M*i*ProbE (B10 Board) Beta Installation Manual

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INTRODUCTION

The MiProbE® Sentry is an automated aquatic monitoring system based on a proprietary microbial sensor technology (US Patent US 10,113,990 and others pending). The microbial sensor technology uses biofilms populating the surface of an electrode as the active sensing surface. The electrical potential is measured between the electrode(s) populated with biofilms versus a reference. The microbial potentiometric sensor (MPS) signals correlate with dissolved oxygen concentrations and/or redox conditions of the aqueous and saturated environments.

The MiProbE® Sentry is a completely automated system capable of collecting real-time data from eight microbial probes. The automated system transmits the data to cloud-based data storage systems. The real-time data is accessible via a cloud-based visualization and dashboards using open-source programs: Redash.

The MiProbE® Sentry was developed to provide operators of wastewater treatment facilities a method of understanding and predicting the processes with their systems.

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1.0 SYSTEM

The MiProbe Sentry is composed of four primary components:

1. Instrumentation box (Section 1.1)
2. Power configuration (Section 1.2)
3. Sensors arrays (Section 1.3)
4. Mounting System (Section 1.4)

The primary components of the MiProbe Sentry are illustrated on Figure 1.

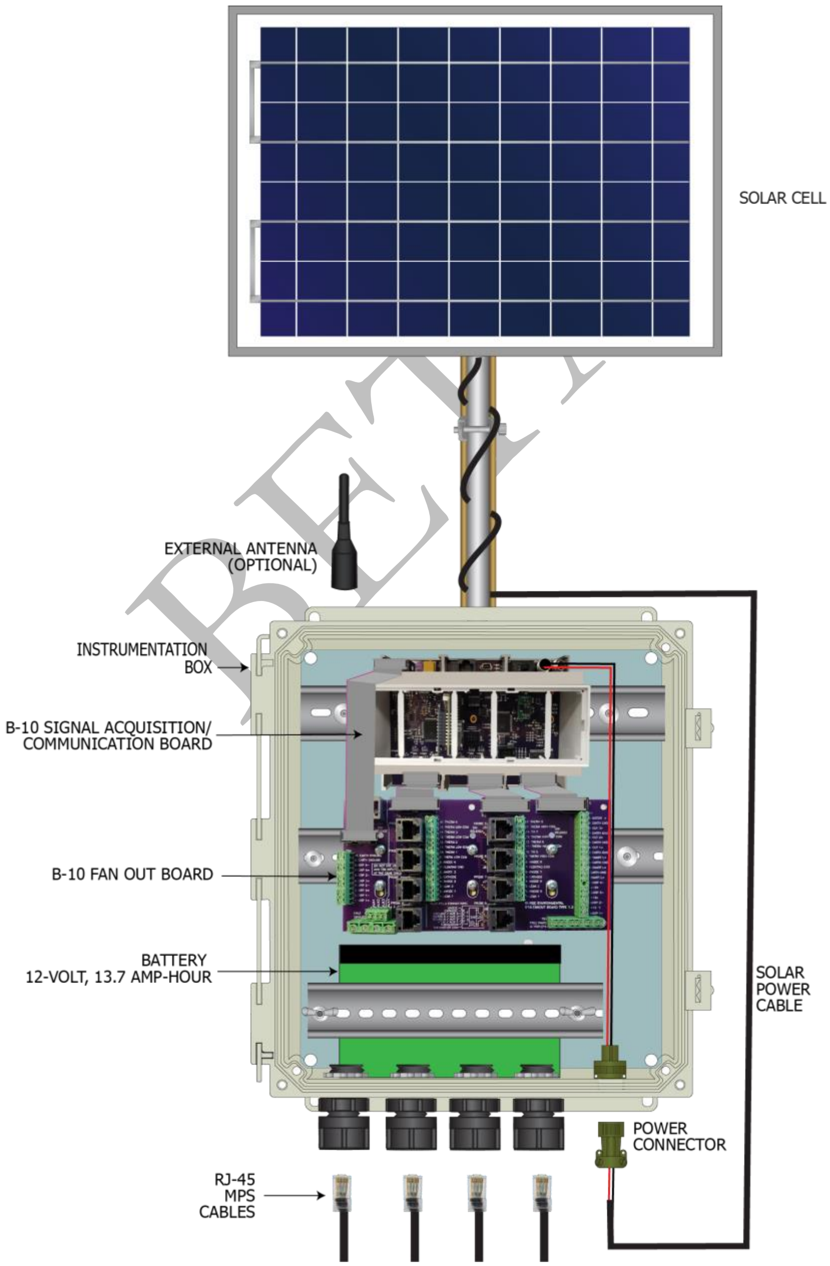


Figure 1: MiProbe primary components

1.1 Instrumentation Box

The instrumentation box houses the B10 signal acquisition/communication board, B10 fanout board, battery and other components used to operate the monitoring system (Figure 2). The ports for connecting the power and sensor arrays are located on the bottom surface of the instrumentation box. Two configurations of the instrumentation box are available: Series 100 and Series 200. The primary difference in the instrumentation box internal configurations are the power configurations employed: solar (Series 100) or 12-volt power supply (Series 200).

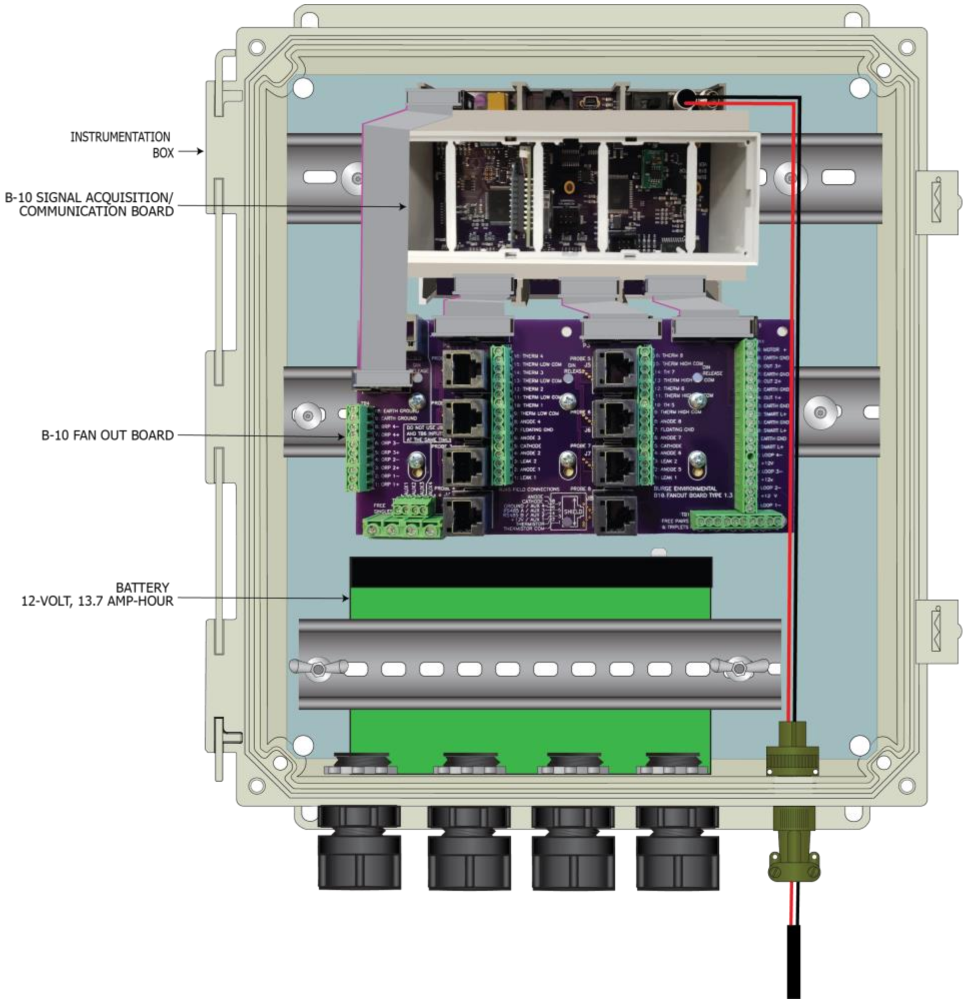


Figure 2: MiProbe Instrumentation Box: Series 100

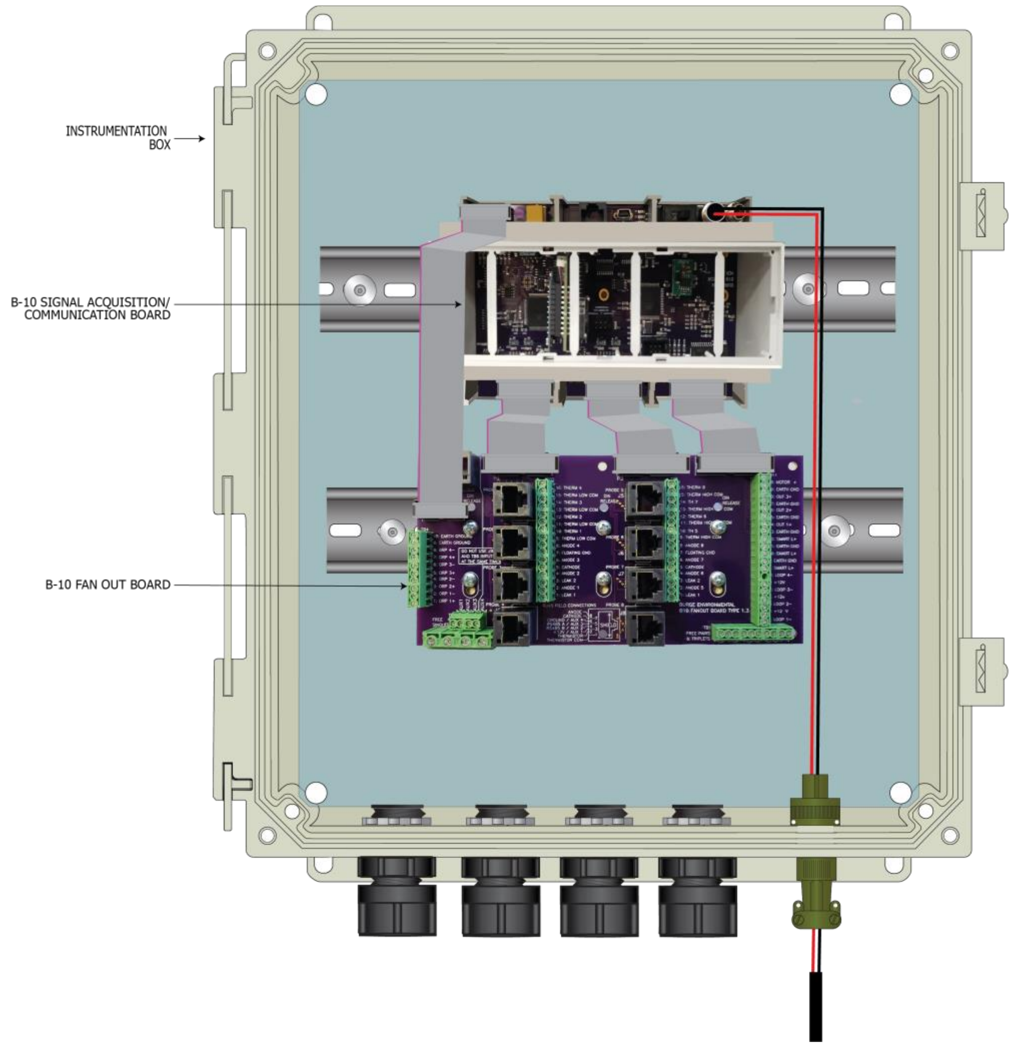


Figure 3: MiProbe Instrumentation Box, Series 200

The two primary electronic boards located within the instrumentation box include the B10 signal acquisition/communication board (Figure 3) and the B10 Fanout Board (Figure 6).

1.1.1 B10 Board

The signal/communication board (B10 Board) connects to the upper DIN rail within the instrumentation box. Two auxiliary boards (Figure 5) connect to the face of the B10 board: 1) cellular modem (connects to a 24-pin connector located near the center of the board), and 2) an optional solar charger (connects to a white 6-pin connector located adjacent to the solar connector).

The cellular modem connects to the face of the B10 board using a cellular modem board (Figure 5). The cellular modem board provides a cooling fan for the cellular modem.

The solar charger board is required if a solar cell is used to charge a battery (Series 100). Two solar chargers (10 and 30 watt) are available depending on the number of watts generated by the solar cell. The 30-watt charger is illustrated on Figure 5.

The B10 board configuration includes an internal cellular antenna for connectivity to the Verizon 3G and 4G wireless networks. The antenna connects to the lower antenna connector located on the cellular modem board (Figure 5). (Note: a second antenna may be connected to the upper connector). The antenna can be either 1) small green antenna mounted within the interior of the instrumentation box (Figures 2 and 3), or 2) an optional SubMiniature version A (SMA) connector for high-gain external antennas is available for remote deployments with limited cellular coverage. The SMA connector port is located on the top of the instrumentation box (Figures 2 and 3).

The B10 board has several communication/power ports allowing communication/programming of the board. The connectors include:

1. USB connector (38400 Baud) (JP5)
2. Programing ports (two 6-pin ribbon connectors)
3. Output/input ports (four ribbon connectors)
4. RJ45 connector
5. Solar Port (coaxial connector)
6. Power/Battery Port (coaxial connector)

The B10 board has two switches:

1. Yellow Button: Push at power up to clear all memory (S1)
2. Switch: Power switch (S2)

There are three indicator lights and their respective functions:

1. D2: Red verifies memory cleared after yellow button pushed
2. D3: Green
3. D4: Yellow verifies a forced transmission event

The B10 Board has six ribbon connectors. Four (J2, J3, J4, J11) connectors electrically connect the B10 board I/O to the B10 Fanout Board (Figure 6). Two six-conductor ribbon connectors located in the central area of the board are used to program the MCU:

1. Floor Level Programming MCU (J1)
2. Mezzaine Level MCU Programming (PE3)

A white 6-pin connector connects the optional solar recharger to the B10 Board. The connector is used to mount either the 10-watt or 30-watt charger (Figure 5).

A black 24-pin connector located near the center of the board connects the cellular modem board to the B10 Board (Figure 5).

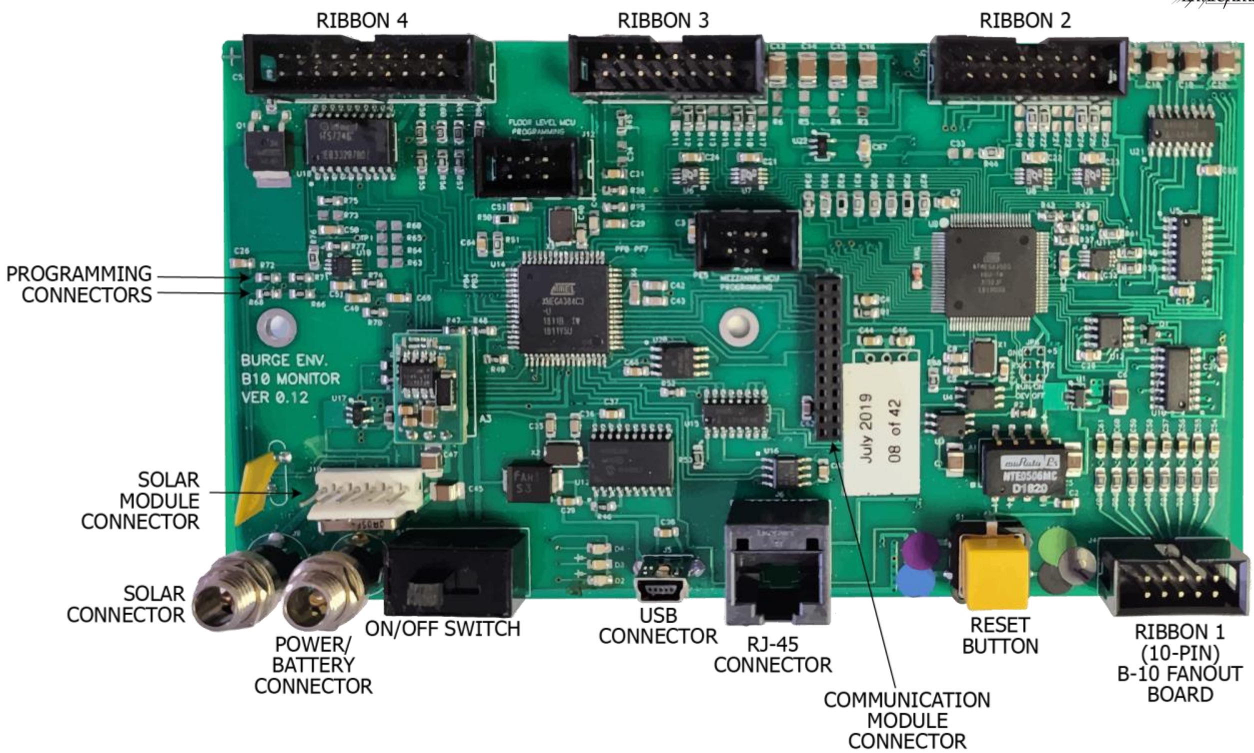
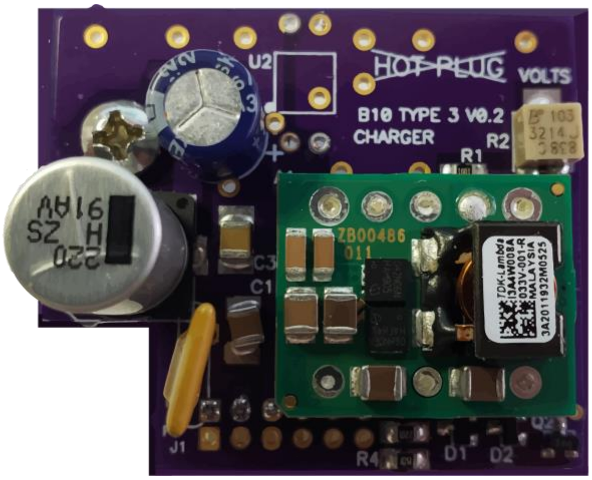


Figure 4: B10 Signal Acquisition/ Communication Board

Modem Board with fan



Solar Charger: 30-watt

Figure 5: B10 Auxiliary Boards: Cellular Modem and Solar Charger

1.1.2 B10 Fanout Board

The B10 fanout board (Figure 6) mounts to the lower DIN rail located below the B10 Board. The B10 Fanout board electrically connects to the I/O ports of the B10 signal acquisition/communication board using four ribbon cables (Figures 2 and 3).

1.1.2.1 I/O Connectors

The B10 board supports a variety of inputs and outputs. This section outlines the connection of these inputs and outputs.

1.1.2.2 Connection of MPS

The B10 Fanout Board provides two methods of connection of the MPSs: 1) screw mount and 2) JP45 connectors. The standard termination of the MPS sensor is a JP45 connector (Figure 9). The standard MPS probe incorporates both the microbial potentiometric and temperature (thermistor) sensors. The probes connect to one of the eight JP45 connectors located on B10 fanout board (Figure 6).

1.1.2.3 Connection of Auxiliary I/O

In addition to the MPS and temperature sensors, the B10 fanout board supports several other sensor inputs (pH, ORP, 4-20 mA) and outputs (relay, motor control) (Tables 1 and 2). The typical method of connection of the auxiliary sensors and outputs is using the screw connectors.

Examples of specific analytical sensors including optical dissolved oxygen and potentiometric (ORP and pH) are documented in Appendix B.

