. One Point Calibration Using RS485

ES-TX sensors also have a digital interface that a user can access through a serial communication protocol RS485. The full list of commands can be found in section 6.3. One such command is “UserCal” that adjusts the slope of the factory calibration to make the conductivity reading most accurate at the point of calibration.

1. Insert the ES1 Sensor, connected to the paired ES-BT, into a NIST traceable reference conductivity solution or a sample solution of known conductivity, within the desired range.
2. The ES1 sensor should have at least 2 inches of clearance in the sample solution and should not be touching any surface. There should be any “air bubbles” in the or on the sensor, as these may effect readings.
    a. If the final installation environment does not have these 2 inches of clearance, this “interference” can be accounted for with a linear calibration at the controller via an in-line grab-sample or a stand-alone solution that mirrors the environment with calibration solution.
3. Allow the Sensor readings to stabilize.
    a. ~3 min (for each point), 4-200 µS/cm
    b. ~1 min (for each point), 200-400,000 µS/cm
4. Enter the command “CondCal:xxxxx” in the terminal emulator window and start the single point conductivity calibration routine, the ESTX will print the measured conductivity in the emulator window and asks the user to select the stable conductivity value to set the offset.
    a. **CondOffset = Measured_Conductivity - Reference_Conductivity**
    b. (User can choose any standard reference conductivity for calibration up to 400,000).
5. To remove this calibration, simply enter the command “CondCalClear” and the ESTX will remove previously saved one-point conductivity user calibration.

6.2. Two-Point or Multi-Point Calibration with a Controller or PLC

The operations in this step may differ from controller to controller and PLC to PLC, so please refer to the respective manual of the controller or PLC connected to the ES-TX. Analog probes are typically scaled/calibrated using linear (2-point) scaling or non-linear (multiple points) scaling. In most cases 2-point scaling is sufficient. Keep in mind that scaling using multiple points often does not apply a best-fit curve through the points, depending on the controller or PLC. They simply connect the individual points and interpolate between two points to generate a number.

1. Perform a one-point calibration as described above, but on the local controller or PLCE, not over RS485.
2. Remove the sensor from the first calibration or reference solution and clean it in DI water and wipe it dry.
3. Then repeat the point calibration process from step one in a new calibration or reference solution.
4. Repeat steps 2 and 3 for as many points as desired.

7. Maintenance

7.1. Cleaning

Probe maintenance may include cleaning the sensor. Gently scrub the AM-ES1 probe with a soft-bristled brush (a toothbrush is great!) or nylon dish scrubber. Soak in vinegar and DI water to remove mineral deposits or extensive fouling. Please note if using any other cleaning agent, care must be given to material compatibility. Please see section 3.3 for Sensor material specifications.

7.2. Reconnecting the Sensor to the Blind Transmitter or the Blind Transmitter with the controller/PLC

If the sensor and/or Blind transmitter are moved from location to location, and taken offline the wiring connections may become loose or disconnected. Refer to section 4.3 to reconnect ay loose wires.

⚠ WARNING

Electrical hazard: Do not open or operate while open the ES-BT (blind transmitter box) when connected to a live power source. The probes and blind transmitter use a 24V power supply and improper installation and handling can result in injury or damage to surrounding equipment including this probe.

8. Spare Parts

There are no replaceable or spare components for this sensor.

9. Accessories/Replacement Parts

Part #	Description
AM-ES1-015*	ES1 wide range toroidal Sensor
AM-ES-BT*	The Blind Transmitter of the ES-TX
AM-CBL	Extension cable

*Please note these need to be paired for factory-level multipoint calibration. When ordering a spare or replacement AM-ES1, please indicate that this is for use with the ESTX so the WA team can facilitate the new paired calibration.

9.1.Mounting

9.1.1.General Installation Requirements

Check the probe to ensure that no air bubbles have formed on the electrodes during submersion.

10.2.4. Inline and Insertion Mounting

The ES1 sensor has ¾" NPT threads that can be used to connect the sensor to a Tee or other threaded connection. The ES1 sensor also has an indicator on it for inline purposes to indicate the desired direction of flow across the sensor.

9.1.2.Submersion Mounting

The ES-TX is a fully submersible sensor. Although not required, submersion hardware to protect the cable from wear and tear is advisable.

10.Troubleshooting

To troubleshoot the AM-ES-TX connect it directly to the power supply avoiding, if possible, all interconnections, splices, and junction boxes.

The next testing level requires a multimeter in current mode. When the red and black wires are connected to the power supply (24±4 VDC), Without disconnecting the power connection add the black lead (COM) of the multimeter to the black wire and red wire (mA) to the input/ground terminal of the power supply/controller. The expected reading is dependent on the solution the sensor is in and the 4-20mA mapping. Calculate the anticipated mA value and choose a solution that is different from the current reading on the controller or PLC. If the output is stuck at 4mA or 20 mA – the sensor is not working.

The sensor can also be connected via RS485 to a computer and using a terminal emulator, the user can connect and get live readings. If the user is not able to connect, then the sensor is not working.

Please contact support@wateranalytics.net or call Water Analytics technical support 978-749-9949

11. Disposal

In accordance with local regulations, please dispose of this product at specified locations for electrical and electronic equipment. Please contact the local government/authority or party responsible from which you purchased this device. Should this device be passed on to other parties (for private or professional use), the content of this regulation must also be related.

12.Warranty

Water Analytics provides this material as-is and makes no warranties, express or implied, regarding its suitability for any specific purpose. Water Analytics shall not be held responsible for any errors or damages, whether incidental or consequential, arising from the use or performance of this material.

Under no circumstances shall Water Analytics be liable for any direct, incidental, or consequential damages resulting from the sale, manufacture, delivery, or use of any product.

Warranty information available on the website www.AquaMetrix.com or www.wateranalytics.net

13. Contact

Please contact us at support@wateranalytics.net or call us at 978-749-9949.

AquaMetrix by Water Analytics

978-749-9949
www.WaterAnalytics.net