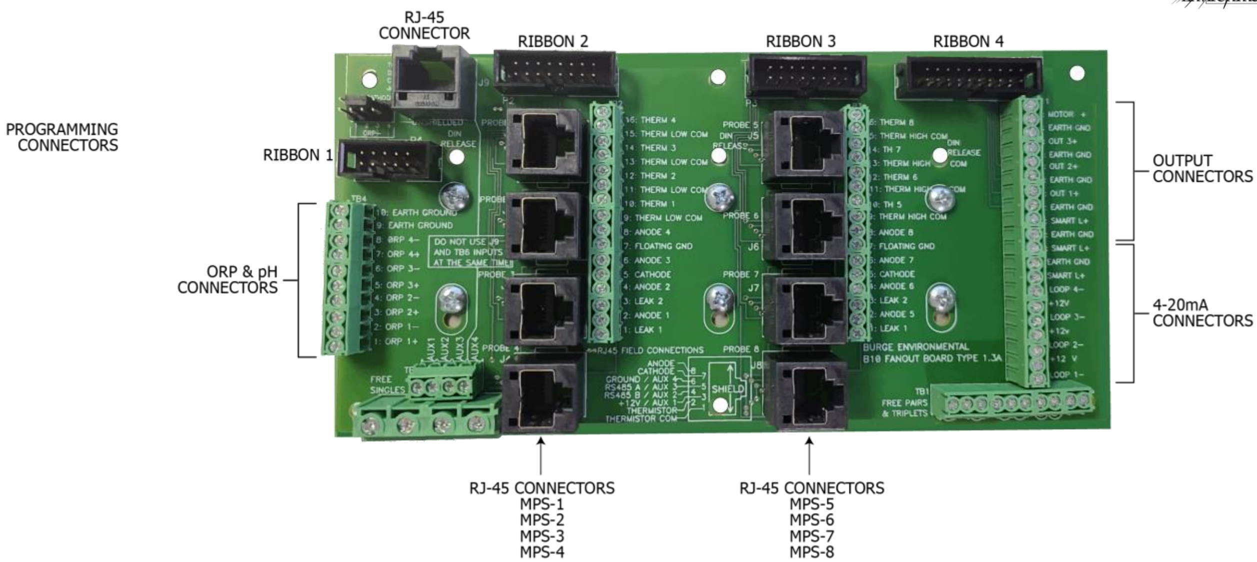


Figure 6: B10 Fanout Board

1.2 Power Configurations

The power configurations include two options: 1) solar-powered (Series 100), and 2) 12-volt powered (Series 200) configurations (Figure 7).

1.2.1 Solar Configuration (Series 100)

The solar configuration allows for the installation of a battery (12-volt, 13.6 amp-hrs) within the instrumentation box (Figure 7A). A solar charger (10 or 30 watt) connects to the 6-pin white connector (J10) located on the face of the B10 signal acquisition/communication board (Figures 4 and 5). A solar cell cable connects to the power connector (screw connector) located on the bottom surface of the instrumentation box (Figure 7A). The solar-powered configuration uses two coaxial cables within the instrumentation box: battery cable and power cable (Figure 7A). The solar cell cable connects to the 12-volt power connector located on the lower surface of the instrumentation box. The solar cell cable connects the 12-volt power connector with the solar connector (coaxial) on the B10 board (Figure 7A). A second cable (battery/power cable) connects the battery connector (coaxial) on the B10 Board (Figure 7B) with the 12-volt battery terminals.

1.2.2 12-volt Power Configuration (Series 200)

The configuration does not include a battery within the interior of the Instrumentation Box (Figure 7B). The 12-volt power supply connects to the power connector (screw connector) located on the bottom surface of the instrumentation box. A power cable connects the power connector with the Power Port (coaxial) on the B10 signal acquisition/communication board (Figure 7B).

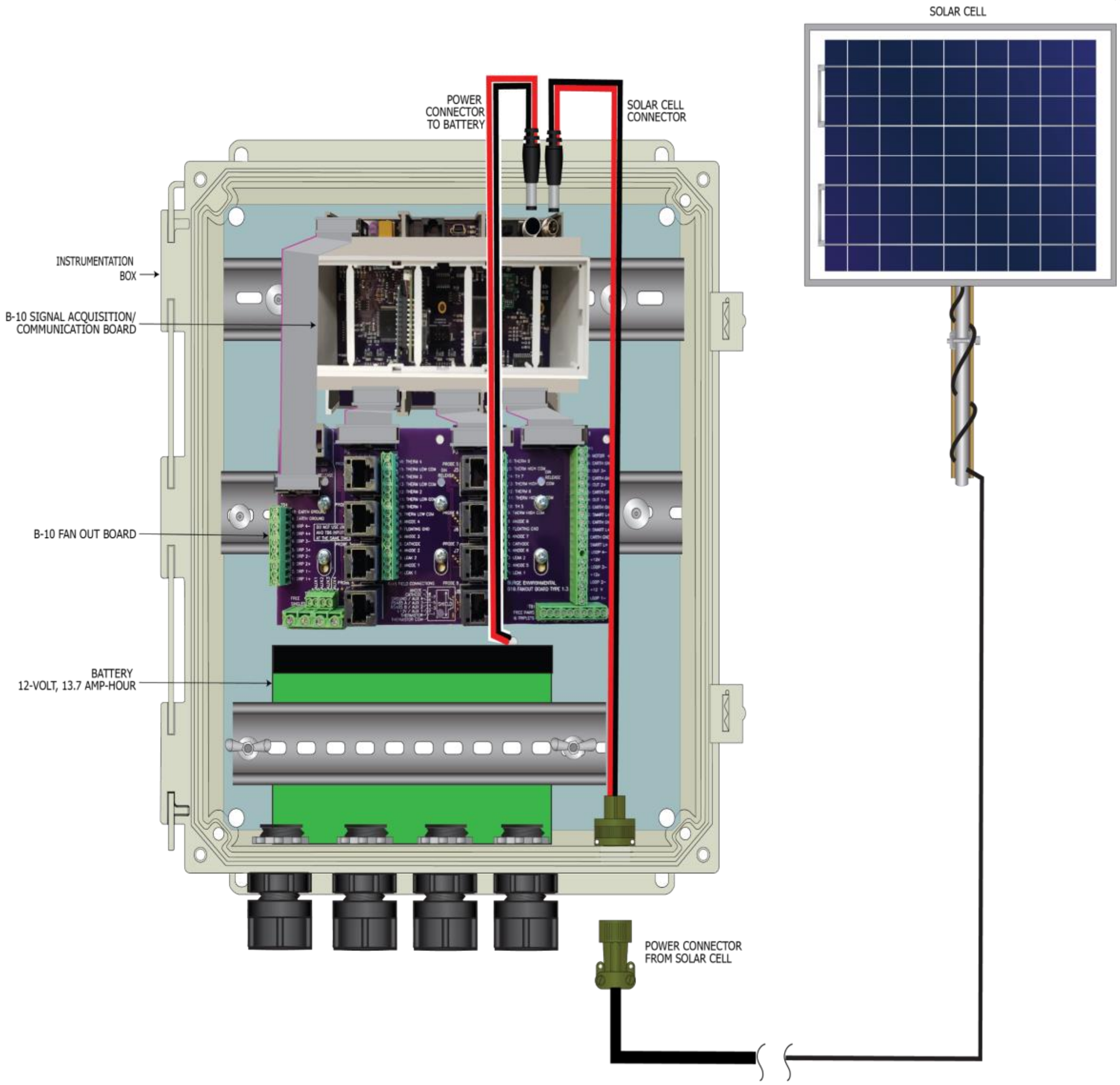


Figure 7A: Solar Cell/Battery Power Option (Series 100)

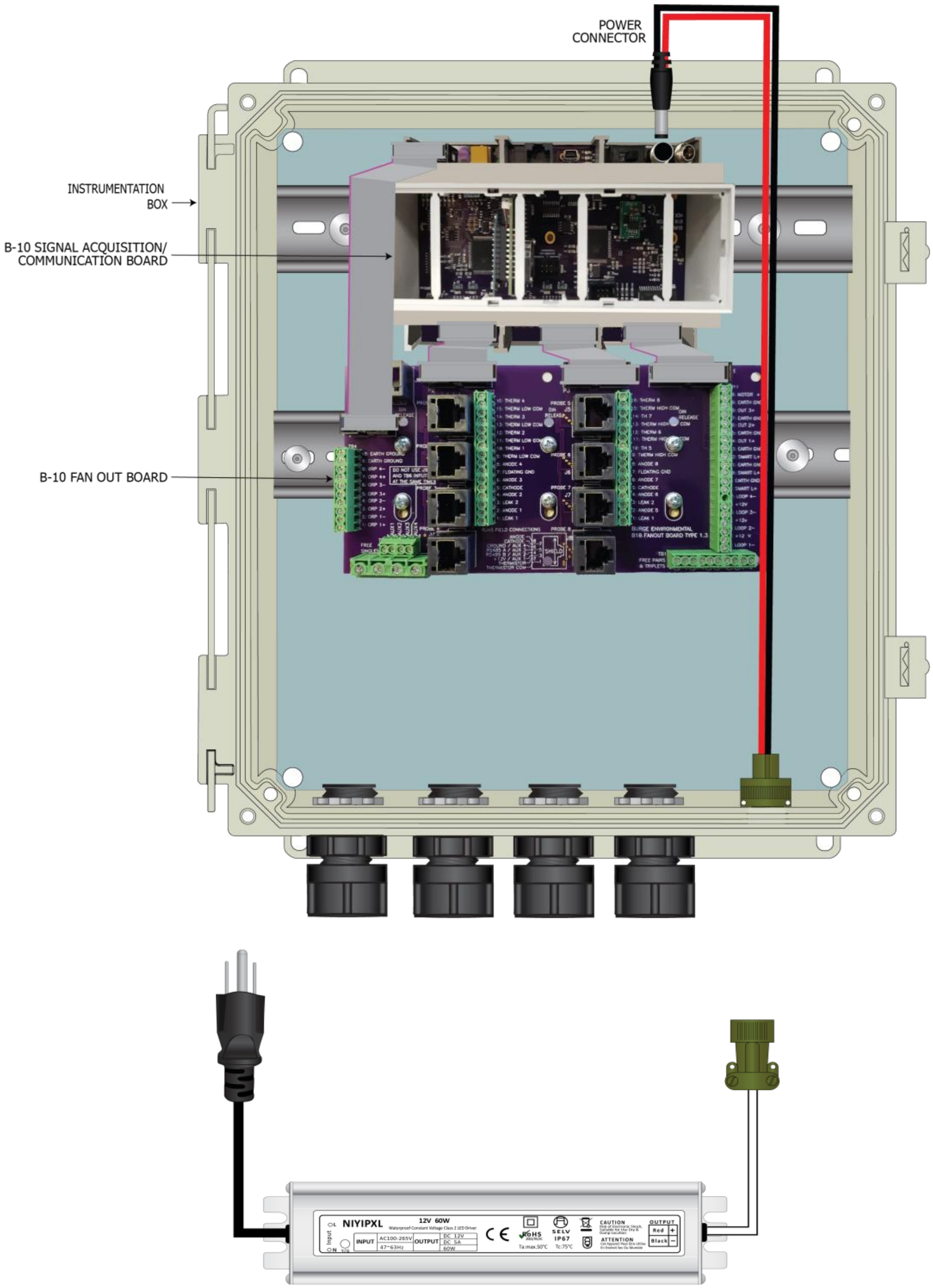


Figure 7B: 12-Volt Power Supply Option: Series 200

Figure 7: MiProbe Power Configurations

1.3 Sensor, References and I/O Options

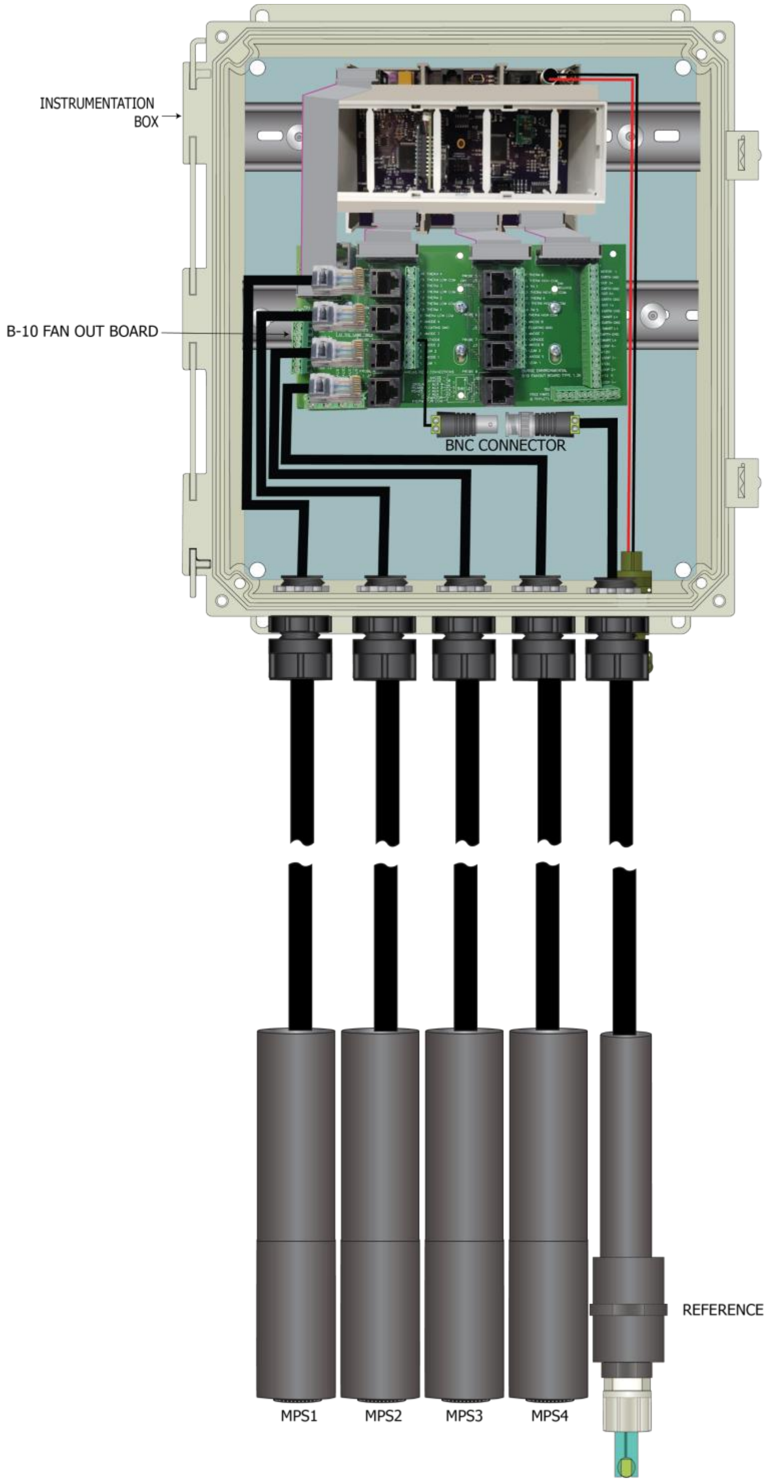


Figure 8A: MPS and Reference Arrays

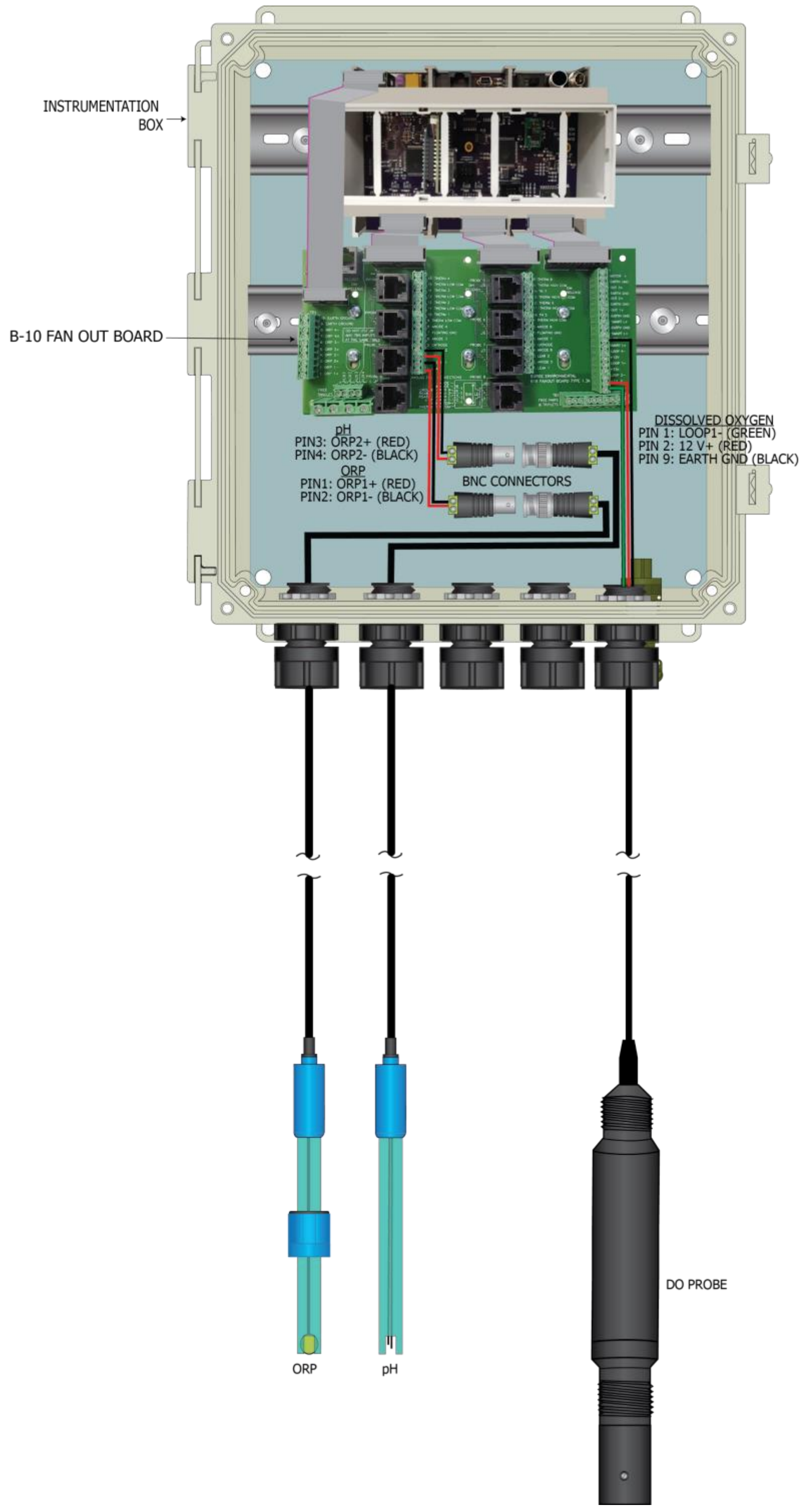


Figure 8B: ORP, pH and DO Probes

Figure 8: MiProbe Sensor Arrays and Options

Several types of sensors (inputs), potentiometric references, and outputs are supported by the sentry system. A list of the inputs and/or sensors is presented on Table 1. The potentiometric references are listed on Table 2. The outputs supported by the board are listed on Table 3.

The sensor outputs connect to the B10 fanout board (Figure 6). The microbial potentiometric/temperature sensors can be connected to the B10 Board using either screw connections or RJ45 connectors. The outputs of the potentiometric (pH, ORP) and 4-20 mA sensors connect using screw connectors (Figure 8).

1.3.1 MPS

The most common configuration of the MPS probe is illustrated on Figure 9. The probe houses two sensors: microbial potentiometric sensor and thermistor (temperature) sensor. The terminal (output) end of the MPS probe has a RJ45 connector for connection with one of the eight RJ45 connectors located on the B10 Fanout Board (Figure 6). A cable grip located on the bottom surface of the instrumentation box is used to pass the MPS probe into the interior of the box. The cable grips have a split gland to allow the installation of the cable in the cable grip.

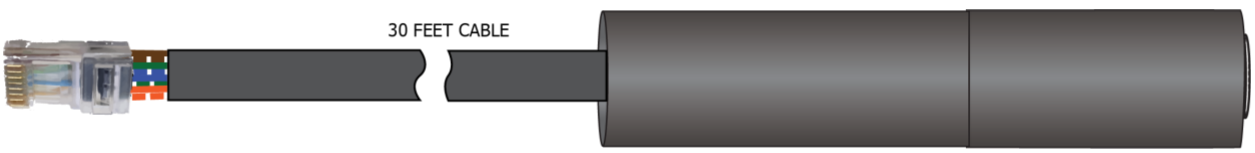


Figure 9: MiProbe MPS Probe with RJ45 connector

Table 1: Sensor Input Configuration

Sensor Type	Number of Sensors	Description
Microbial Potentiometric	8	Graphite Surface
Temperature	8	Thermistors 10K
Potentiometric (pH, ORP)	4	pH, ORP
4-20 mA	4	Dissolved Oxygen Water Level

1.3.2 References

The potentiometric references available for connection to the B10 system are listed on Table 2.

Table 2: Reference Configurations

Reference	Terminal	Concentration	Voltage vs SHE
Cathode	BNC		
Ag/AgCl	BNC	Saturated	
Pd/PdCl	BNC		

1.3.3 Auxiliary Sensors

In addition to the sensors and other inputs supported by the B10 signal acquisition/communication board, several outputs are available (Table 3). The outputs are connected to the B10 Fanout Board (Figure 6).

The wiring for selected sensors is attached as Appendix D.

Table 3: Output Configurations

Output type	Load	Control
Out 1+	1 amp	
Out 2+	1 amp	
Out 3+	1 amp	
Motor +	1 amp	PWM

1.3.4 Mounting Configurations

The installation of the *MiProbe* system will vary based on the actual configuration of the wastewater treatment facility (WWTF) and the locations of sensors within the various operations (headworks, aeration basin, etc.) of the facility. Three primary configurations: vertical, horizontal and monitoring well are illustrated on Figures 14, 15 and 16.

The MPS probes are deployed within the various WWTP operations using two primary methods: 1) directly suspending the sensors into the pond/basin, or 2) deploying the sensors within heavy-walled PVC pipe (Figures 10, 11 and 12). The first method is used for treatment facilities with low water flows. The second method is used for facilities with greater flows. The PVC piping resists horizontal movement of the probes.

The most common configuration of the MPS probe is illustrated on Figure 9. The configuration has a standard length of 15 feet. The cable is waterproof and can be directly suspended in the WWTF operation providing the flow through the system is low.

For WWTF with higher flows, the most common configurations of the MPS probes or reference within PVC pipes are presented on Figures 10, 11 and 12. The upper terminal end of the configurations are illustrated on Figure 13.

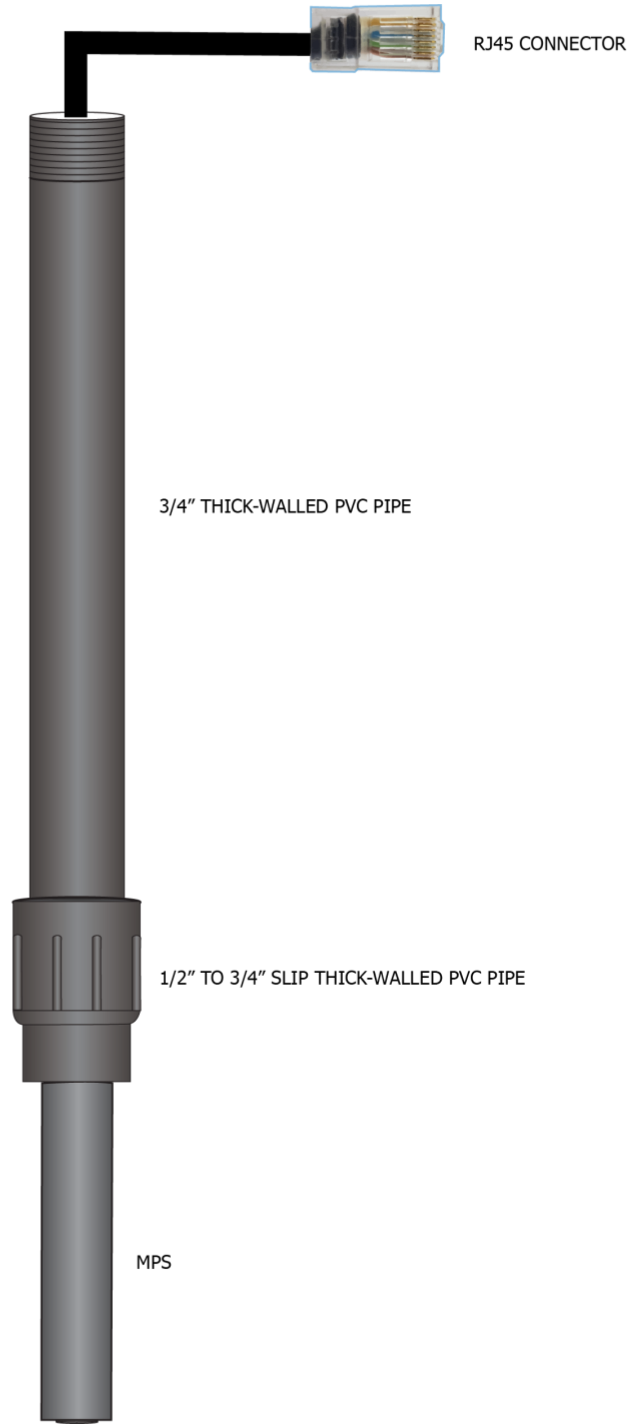


Figure 10: Single MPS Mounting System

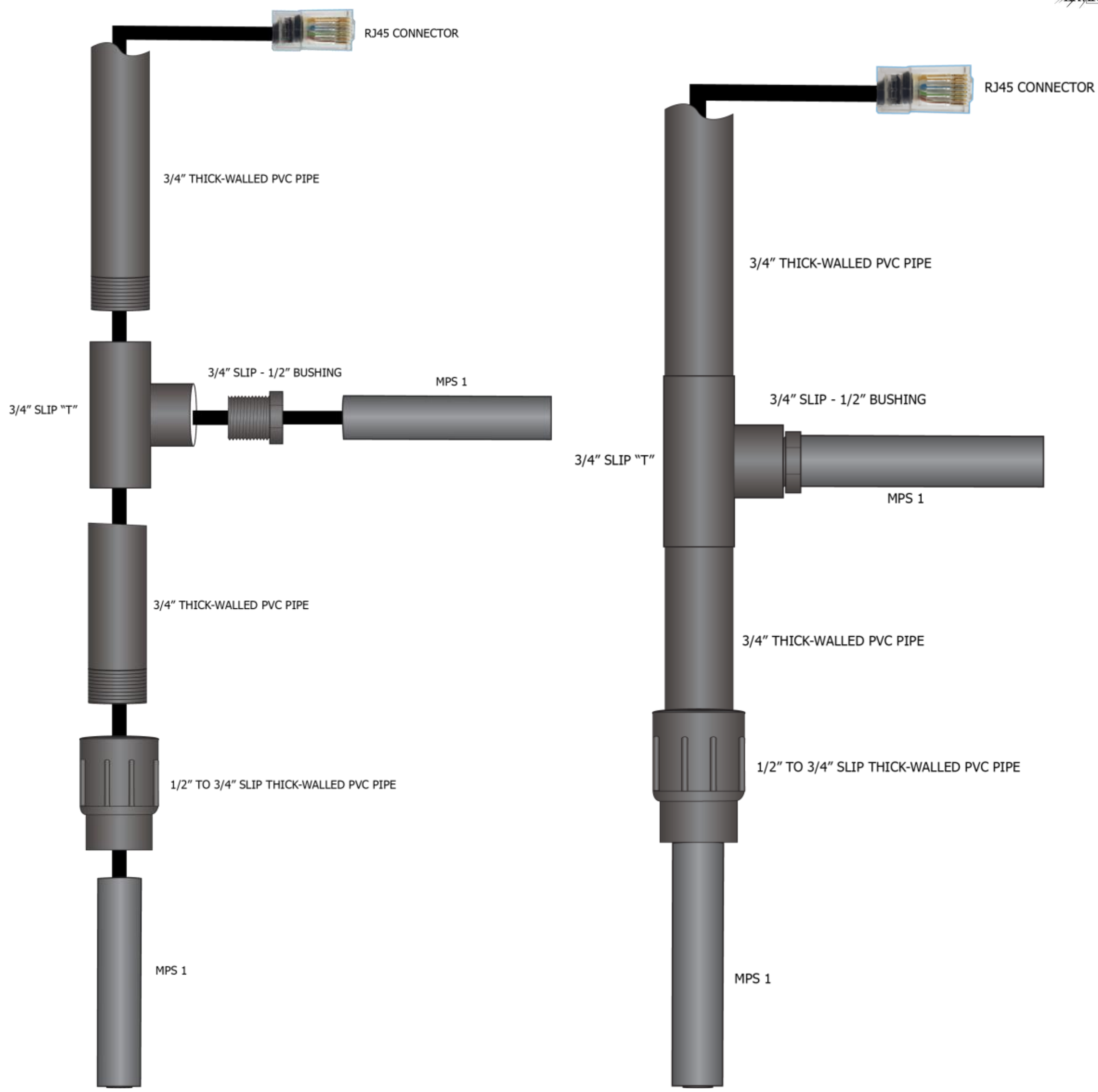


Figure 11: Multiple MPS Mounting System

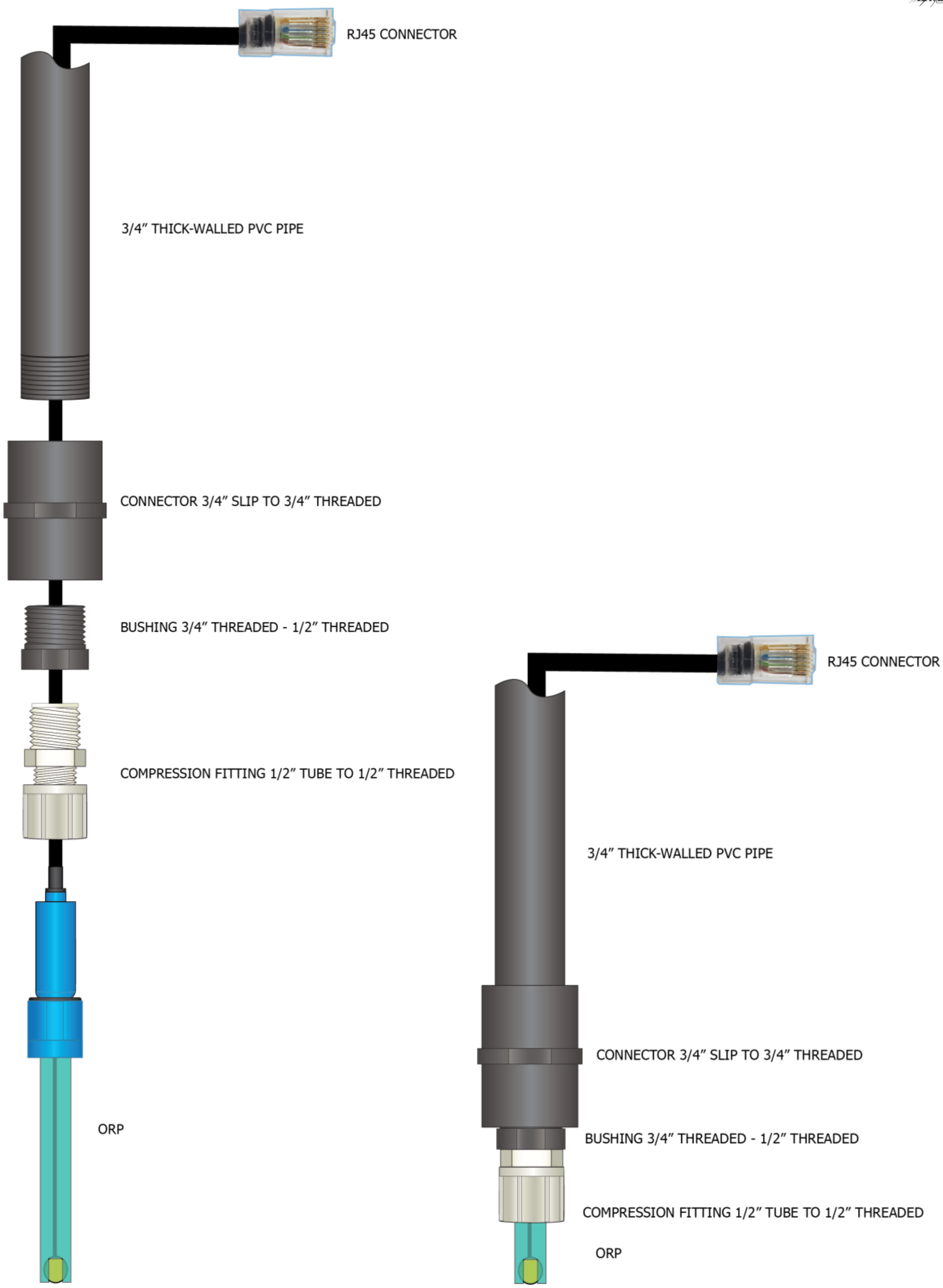


Figure 12: Reference Mounting System

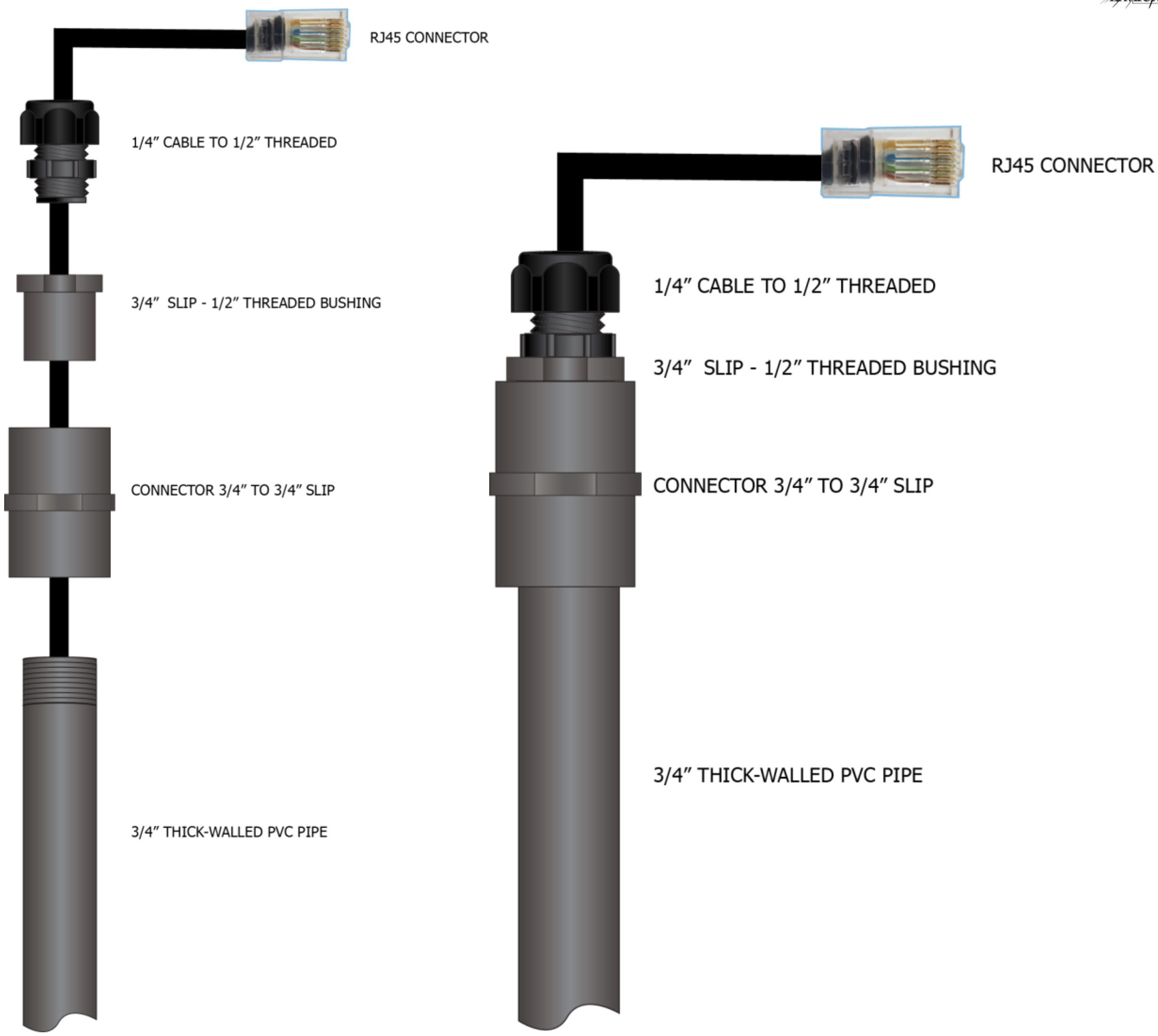


Figure 13: Top View of the Sensor/Reference Mounting System

The most common deployment configurations include:

1. Vertical MPS Array Configuration (Figure 14)
2. Horizontal MPS Array Configurations (Figures 15 and 16)
3. Monitoring Well MPS Array Configuration (Reserved)

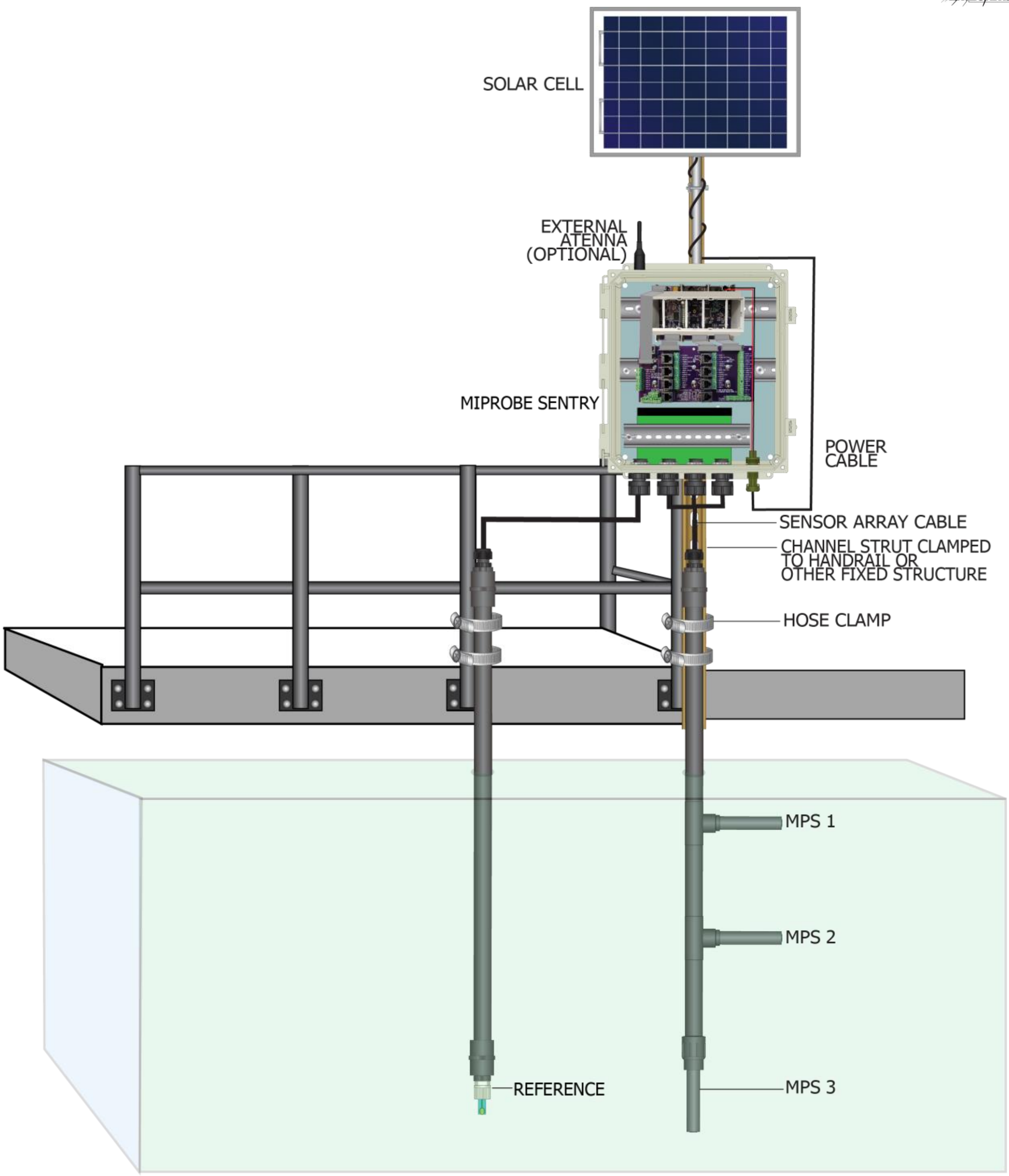


Figure 14: Vertical Sensor Array Configuration

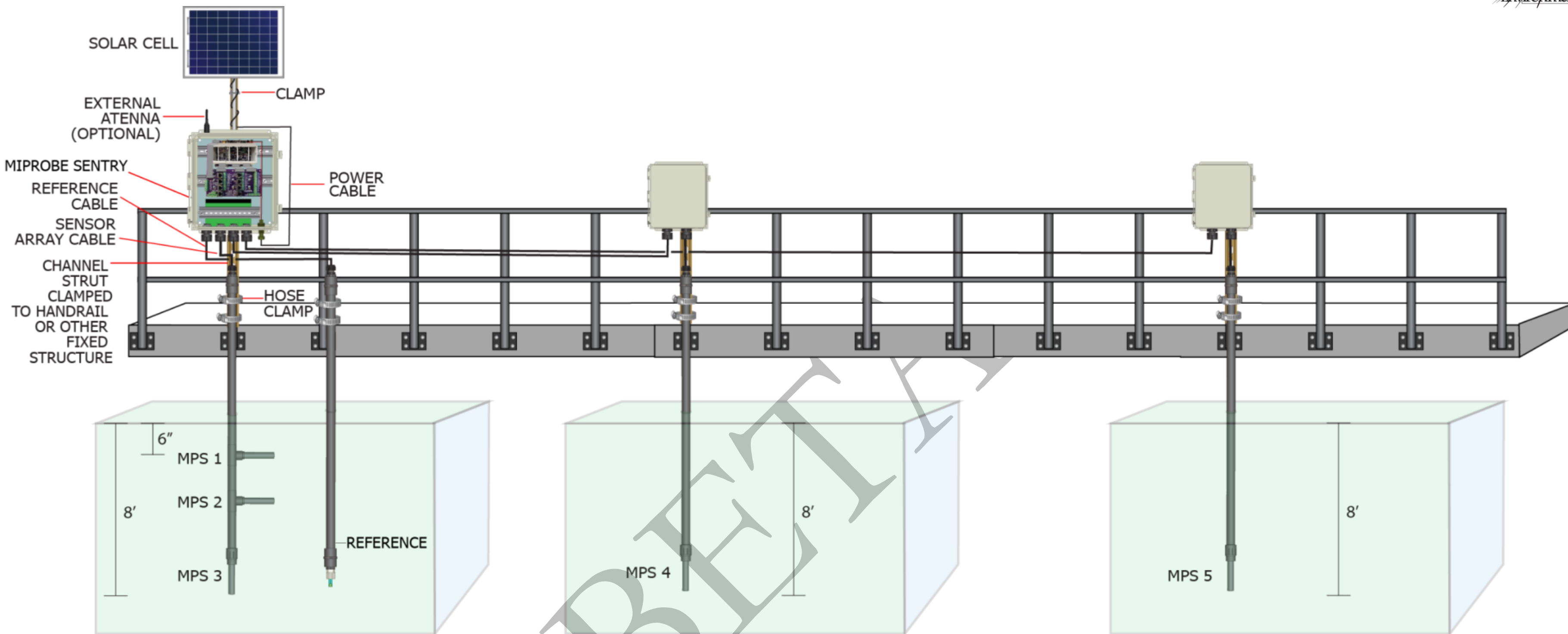


Figure 15: Horizontal Sensor Array Configuration

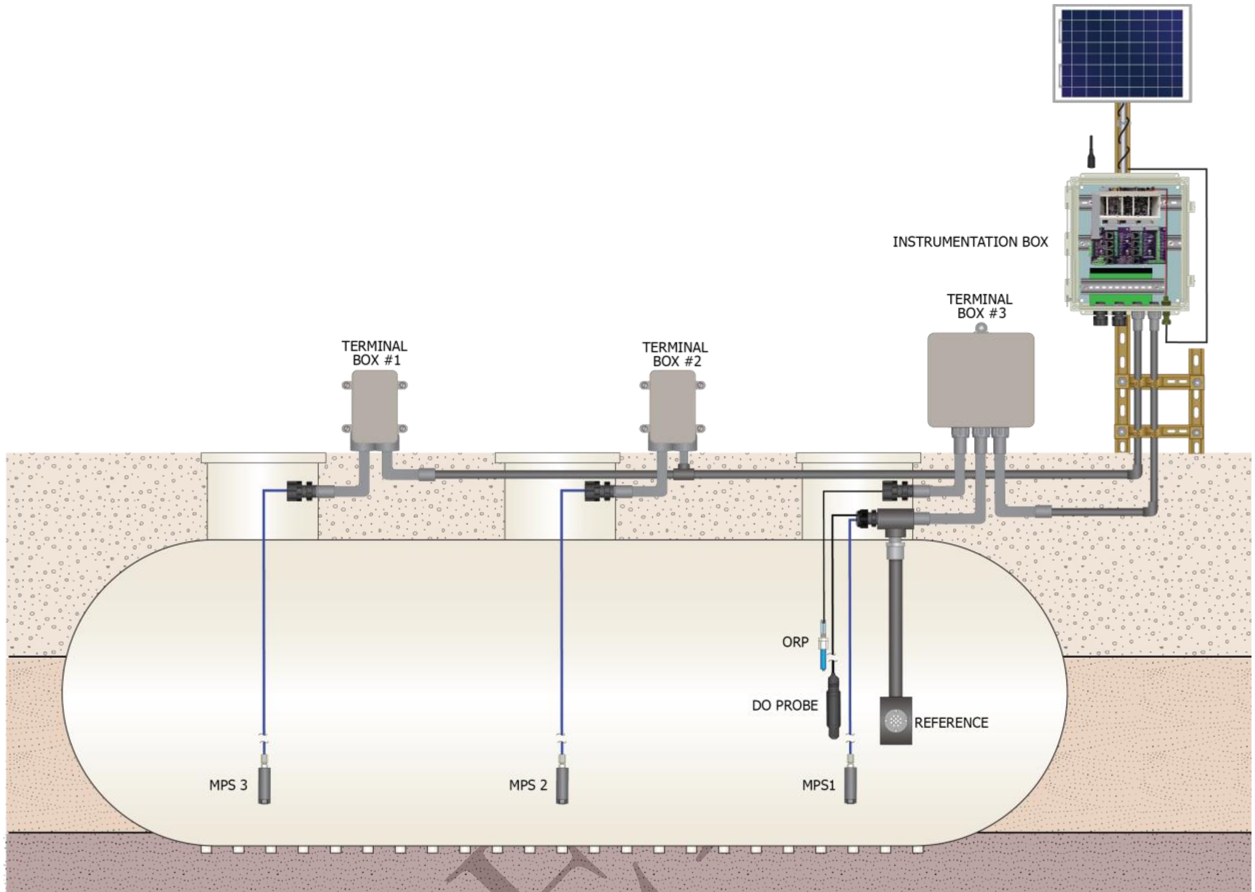


Figure 16: Horizontal Sensor Array Configuration

Reserved

Figure 17: Well Installation

2.0 SYSTEM CONFIGURATIONS

2.1 Vertical MPS Array Configuration

Two or more MPS probes are incorporated within a vertical sensor array (Figure 11). The vertical MPS arrays are deployed at a WWTF as illustrated on Figure 14. *Please note: MiProbe system can support eight (8) MPS sensors*. The reference cell is deployed within a separate array (Figure 14). An auxiliary sensor array may be used to deploy auxiliary sensors such as dissolved oxygen (DO), ORP, temperature, ion-specific electrodes, etc. (Figure 18).

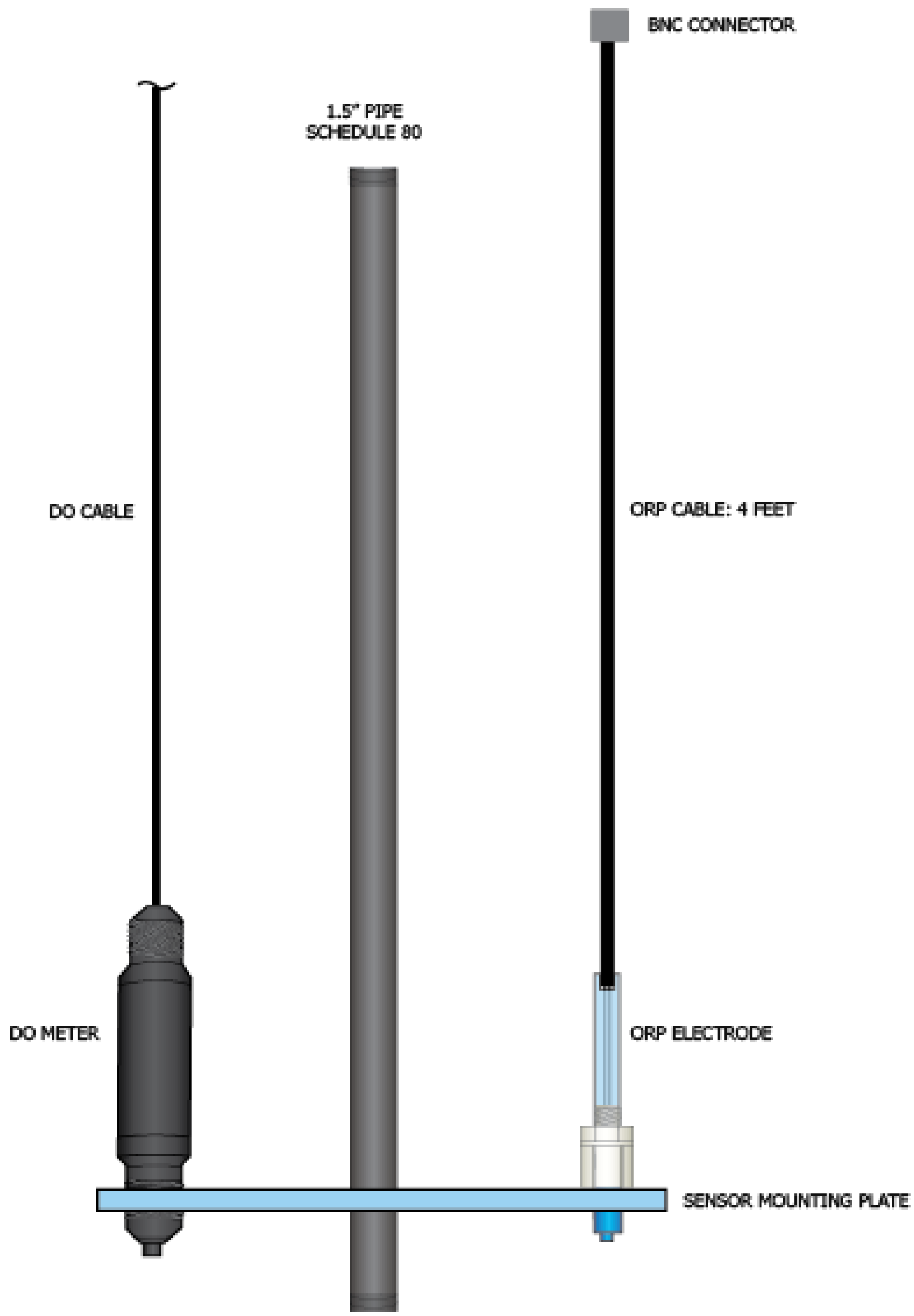


Figure 18: Auxiliary Sensor

2.1.1 Mounting of the System

The mounting system design varies based on the requirements of the site conditions. Two commonly employed designs are the 1) handrail (Figure 19) and single pole (Figure 20).

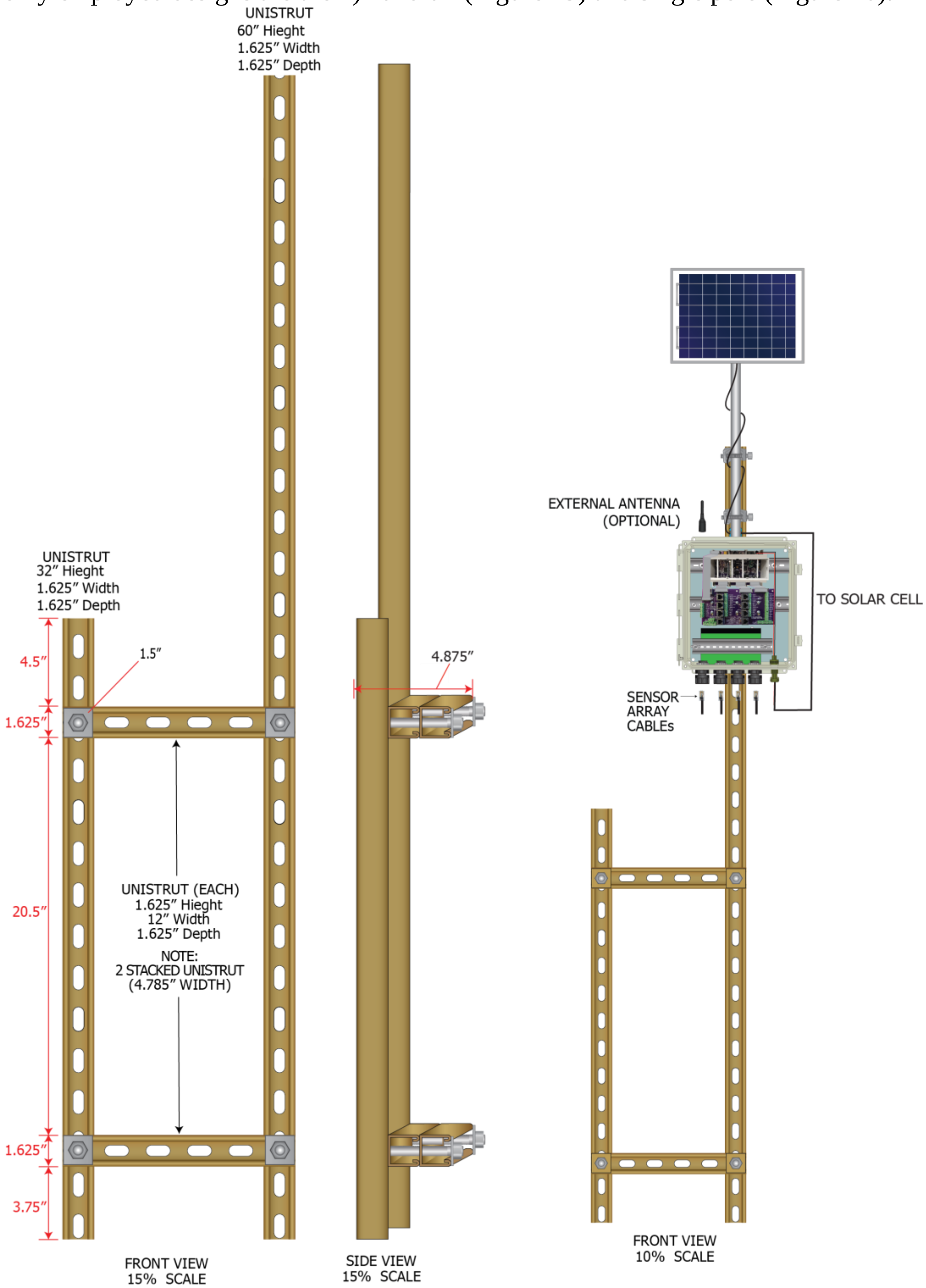


Figure 19: Handrail Mounting System

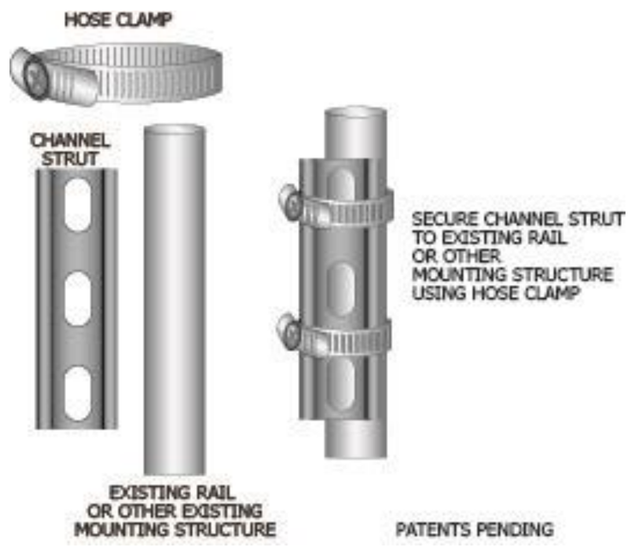


Figure 20: Single-Pole Mounting System

A handrail mounting bracket is designed to mount several components including:

- Instrumentation box
- Solar cell panel (Series 100 Instrumentation Box)
- 12-volt power supply (Series 200 Instrumentation Box)
- MPS array
- Reference array
- Auxiliary sensor array

The handrail mounting system and the components are illustrated on Figure 19. The instrumentation box/solar cell mounting structure is bolted to the outside of the handrail. The handrail mounting system is attached to the handrail using strut pipe clamps (typically 1.5-inch pipe clamps for most railing systems).

Single pole mounting system uses existing vertical structures at the site (poles, vertical structures) or a fence post driven into the ground to mount a strut channel. Pipe clamps connect strut channel to the vertical structure (Figure 20).

2.1.1.1 Mounting of Instrumentation Box

The instrumentation box is mounted to the vertical strut channel (handrail or single pole mounting systems) using the two horizontal struts connected to the back of the instrumentation box (Figure 21). A cone (1/4-20) nut is inserted at the center of the each of the horizontal struts. Bolts (1/4-20) with washers connect the vertical mounting strut with each of the cone nuts located within the horizontal struts. The mounting of the instrumentation box is a two-step process:

Step 1: insert the ¼-inch cone nuts into the horizontal strut channel.
Step 2: bolt the vertical strut to the horizontal strut using the cone nut using ¼-inch bolts.

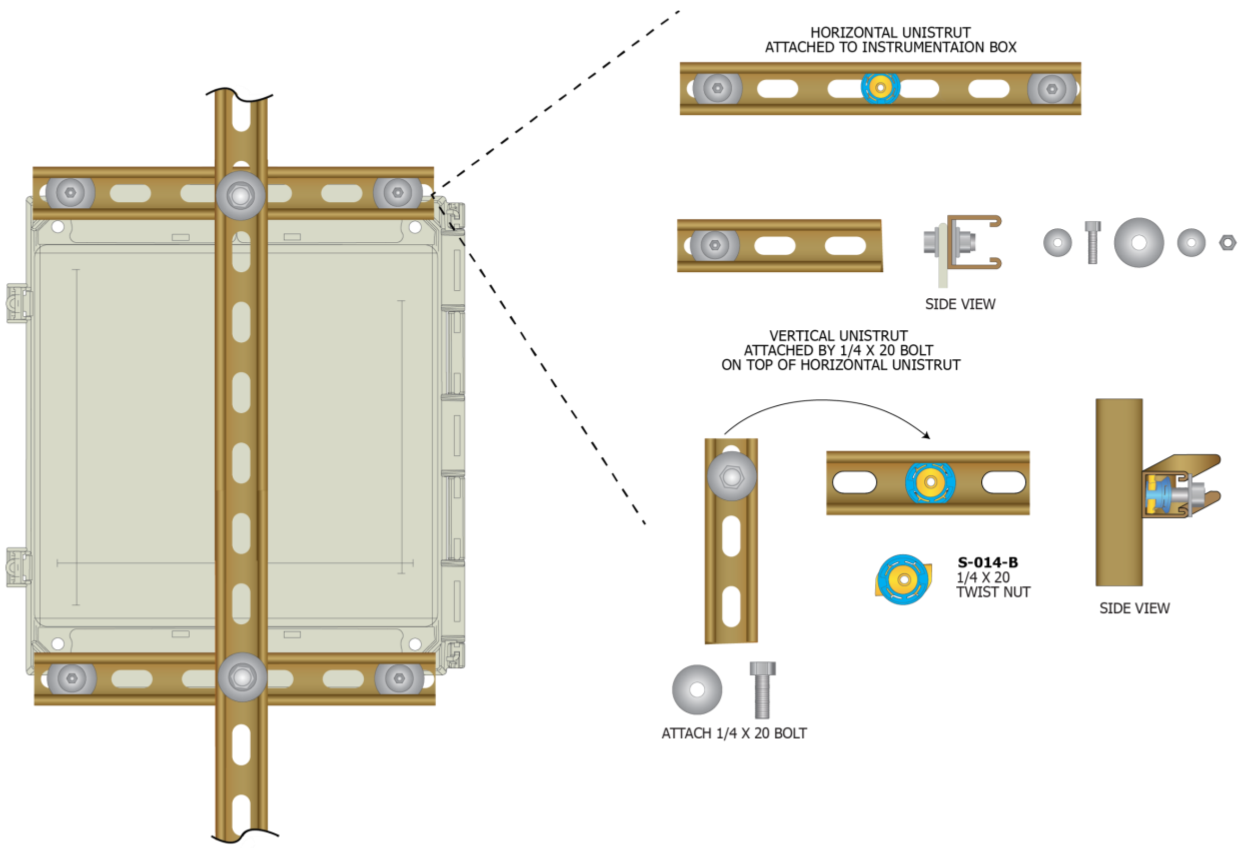


Figure 21: Mounting of the Instrumentation Box

2.1.1.2 Mounting of the Solar Panel (optional)

If the solar-powered option (Series 100 instrumentation box) is used, the solar panel assembly mounts on the strut channel above the instrumentation box (Figure 22). The solar panel is mounted using a four-step process:

Step 1: insert the two ¼-20 cone nuts into the vertical strut channel above the instrumentation box.

Step 2: attach the two mounting clamps using ¼-20 bolts into each of the ¼-20 cone nuts.

Step 3: insert the solar cell mounting tube within the jaws of the mounting clamps and tighten the mounting bolt.

Step 4: connect the solar cell cable to the power connector located on the lower surface of the instrumentation box (Figure 7A).

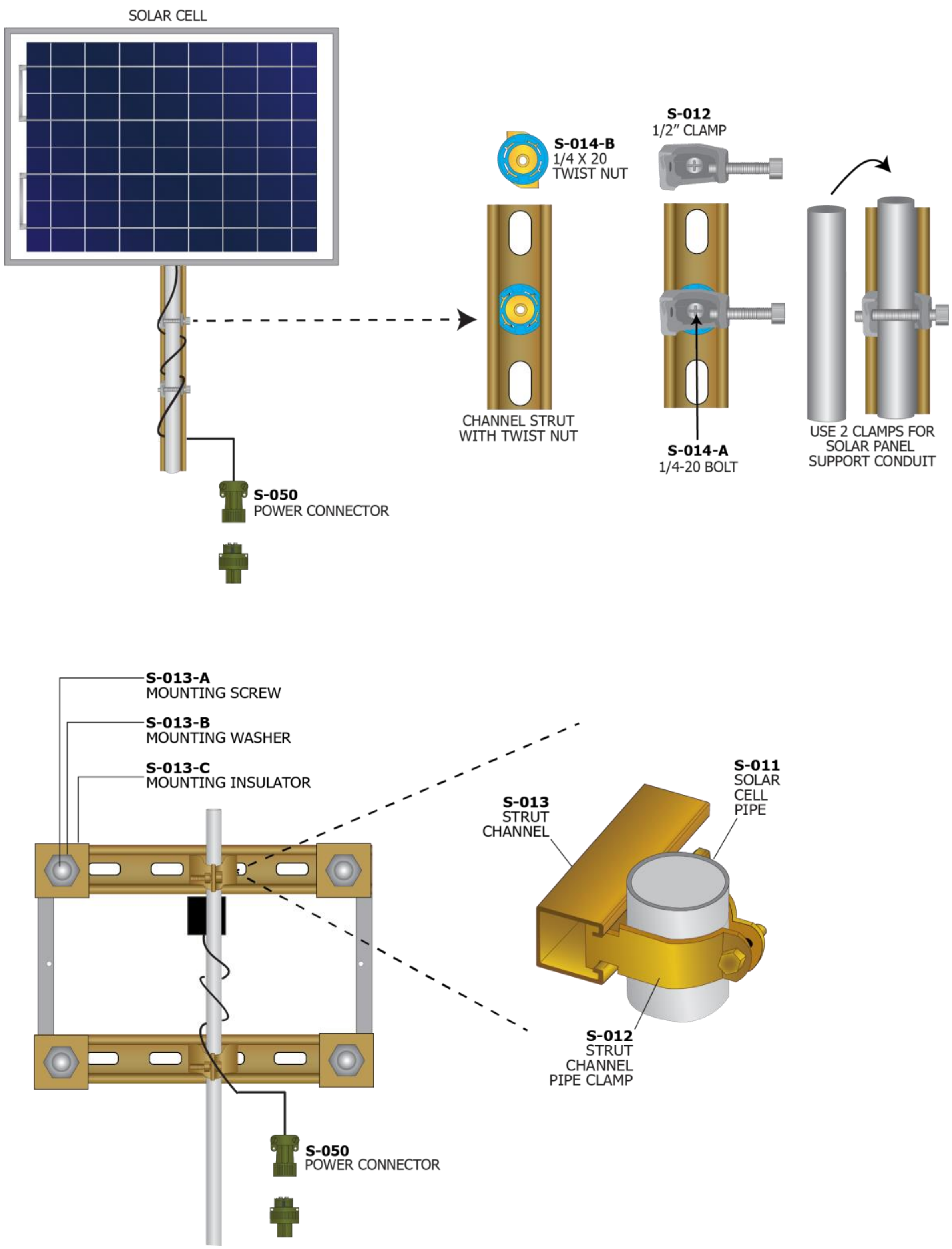


Figure 22: Mounting of the Solar Cell Assembly

2.1.1.3 Mounting of the Sensor and Reference Cell Arrays

The MPS and reference arrays are mounted onto the two horizontal struts of the handrail mounting system (Figure 19). In addition, the optional auxiliary sensor array mounts onto the same two horizontal struts. The MPS and reference arrays are mounted using 3/4-inch strut pipe clamps to the two horizontal struts of the handrail system. Each array requires two pipe clamps.

The tops of the two arrays (sensors and reference arrays) should be either fabricated or altered in the field to be located at the same height, above the upper horizontal strut channel (typically 4 to 6 inches), and approximately 12-inches apart after connection with the pipe clamps to the handrail mounting system (Figure 23).

The installation of the MPS and reference arrays is eight-step process:

Step 1: The MPS array is lowered into the proper position within the treatment process being monitored. The top of the array should be located 4 inches or higher above the highest horizontal strut of the handrail mounting system.

Step 2: 3/4-inch pipe clamps are applied to the MPS array firmly mounting onto the two horizontal struts of the handrail mounting system.

Step 3: reference cell array is lowered into the proper position within the treatment process. The reference should be located 4 to 12 inches below the surface of the water. The top of the reference array should be at the same height as the sensor array (at least four inches above the upper horizontal strut) and approximately 12 inches from the sensor array.

Step 4: 3/4-inch pipe clamps applied to the reference array firmly mounting onto the two horizontal struts of the handrail mounting system.

Step 5: the MPS cables are routed through the cable grip fittings (split gland) located on the bottom of the instrumentation box.

Step 6: the RJ45 fittings of the terminal end of the MPS cables are connected to the appropriate RJ45 fitting of the B10 fanout board

Step 7: the terminal end (BNC connector) of the reference cell is routed through the cable grip fitting (split gland) on the bottom of the instrumentation box.

Step 8: the terminal end of the reference cell is connected to the BNC connector (reference) located on the B10 Fanout board.

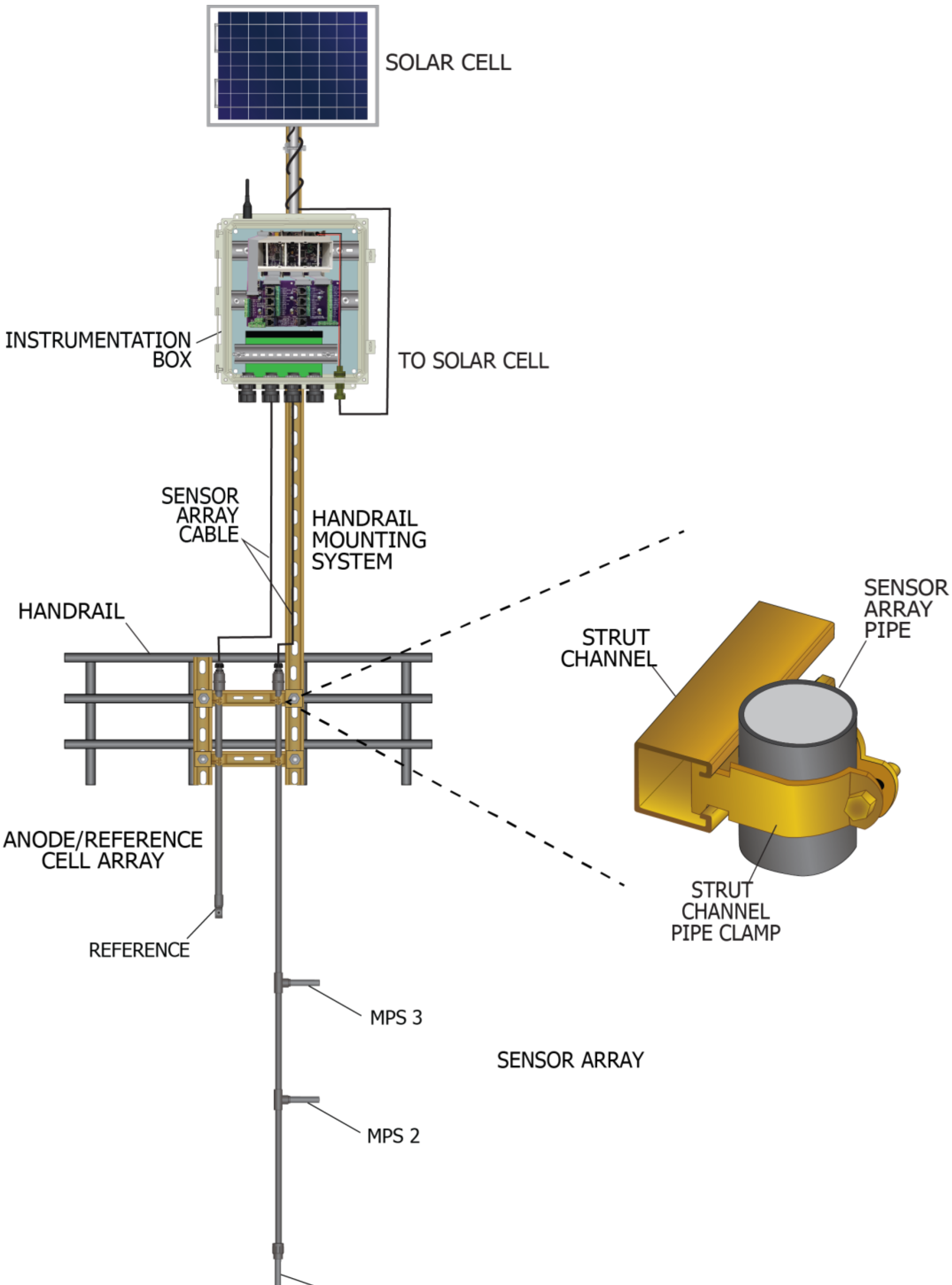


Figure 23: Mounting of Sensor and Reference Cell Arrays to the Handrail Mounting System

2.1.1.4 Mounting of the Auxiliary Sensors

The auxiliary sensors (Table 3) are typically mounted on an auxiliary sensor mounting plate (Figure 18). The sensor mounting plate is mounted to the terminal end of an auxiliary sensor mounting rod (1 to 1.5-inch heavy wall PVC pipe) (Figure 24). The opposite (upper) end of the auxiliary sensor rod attaches to the handrail mounting system using the appropriate size (1 or 1.5-inch) strut-pipe clamp. This is similar with the method used with the attachment of the sensor and reference arrays (Section 2.1.1.3 and Figure 27).

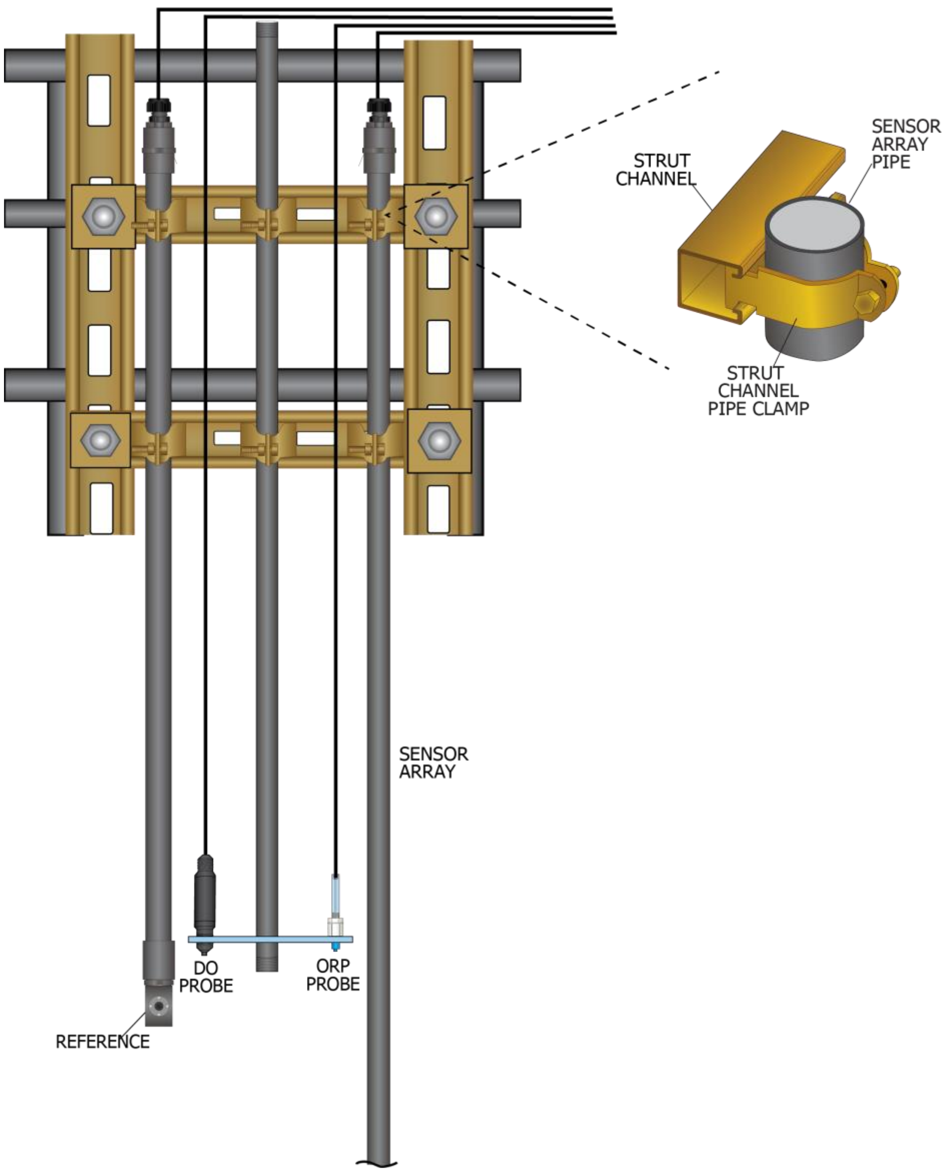


Figure 24: Mounting of the Auxiliary Sensor(s)

2.1.2 Wiring of the System

After the mounting all the components in the vertical configuration including:

1. Instrumentation Box
2. Solar Cell System (optional)
3. MPS and Reference Arrays
4. Auxiliary Sensor Array (optional)

The system is wired between the instrumentation box and the following subsystems:

1. Power Options (solar or 12-volt power supply)
2. MPS array
3. Reference Electrode
4. Auxiliary Sensors

2.1.2.1 Instrumentation Box: Wiring

The instrumentation box houses the B10 signal/communication board (with cellular modem), B10 Fanout board, antenna and battery (Figures 1,2 and 3). Two configurations of the instrumentation box differ based on the power requirements (solar or 12-volt power supply):

1. Instrumentation Box, Series 100 (Figure 7A): Section 1.2.1
2. Instrumentation Box, Series 200 (Figure 7B): Section 1.2.2

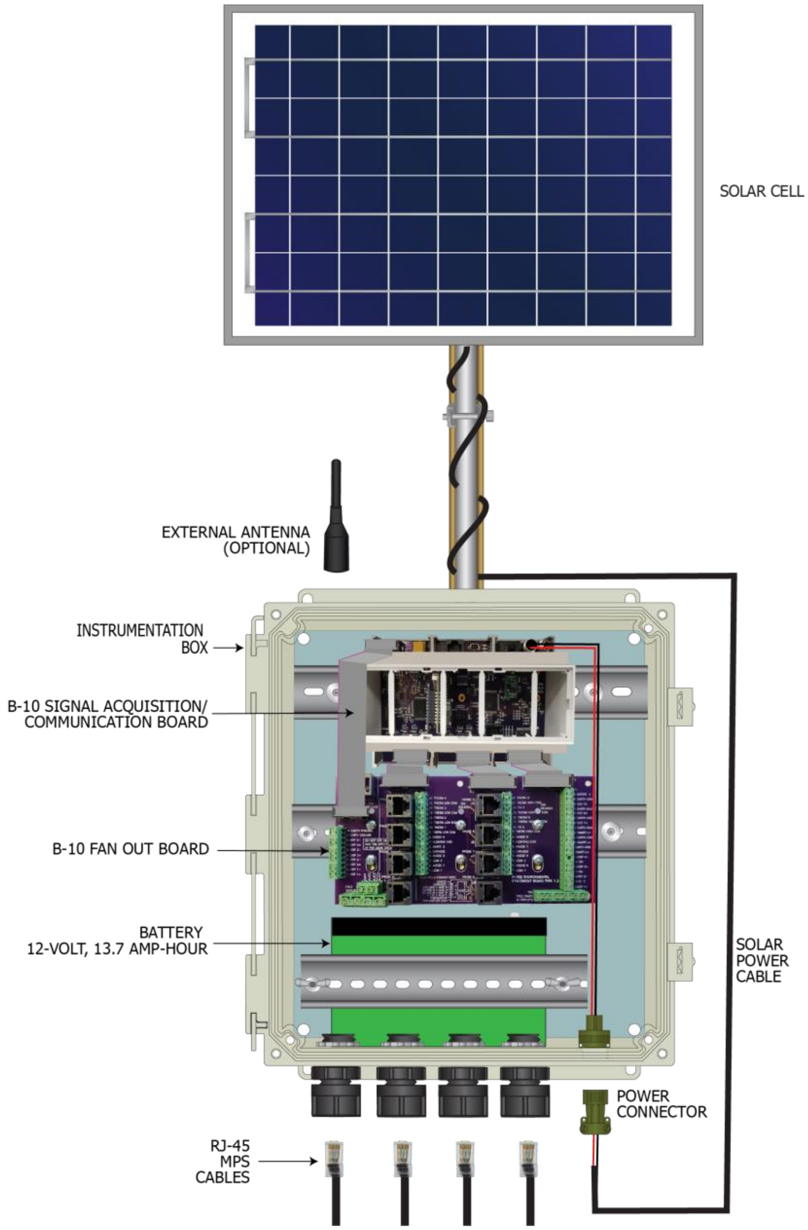


Figure 25: Instrumentation Box (Series 100): Solar Power Configuration

2.1.2.1.1 Instrumentation Box, Series 100

The B10 Board, B10 Fanout Board and battery for the solar power system is illustrated on Figure 2. The wiring within the instrumentation box include:

1. Power Connections: Figure 7B
2. MPS/Reference Connections: Figure 8A
3. Auxiliary Sensor Connections: Figure 8B

2.1.2.1.2 Instrumentation Box, Series 200

The Series 200 box is employed when a 12-volt power supply is used instead of the solar power option (Series 100). The Series 200 instrumentation box does not contain a battery and has one power cable (coaxial) originating from the power connector located on the lower surface of the instrumentation box and connection to the coaxial power connector on the B10 Board (Figure 7B).

The wiring within the instrumentation box include:

1. Power Connections: Figure 7B
2. MPS/Reference Connections: Figure 8A
3. Auxiliary Sensors Connections: Figure 8B

2.1.2.2 MPS and Reference Wiring

The *MiProbe* System acquires signals from one to eight MPS probes. The user should create a map of the operation(s) that are to be monitored and match the location with a corresponding sensor number. The map of the location and sensor number will allow the user to correlate the sensor number with the location being monitored. The best system is to assign Sensor 1 to either the highest sensor in a vertical array or assign Sensor 1 to the sensor at the farthest upstream location within an operation (aeration basin).

Figure 26: Illustration of a sensor location map for a WWTP

MPS Probes

The probes incorporate two sensors within each of the probes: microbial and temperature (Figure 9). The standard MPS probes terminate with a RJ45 connector for connection with the eight RJ45 connectors located on the B10 fanout board (Figures 6 and 28).

Note: The B10 Fanout Board provides two methods of connection of the MPSs: 1) screw mount and 2) JP45 connectors. However, most systems will use the JP45 connection method.

Each of the MPS probes are passed through a separate cable grip located on the bottom side of the instrumentation box (Figure 8). The cap and the gland of the cable grip are removed. The RJ45 connector is passed through the cap and mounting base of the cable grip and into the interior of the instrumentation box. The gland (split) is fitted around the cable and the cable grip reassembled. The RJ45 connected is inserted into the designed RJ45 connector on the B10 fanout board. After the connection, the cable grip is tightened.

Reference Probe

The *MiProbe* System supports one reference cell for the MPS probes. The reference cell may be selected from a variety of standard electrodes or a cathode (Table 2). Most of the reference cells terminate with a BNC connector. The BNC connector of the reference cell is passed through a cable grip located on the bottom side of the instrumentation box. The cap and the gland of the cable grip are removed. The BNC connector is passed through the cap and mounting base of the cable grip and into the interior of the instrumentation box. The gland (split) is fitted around the reference cable and the cable grip reassembled. The reference connected is inserted into the BNC connector located on the B10 fanout board. After the connection, the cable grip is tightened.

2.1.2.3 Auxiliary Sensors

Potentiometric Sensors

Potentiometric sensors (pH and ORP) are typically terminated with a female BNC connector. Therefore, two options to connect these sensors may be employed (Figure 8B). The first is to connect a male BNC connector to the two screw terminals of the selected sensor inputs on the B10 fanout board. The second is to cut the BNC connector off the terminal end of the cable, strip the cable and connect the sensor to the screw terminals of the selected inputs.

2.1.2.4 4-20 mA Sensors

The MiProbe system can accommodate four 4-20 mA sensors. The 4-20 mA sensors have either 2 or 3 wire designs. The *MiProbe* system will accommodate either system (Figure 8B). In addition, most 4-20 mA sensors terminate with bare wires.

2.1.2.4.1 Dissolved Oxygen (DO) Sensor

An optical DO (Model Number AM-ODO AquaMetrix) is a 3-wire 4-20 mA sensor (Figures 8 and 27). The dissolved oxygen sensor has two primary components:

1. Submersible probe with 12 feet of cable terminating with a small circular connector
2. A small circular connector with three feet of cabling, a calibration box with an additional 2 feet of cabling terminating with three color-coded wires (red, black, green)

The submersible probe and its cable (except the small circular connector) are located below the water surface. The small circular connectors and calibration box must be located within a weatherproof housing (Figure 27). Water (rain, wash downs) impacting the small circular connector and calibration box with adversely affect the performance of the DO sensor.

A commonly employed method of deploying the dissolved oxygen probe is to house the calibration box within a small terminal (auxiliary) box. The interior of the terminal box is illustrated on Figure 27.

Two ¼-inch-cable cable grips (an inlet and an outlet) are located on the bottom surface of the auxiliary box (Figure 27). One of the glands of the water-tight fittings (inlet) is split allowing the insertion of the small circular connector through the cable grip and into the interior of the auxiliary box. Additionally, the calibration box is located within the auxiliary box. The cable connecting to the instrumentation box is passed through the second cable grip of the auxiliary box. The DO cable is then passed through ¼-cable grip located on the bottom surface of the instrumentation box. The three wires (red, black and green) exiting the terminal end of the DO cable connect to the screw terminal located on the B10 Fanout Board (Figure 27).

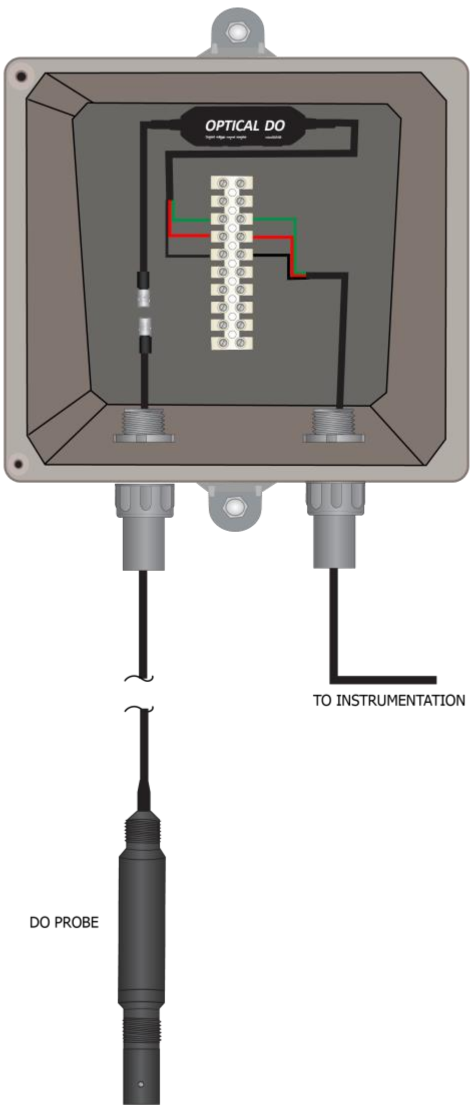


Figure 27: Mounting of Auxiliary Sensors: Auxiliary Box

2.1.2.4.2 Other 4-20 mA

Reserved

2.2 Horizontal Configurations

Horizontal configurations are designed for either above-ground or below-ground installations. This section is divided into two different subsections to present the installation instructions for the two configurations (Figures 15 and 16).

The primary difference between the vertical and horizontal deployments is the use of auxiliary boxes to terminate the MPSs at remote locations from the instrumentation box. Because the standard length of the MPS probe cables is 15 feet, the MPS cables may not have the length to reach from the monitoring points in a horizontal configuration to the instrumentation box. The auxiliary box presents a convenient method of addressing the problem of cabling from remote locations to the instrumentation box. The MPS extension board auxiliary box can handle 3 MPSs, two sensors terminating with BNC connectors and six screw wire connectors. Figure 28 illustrates the use of auxiliary box for connection of two MPSs. Two MPS sensor cables are passed through cable grips with split glands located on the bottom surface of the auxiliary box and connect to the RJ45 (in) connectors within the auxiliary box. Two extension cables connected to the RJ-45 (out) connectors, are passed from the interior of the auxiliary box through cable grips. The extension cables are routed from the auxiliary box to the instrumentation box. The extension cables may be routed as either 1) a bare cables, or 2) through electrical conduit from the auxiliary box to the instrumentation box.

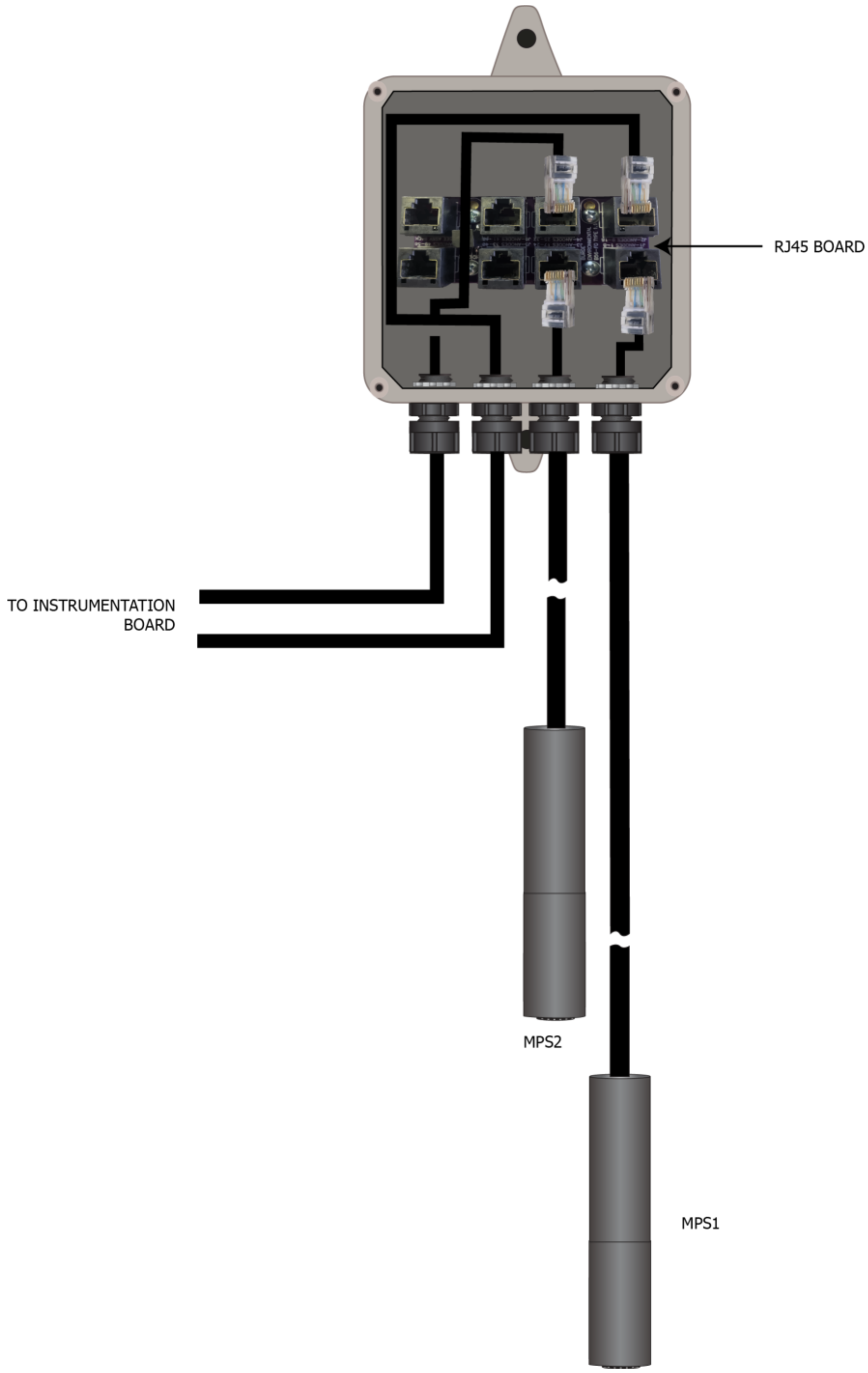


Figure 28: Auxiliary Box and MPS sensor termination (JP-45).

The mounting of the monitoring system components is presented in Section 2.2.1 and the wiring of the components are presented in Section 2.2.2.

2.2.1 Mounting the System

The instrumentation box, solar panel assembly and optional auxiliary boxes for horizontal configurations may be mounted to either: 1) a handrail mounting system (Figure 19), or 2) a pole-mounted mounting system (Figure 20). The two mounting systems are presented in Section 2.1.1.

2.2.1.1 Mounting of the Instrumentation Box

The instrumentation box and auxiliary box (optional) are mounted to vertically orientated strut channel (Figure 21). The mounting of the instrumentation box is presented in Section 2.1.1.1.

The primary reason for the mounting of an auxiliary box adjacent to the instrumentation box is to house the optional dissolved oxygen sensor presented in Section 2.1.2.4.1 and Figure 27. The dissolved oxygen sensor has a calibration box that must be protected form the environment. An auxiliary box provides protection housing of the calibration box of the dissolved oxygen probe.

2.2.1.2 Mounting of Solar Panel

The solar panel assembly is mounted to vertically orientated strut channel above the instrumentation box (Figure 42). The mounting of the solar panel is presented in Section 2.1.1.2.

2.2.1.3 Mounting of MPS and Reference Arrays: Below-ground Installation

This configuration is used when microbial sensors are horizontally distributed in an array and the cabling is protected within underground electrical (PVC) conduits (Figure 16). The system is placed underground to avoid physical and/or biological restraints: traffic, animals, weather conditions.

The installation uses a series of terminal (auxiliary) boxes located above ground surface to transition the sensor cables to extension cables passing through electrical conduit to the instrumentation box. The sensor cables terminate at a terminal block or JP-45 connection board located within the auxiliary box (Figure 28 and 30). The extension cables from the auxiliary boxes (MPS and reference) connect to the B10 fanout board located within the instrumentation box (Figure 29).

2.2.1.3.1 Auxiliary Box for MPS probes

The most basic auxiliary box for a horizontally distributed system handles a single MPS probe. The MPS probe may be deployed in several configurations including: 1) through the wall of an underground treatment system, or 2) above ground treatment basin. An illustration of the monitoring of an underground treatment system is illustrated on Figure 16.

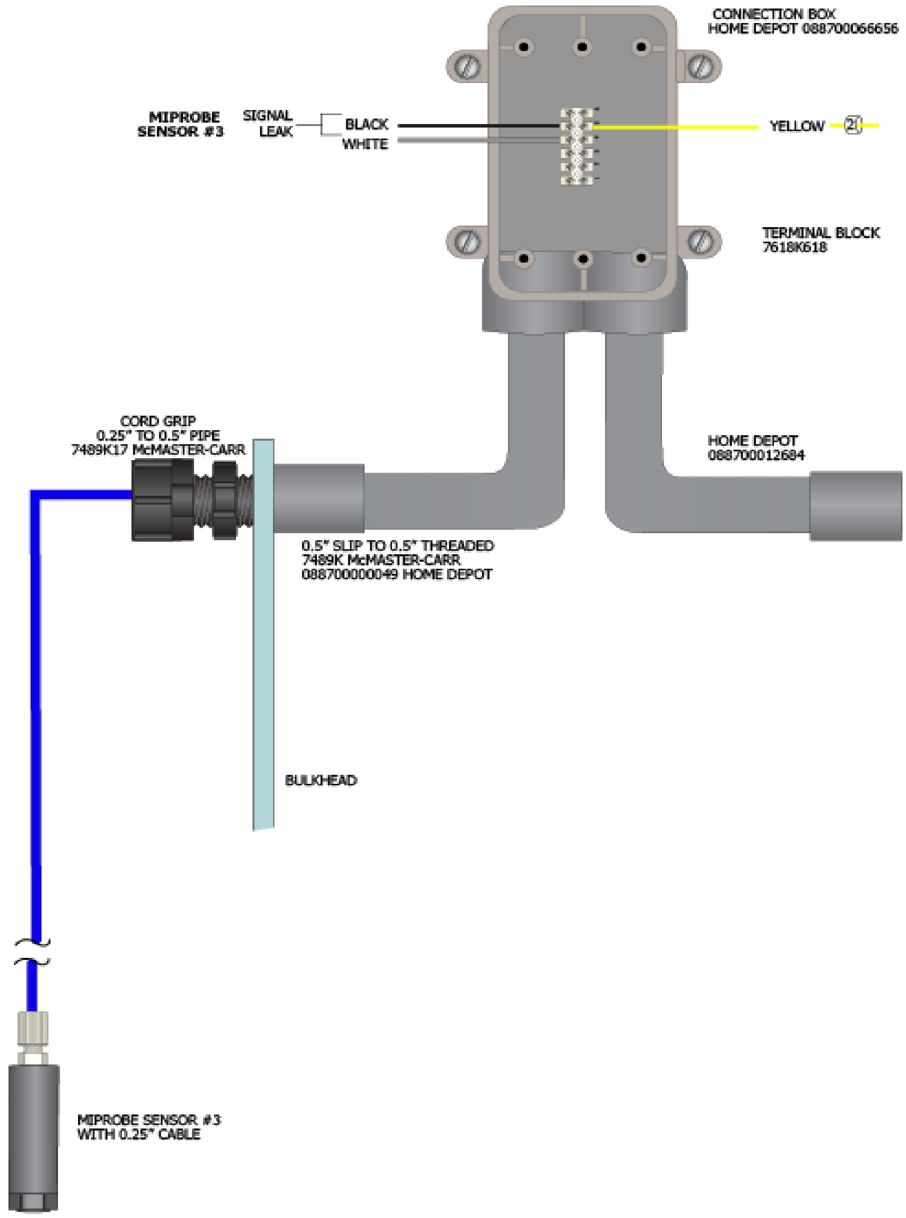


Figure 29: Auxiliary Box with terminal block for Single Microbial Sensor: Subsurface Horizontal Deployment

Reserved

Figure 30: Auxiliary Box with RJ-45 connection Board for Single Microbial Sensor: Subsurface Horizontal Deployment

The MPS is located within an underground structure (such as a manhole port of an underground storage tank system). The ¼-inch MPS cable passes through a water-tight compression (0.25-inch cable to ½-inch NPT) fitting. A hole is drilled through the underground structure (7/8-inch step drill) and the threaded 1/2-inch pipe (male) fitting of the compression fitting is passed through the hole and connects with a 1/2-inch threaded (female) to 1/2-inch slip (female) electrical conduit fitting (Figure 29). The 1/2-inch electrical conduit connects to the 1/2-inch (female) slip port of the electrical conduit fitting. The electrical conduit is located underground. The electrical conduit uses 45° sweeps to connect to an auxiliary box located above ground. The auxiliary box is mounted to a length of strut channel. The strut channel can be 1) directly driven in the ground, or 2) connected using pipe clamps to a stake driven into the ground.

The terminal end of the MPS cable connects within the auxiliary box to a second (extension) cable using two methods: 1) RJ-45 connection board (Figure 30), and 2) bare-wire connection (Figure 29).

Wiring Method 1:

The MPS cable terminates with a RJ-45 connector. The RJ-45 connector is passed through the conduit and into the interior of the auxiliary box fitted with RJ-45 extension board (Figure 30). The terminal end of the MPS cable connects to the first (in) port of the RJ-45 connection board. A second (extension) cable with a RJ-45 fitting connects to the first (out) port of the RJ-45 connection board. The extension passes out of the auxiliary box through a second 1/2-inch electrical conduit to the instrumentation box. The cable passes out of the electrical conduit into the interior of the instrumentation box. The RJ-45 connector connects to the first port of the B10 fanout board.

Wiring Method 2:

The MPS cable terminated without a RJ-45 connector. The appropriate wires (brown, black and red wires) within the ¼-inch microbial sensor cable are exposed and connected to the terminal (screw) block within the auxiliary box (Figure 29). The signal from the MPS is the brown wire and temperature are the red and black wires (Figure 31). An extension cable passes from the interior of the auxiliary box into the interior of the instrumentation box. The extension cable connects to the terminal strip within the auxiliary box. The extension cable passes from the interior of the auxiliary box through the conduit and into the interior of the instrumentation box. The terminal end of the cable connects to the MPS port on the B10 fanout board.

2.2.1.3.2 Auxiliary Box for Reference and Auxiliary Sensors

An auxiliary box for the deployment of MPS, references and auxiliary sensors is illustrated on Figure 31. It is highly recommended this auxiliary box be located closest to the instrumentation box (Figure 16).

Special Note: This section assumes that a cathode is being used as the reference. If a silver/silver chloride reference is used as the reference, then the cathode maybe deleted from the illustration (Figure 31) and instructions.

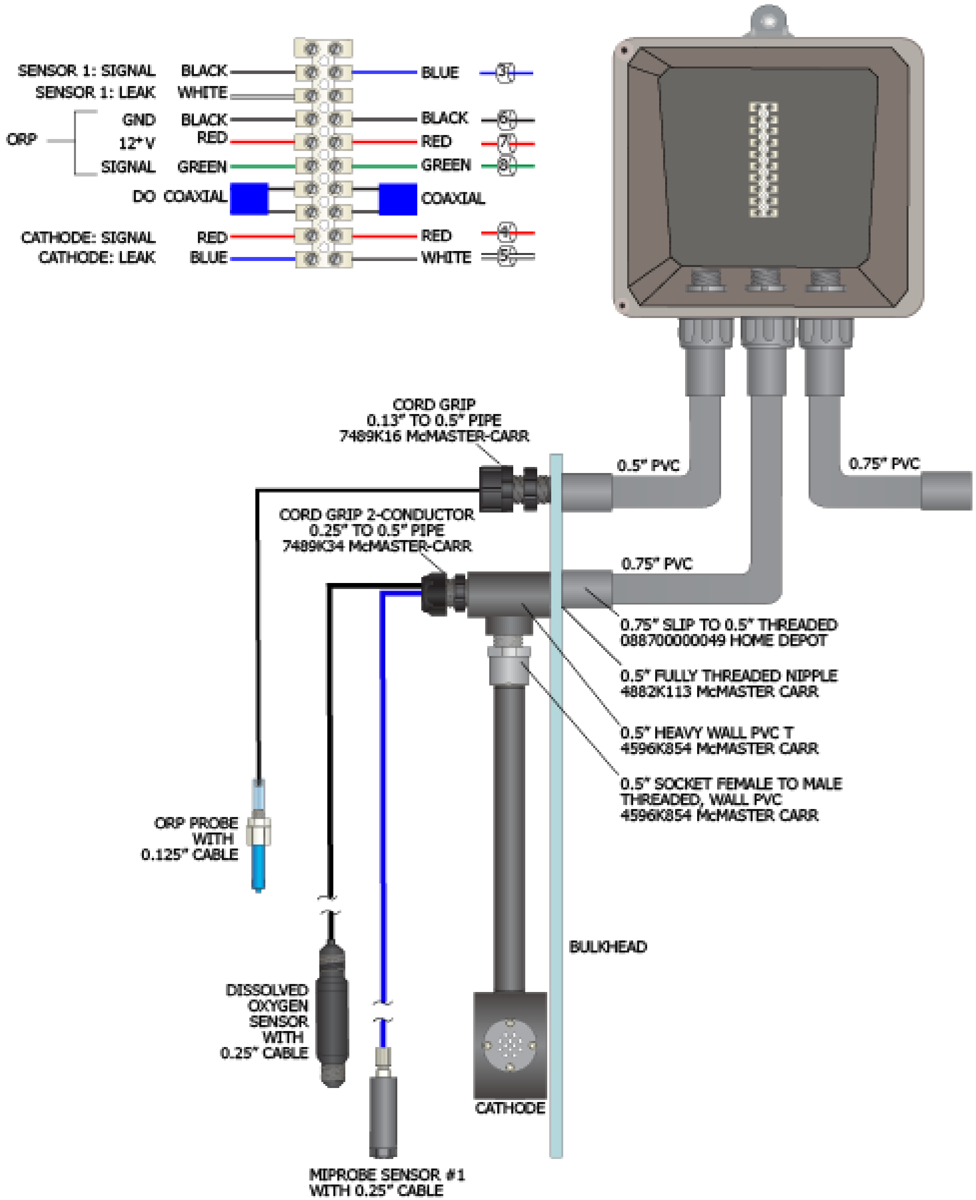


Figure 31: Auxiliary Box for Microbial Sensor, Cathode and Auxiliary Sensors

The auxiliary box (Figure 31) is larger than the auxiliary box used for handling a single microbial sensor (Figure 29). A 10-position terminal block is mounted within the auxiliary box. Figure 31 illustrates the deployment and wiring of a MPS, reference, and auxiliary sensors (ORP probe and DO probe).

If a DO probe is used, the auxiliary box is used to house the calibration box of the DO probe. Figure 31 illustrates two separate sensor arrays:

1. MPS, reference, and DO probe array
2. ORP array

The auxiliary box is mounted to a length of strut channel. The strut channel can be 1) directly driven in the ground, or 2) connected using pipe clamps to a stake driven into the ground.

2.2.1.3.2.1 MPS, Reference and DO Probe Array

Special Note: This section assumes that a cathode is being used as the reference for the MPS arrays. If a silver/silver chloride cell is used, disregard the installation and wiring of the cathode assembly and use the reference cell of the ORP electrode.

This section will be divided into four sections to document the installation of MPS, reference and DO probe array.

Installation of MPS and DO Probes

The cables of the MPS and DO probe are passed through a dual-port compression fitting. The polymer gland of the compression fitting is split to allow the installation of the cables within the compression fitting. The ½-inch pipe (male) end of the compression fitting is connected two different configurations based on whether a: 1) cathode assembly is used as the reference, and 2) no cathode assembly used as the reference (Ag/AgCl cell is used). If the cathode option is selected, then the ½-male NPT of the compression fitting connects to a ½-inch T (female) with a threaded fitting. The DO and microbial sensor cables are extended through the T and exit the opposite threaded port (Figure 31).

If the cathode is not used, then the ½-inch NPT fitting is connected to a ½-inch NPT connector.

Installation of the Cathode Assembly (Optional)

The cathode (***see note above***) is mounted on a 3/4-inch heavy-walled PVC pipe. The 3/4-inch pipe from the cathode assembly is threaded. Two wires (red and white) exit the top of the reference pipe from the reference assembly. A second length of 3/4-inch pipe connects using a 3/4-inch pipe (female) union to the threaded pipe fitting of the cathode assembly. The purpose of the second pipe is to allow for the adjustment of the pipe length to ensure the cathode is located at the optimal depth (4 to 6 inches below the water surface) below the water surface of the treatment system being monitored.

The two wires of the cathode (***see note above***) assembly must be passed through the entire length of the connected 3/4-inch piping of cathode assembly. A fast-acting PVC cement should be used at the pipe connection (union) to ensure water does not enter the cathode piping.

After the optimal length of the piping of the cathode assembly is determined, the 3/4-inch reference pipe is cut to the optimal length. WARNING: DO NOT CUT THE WIRES ORIGINATING FROM THE CATHODE ASSEMBLY WHEN CUTTING THE PIPE.

A fitting (cathode fitting***, see note above***) connects to the 3/4-inch pipe side (female) port of the T fitting to secure the cathode assembly. The cathode fitting is 3/4-inch threaded to 3/4-inch slip. The connection of the cathode assembly is a three-step process:

Step 1: Connect the 3/4-inch threaded to 3/4-inch slip fitting to the 3/4-inch threaded side port of the T fitting.
Step 2: Pass the reference cable with BNC terminal connector through the reference fitting and T fitting and then through the open port of the T fitting.
Step 3: connect the unthreaded terminal end of the3/4-inch pipe of the cathode assembly to the3/4-inch slip fitting. Apply fast-acting PCV cement to the connection.

Note: it is important not to twist or turn more than one rotation the reference assembly pipe when inserting into the cathode fitting. Severe rotation will result in the damage of the wires within the cathode assembly.

Mounting of the MPS, cathode and DO probes onto the wall of the chamber

A 3/4-inch pipe nipple is connected the exit port of: 1) the T-fitting (if a cathode assembly is used), or 2) ¾-inch NPT connector (if no cathode is used). The nipple is passed through a hole drilled (7/8-inch hole drilled with step drill) through bulkhead of the treatment system to be monitored. A 3/4-inch threaded (female) to slip (female) fitting union is used to secure the T fitting to the bulkhead of the treatment system (Figure 31). *Note: it is important that only the union be turned while securing the T fitting against the bulkhead. If the T is turned, damage to the cathode wires may result.* Gasket material should be used to insure a tight fit of the sensor array and union to the bulkhead. The MPS and DO probe cables and cathode (optional) wires should be passed through the pipe nipple and union prior to tightening the fitting. A 3/4-inch electrical conduit connects to the slip end of the union fitting. PVC cement should be applied to the joint between the conduit and the union. The cabling and wires must be passed through the electrical conduit. A 3/4-inch 45° conduit sweep fitting is used direct the electrical conduit located below the surface to the auxiliary box located above ground surface (Figures 16 and 31).

The wires and cables of the MPS, DO and cathode are connected to the terminal strip located within the auxiliary box (Figure 31). The wiring instructions are presented in Section 2.2.2.

The calibration box of the DO probe must be protected within the interior of the auxiliary box.

2.2.1.3.2.2 ORP Array

The ORP probe has a BNC fitting located at the terminal end of the cable. The large diameter of the BNC connector is the primary reason for the second sensor array and use of ¾-inch PVC electrical conduit and fittings (the coaxial connector will not pass through ½-inch conduit, 45° sweeps). The ORP cable is passed through a compression fitting. The gland of the compression fitting is split to allow the installation of the cable into the compression fitting. The 3/4-inch pipe (male) threaded end of the compression fitting is passed through a hole (7/8-inch hole drilled by a step bit) drilled through the bulkhead of the treatment system and connected with a 3/4-inch threaded to ¾-inch slip union fitting.

The 3/4-inch threaded (female) end of the union is used to secure the compression fitting against the bulkhead. A gasket material should be used to insure a tight fit of the compression fitting and union against the bulkhead.

A ¾-inch electrical conduit connects to the slip end of the union. The ORP cable is passed through the conduit. PVC cement should be applied to the joint between the conduit and the union. The cabling and coaxial fitting must pass through the electrical conduit. A 45° sweep conduit is used direct the underground electrical conduit to the auxiliary box located above ground (Figure 31).

The BNC connector connects to the BNC connector located within the auxiliary box (Figure 31).

All the wiring and the coaxial cable (ORP) passes through ¾-inch electrical conduit from the terminal box to the instrumentation box. NOTE: THE COAXIAL CABLE MUST BE PULLED THROUGH FIRST OR IN CONJUNCTION WITH THE OTHER WIRES.

The wires from the auxiliary box are connected in accordance with the wiring diagram illustrated on Figure 31. The wiring instructions are presented in Section 2.2.2.

2.2.1.4 Mounting of MPS and Reference Probes: Above-Ground Deployments

This configuration is typically used when MPS sensors are being horizontally distributed along: 1) the railing of water treatment facility, or 2) in installations where above-ground electrical cabling and/or conduits do not interfere with normal traffic (Figures 15 and 32).

The cabling originates from the sensor arrays and are passed through a series of auxiliary boxes terminating within the instrumentation box. The cabling may be passed through electrical conduit or routed as a bare cable (Figure 32) attached to the handrails. A typical installation is illustrated on Figure 15.

The MPS and reference arrays may be deployed with a WWTF operation using two methods: 1) bare cable directly submerged in the treatment operation (Figure 9), or 2) mounted within ¾- heavy wall PVC pipe (Figures 10, 11, 12). The first method can be used at operations of WWTF where the horizontal flow is low (< __ feet/min). The second method is used in operations of WWTF with greater flows (Figure 32).

Several MPSs may be mounted within a sensor array (Figure 11). The MPS and reference arrays are mounted directly to the railings or to strut channel connected to the railing (Figure 32 and Section 2.1.1.3).

The reference should be mounted 6 to 12 inches below the surface of the water (Figure 32).

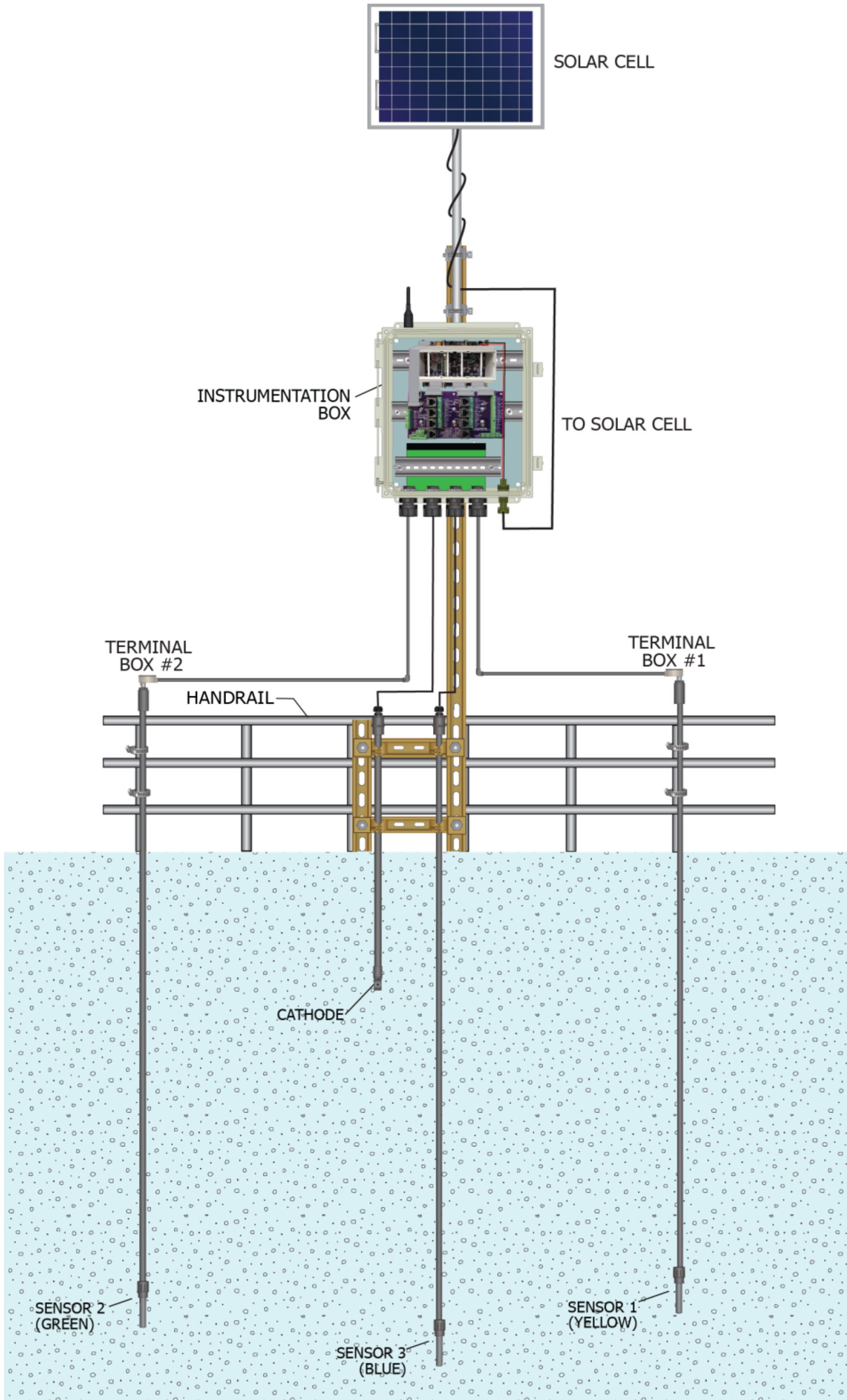


Figure 32: Microbial Monitoring System: Horizontally-Distribution System located Above Ground Surface

2.2.1.4.1 Auxiliary Boxes for MPSs

The auxiliary boxes are typically mounted adjacent to the top of the MPS arrays (Figure 15). The sensor cables from the MPSs exit the top port of the 3/4-inch pipe sensor array (Figure 13). The sensor cable can be either routed directly (Method 1) as a bare cable to the auxiliary box, or through ¾-inch conduit (Method 2).

Method 1: The sensor cable is routed directly to the auxiliary box. The sensor cable is passed through a compression fitting located on the bottom surface of the auxiliary box and into the interior of the auxiliary box. The RJ-45 fitting located on the terminal end of the sensor cable connects to the RJ-45 (in port) extension board. The RJ-45 connector on the terminal end of an extension cable connects to the RJ-45 (out port) of the RJ-45 extension board. The extension cable exits the auxiliary box by passing the cable through a second compression fitting and the extension cable is routed to the instrumentation box. The extension cable is passed through a compression fitting into the interior of the instrumentation box and the RJ-45 fitting of the extension cable connects to the appropriate port on the B10 fanout board (Figure 6).

Method 2: The wiring of the sensor and extension cables are similar except the cables are passed through a conduit.

The wiring diagram and instructions of the auxiliary box are presented in Section 2.2.2.

2.2.1.4.2 Auxiliary Box for Reference Array

A reference array is located on the lower terminal end of a 3/4-inch heavy-wall PVC pipe (Figure 12). The reference cable exits the top port of the 3/4-inch reference array. The reference signal carried by the outside conductor of the BNC connector. The terminal end of the reference cable connects to the BNC connector located on the B10 fanout board within the instrumentation box. However, if the reference cable is of insufficient length, an auxiliary box may be required to supply an extension cable.

The reference cable can be either routed as bare cable directly (Method 1) to the auxiliary box, or through ¾-inch conduit (Method 2).

Method 1: The reference cable is routed directly to the auxiliary box, the cable is passed through a compression fitting located on the bottom surface of the auxiliary box and into the interior of the auxiliary box. The BNC fitting located on the terminal end of the reference cable connects to the BNC connector connected to a terminal block within the auxiliary box. A BNC connector on the terminal end of a reference extension cable connects to the second BNC connector located on the terminal block. The reference extension cable exits the auxiliary box by passing the cable through a second compression fitting and the cable is routed into the instrumentation box. The cable is passed through a compression fitting into the interior of the instrumentation box and the BNC fitting connects to BNC fitting labeled cathode on the B10 fanout board (Figure 6).

Method 2: The wiring of the sensor and extension cables are similar except the reference and reference extension cables are passed through a conduit.

The wiring diagram and instructions of the reference array is presented in Section 2.2.2.

2.2.2 Wiring of System

This section documents the wiring of the two types of horizontal systems:

1. Above-ground systems
2. Below-ground systems

2.2.2.1 Instrumentation Box

Two types of instrumentation boxes are used in the deployment of the microbial monitoring system.

1. Solar-powered (Series 100)
2. 12-volt power supply (Series 200)

2.2.2.1.1 Instrumentation Box, Series 100

The instrumentation box and auxiliary box (optional) are mounted to vertically orientated strut channel (Figure 21). The mounting of the instrumentation box is presented in Section 2.1.1.1.

The primary reason for the mounting of an auxiliary box adjacent to the instrumentation box is to house the optional dissolved oxygen sensor presented in Figure 27.

2.2.2.1.2 Instrumentation Box, Series 200

The cabling of the interior of the Instrumentation Box is similar with the cabling instructions illustrated on Figures 2 and 3.

2.2.2.1.2.1 Horizontal System, Above Ground

Reserved

2.2.2.1.2.1.1 Microbial Sensor and Cathode Wiring Configuration

Reserved

2.2.2.1.2.1.2 Auxiliary Sensor: Wiring Configuration

Reserved

2.2.2.1.2.2 Horizontal System, Below-ground System

The wiring configuration of a horizontally distributed system with the Series 200 instrumentation box and three terminal boxes are illustrated on Figure 16. The system configuration illustrated includes MPSs (three sensors), reference assembly and auxiliary sensors (DO, ORP and temperature).

MPS and Reference Wiring Configuration

The MPSs can be used to monitor above- or below-ground treatment structures. An example of monitoring of a below-ground structure is illustrated on Figure 16. The MPS is connected to a waterproof cable (Figure 9). The cable is passed through a compression fitting and into the interior of an auxiliary box located adjacent to the structure under investigation (Figure 16). The RJ-45 fitting at the terminal end of the sensor cable is connected to the (in port) RJ-45 extension board within the auxiliary box. An extension cable connects to the (out port) of the RJ-45 extension board passed through a second compression fitting of the auxiliary box. The extension cable is routed to the instrumentation box. The extension cable passes through compression fitting on the lower surface of the instrumentation box and connects with the appropriate RJ-45 port on the B10 fanout board (Figure 6). The extension cable can be routed as a bare cable or through ¾-inch conduit.

The cable of the reference array (Figure __) terminates with a BNC connector. The terminal end of the reference cable is passed through compression fitting and into the interior of the auxiliary box. The BNC connector connects to the BNC connector on the extension board. A reference extension cable terminating with a BNC connector connects to the BNC out port of the extension board. The reference extension cable passes through a compression fitting on the bottom surface of the auxiliary box. The reference extension cable is routed from the auxiliary box to the instrumentation box. The terminal end of the extension cable passes through the compression fitting into the interior of the instrumentation box and connects to the reference BNC connector. The mounting of the reference is documented in Section 2.2.1.3.2. The cabling of the cathode array is illustrated on Figure __. The reference extension cable is routed either as a bare cable or through a ¾-inch electrical from the auxiliary box to the instrumentation box.

The initial testing of the wiring of the reference array is documented in Section 2.3.3 and illustrated on Figure __.

2.2.2.1.2.2.1 Auxiliary Sensor: Wiring Configuration

The mounting of the auxiliary sensor for an underground structure is documented in Section 2.2.1.3.2 and illustrated on Figure __.

Dissolved Oxygen Sensor

An optical DO (Model Number AM-ODO AquaMetrix) is a 3-wire 4-20 mA sensor (Figures 8 and 27). The dissolved oxygen sensor has two primary components:

1. Submersible probe with 12 feet of cable terminating with a small circular connector
2. A small circular connector with three feet of cabling, a calibration box with an additional 2 feet of cabling terminating with three color-coded wires (red, black, green)

The submersible probe and its cable (except the small circular connector) may be located below the water surface. The small circular connectors and calibration box must be located within a weatherproof housing (Figure 27). Water (rain, wash downs) impacting the small circular connector and calibration box with adversely affect the performance of the DO sensor.

A commonly employed method of deploying the dissolved oxygen probe is to house the calibration box within a small terminal (auxiliary) box. The interior of the terminal box is illustrated on Figure 27.

Two ¼-inch-cable cable grips (an inlet and an outlet) are located on the bottom surface of the auxiliary box (Figure 27). One of the glands of the water-tight fittings (inlet) is split allowing the insertion of the small circular connector through the cable grip and into the interior of the auxiliary box. Additionally, the calibration box is located within the auxiliary box. The extension cable connecting to the instrumentation box is passed through the second cable grip of the auxiliary box. The DO extension cable is then passed through ¼-cable grip located on the bottom surface of the instrumentation box. The three wires (red, black and green) exiting the terminal end of the DO cable connect to the screw terminal located on the B10 Fanout Board (Figure 27).

The DO sensor has three wires (black, red and green). The wire color, number and use are presented on Table 6. The DO sensor wires are connected to the terminal block within the large auxiliary box (Figure __). The wiring diagram is illustrated on Figure __. Three wires (red, black and green) from the extension cable connect the terminal block of the auxiliary box (Figure __) with the B10 Fanout board of the instrumentation box (Figure 6). The three wires are passed through a ¾-inch PVV conduit between the auxiliary box and the instrumentation box (Figure __).

Table 4: Auxiliary Sensors and Terminal Box

Terminal Box	Wire color between Auxiliary sensor and the terminal block	Wire color between Terminal block and instrumentation box	Wire Number	Purpose
3	Red	Red	7	12V+
3	Black	Black	6	GND
3	Green	Green	8	Signal

ORP Probe

The mounting of the ORP probe is documented in Section 2.2.1.3.2.2 and illustrated on Figure __. A BNC connector is located at the terminal end of the ORP probe. The BNC connector from the probe connects to the BNC connector located on the terminal block within auxiliary box (Figure __). A ORP extension cable connects with the BNC on the terminal block of the auxiliary box (Figure __) and the B10 fanout board of the instrumentation box (Figure 6). The extension cable is passed through a ¾-inch PVC conduit between the auxiliary and instrumentation boxes (Figure __).

2.3 Monitoring Well Configurations

Reserved

2.3.1 Mounting the System

Reserved

2.3.1.1 Mounting of Instrumentation Box

Reserved

2.3.1.2 Mounting of Solar Panel

Reserved

2.3.1.3 Mounting of Sensor and Anode/Reference Array

Reserved

3.0 SYSTEM OPERATION

3.1 Power On

A two-conductor connects to the power connector on the B10 Board (Figures 7A and 7B). After the coaxial power cable is connected, the power switch is placed into the ON position. A green LED (modem is active) located in the center of the board will light.

3.2 Send Signal

A signal can be manually sent by depressing the yellow button located on the B10 board (Figure 4). After the button is depressed, a green LED light indicating the data is being acquired and transmitted to the cellular network.

After the green light terminates, the red light will begin to blink. The pattern of the blinking indicates the status of the cellular transmission (Table 7).

Table 4 : B10 Transmission Status

Number of Flashes	Interpretation	Response

Based on the information, provided on Table 5, a blinking pattern of 1 flash is the only acceptable pattern for a successful transmission.

3.3 Initial Measurements

After the initial installation of the system, the following measurements should be performed to determine if the system is working.

3.3.1 Power Supply: Confirmation of Operation

A Fluke meter (or equivalent) is used confirm the power supply is properly connected and has available voltage to power the system (Figure __). The measurement of the voltage is dependent on the type of instrumentation box:

Instrumentation Box (Series 100)

Series 100 is the solar power configuration (Figures 2 and Figure 33A). The configuration has two coaxial cables (solar and battery/power) used to supply the MPS system power (Figure __). The measurement of voltage of terminal ends of the two coaxial cables is required to ensure the system is adequately powered.

Battery/Power Cable: The power/battery cable is detached from the coaxial connector located on the B10 board and the leads of the Fluke Meter are used to measure the battery voltage. The red lead (+) is positioned inside the coaxial fitting and the black lead (-) is positioned on the outside conductor (Figure 33B). The voltage should be above 13 volts. Record the voltage on sheet included as Appendix __.

Solar Cable: The solar panel should be faced toward the sun. The solar cable is detached from the coaxial connector located on the B10 board and the leads of the Fluke Meter are used to measure the solar cell voltage (Figure 33A). The red lead (+) is positioned inside the coaxial fitting and the black lead (-) is positioned on the outside conductor. The voltage should be above 18 volts. Record the voltage on sheet included as Appendix __.

Instrumentation Box (Series 200)

Series 200 is the 12-volt power supply configuration (Figures 2). The configuration has one coaxial cables (power) used to supply the MPS system power (Figure __). The measurement of voltage of terminal end of the coaxial cables is required to ensure the system is adequately powered.

Power Cable: The battery cable is detached from the coaxial connector located on the B10 board and the leads of the Fluke Meter are used to measure the battery voltage. The red lead (+) is positioned inside the coaxial fitting and the black lead (-) is positioned on the outside conductor. The voltage should be above 12 volts (Figure 33C). Record the voltage on sheet included as Appendix __.

The initial voltage should be above 12 volts. The voltage can be recorded in the chart attached as Appendix E.

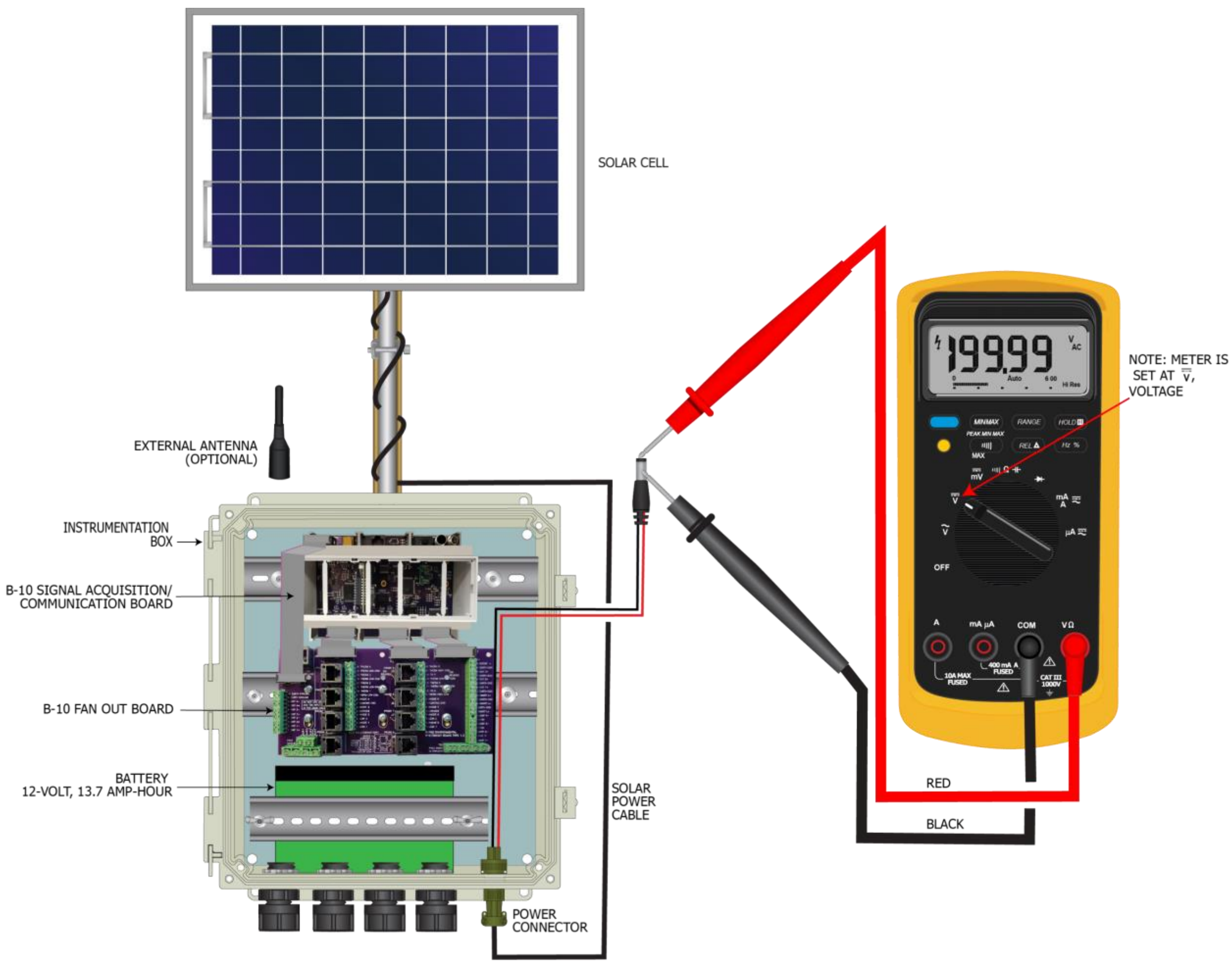


Figure 33A: Measurement of the voltage from the solar cell

Figure 33B: Measurment of the voltage from the battery

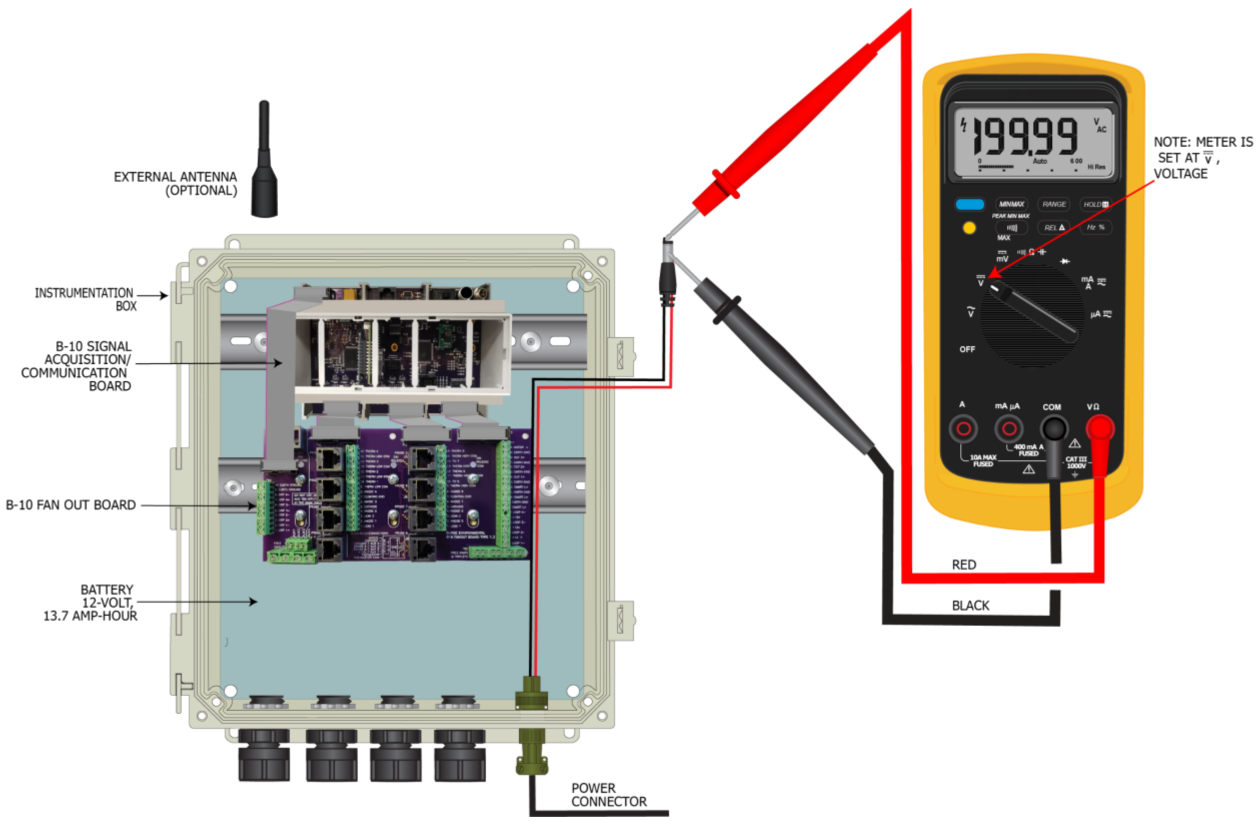


Figure 33C: Measurment of the voltage from 12-volt power supply

Figure 33: Measurement of Power Supply: Voltage

3.3.2 Microbial Sensor: Confirmation of Operation

A Fluke meter (or equivalent) should be used to confirm if microbial signals are being transmitted to the B10 fanout board located in the instrumentation box. The Fluke meter must be set at measuring voltage and the voltages measured between the reference terminal (Cathode) and each of the eight microbial sensor (Anode 1 through Anode 8) terminals (Figure 34). The data can be recorded in the chart attached as Appendix E.

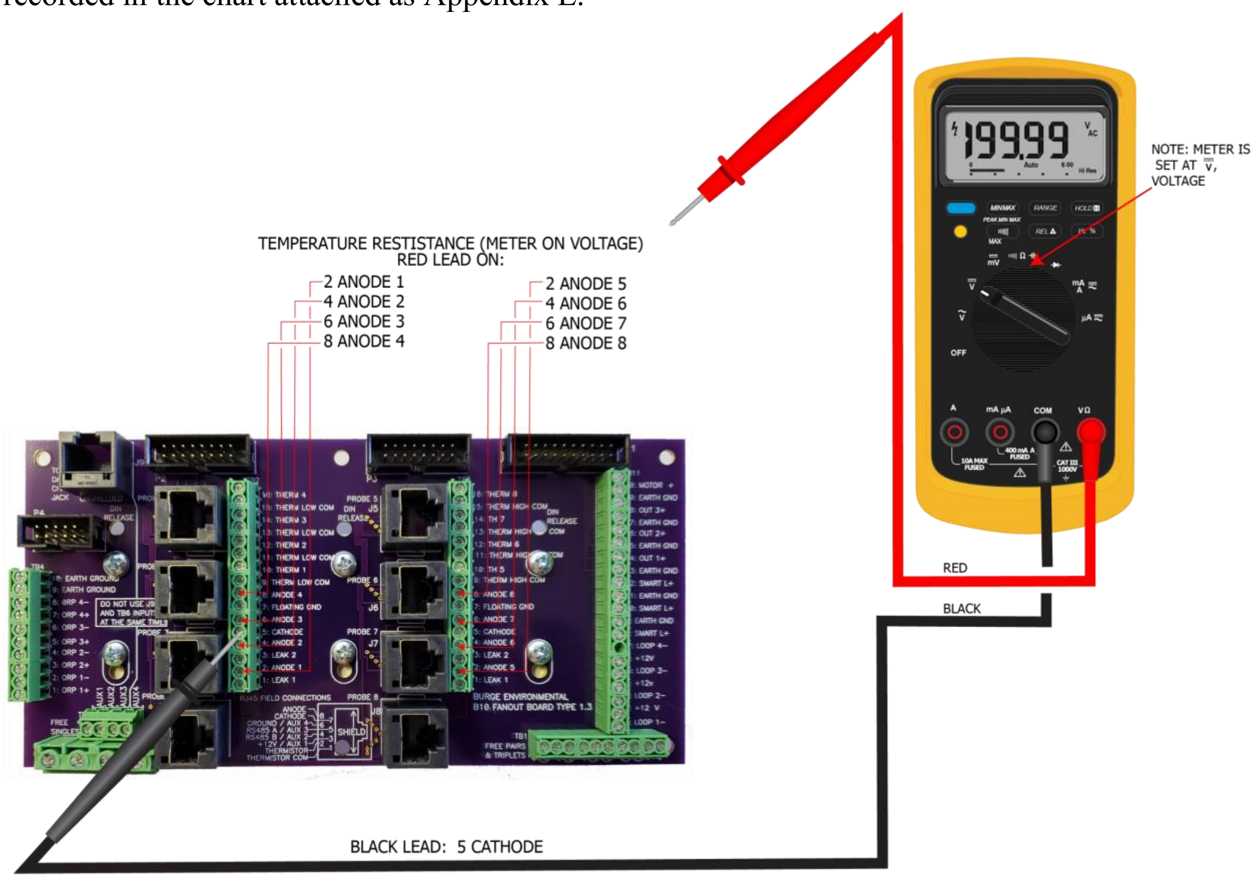


Figure 34: Measurement of Microbial Sensor: Voltage

3.3.3 Reference: Confirmation of Operation

The reference cable has a BNC connector. The outside conductor of the BNC connector is the reference signal. A Fluke meter or equivalent should be set to measure the voltage between reference and each of the MPSs (Anode 1 through Anode 8) (Figure __). The data may be recorded on the data sheet attached as Appendix E.

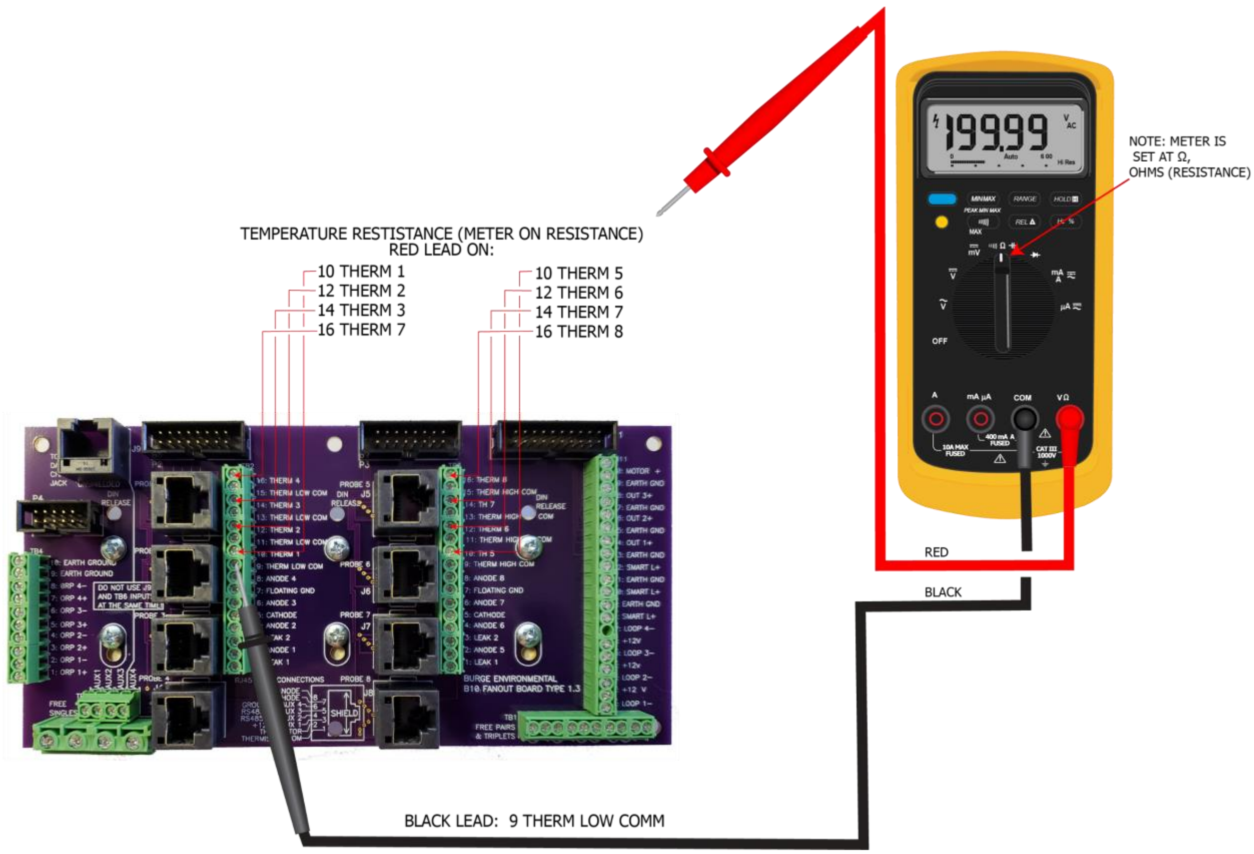


Figure 35: Measurement of Thermistors: Resistance

3.3.4 Temperature of Microbial Sensors

A Fluke meter (or equivalent) should be used to confirm if temperature (thermistor) are being transmitted to the B10 fanout board located in the instrumentation box. The Fluke meter must be set at measuring resistance (ohms) and the resistance measured between the thermistor common and each of the eight thermistors (Tem1 through Tem8) terminals (Figure 35). The resistance reading should be 10K ohms ± 2K ohms. The data can be recorded in the chart attached as Appendix E.

3.3.5 Leak Detection of Microbial Sensors

It is recommended that at the initial installation of the system and periodically after the installation that the microbial sensors be checked to determine if water is within the MPS probe. Water located within the MPS probe compromises the operation of the probe. The instrumentation box is opened and the leads of the Fluke meter or equivalent measure the resistance between the MPSs (Anode 1 through Anode 8) and the corresponding thermistor lead for the thermistor located within the probe (Figure __). *Note: Fluke meter must be set to resistance (ohms)*. The resistance should be infinite or out of limit. The data may be recorded on the data sheet attached as Appendix E.

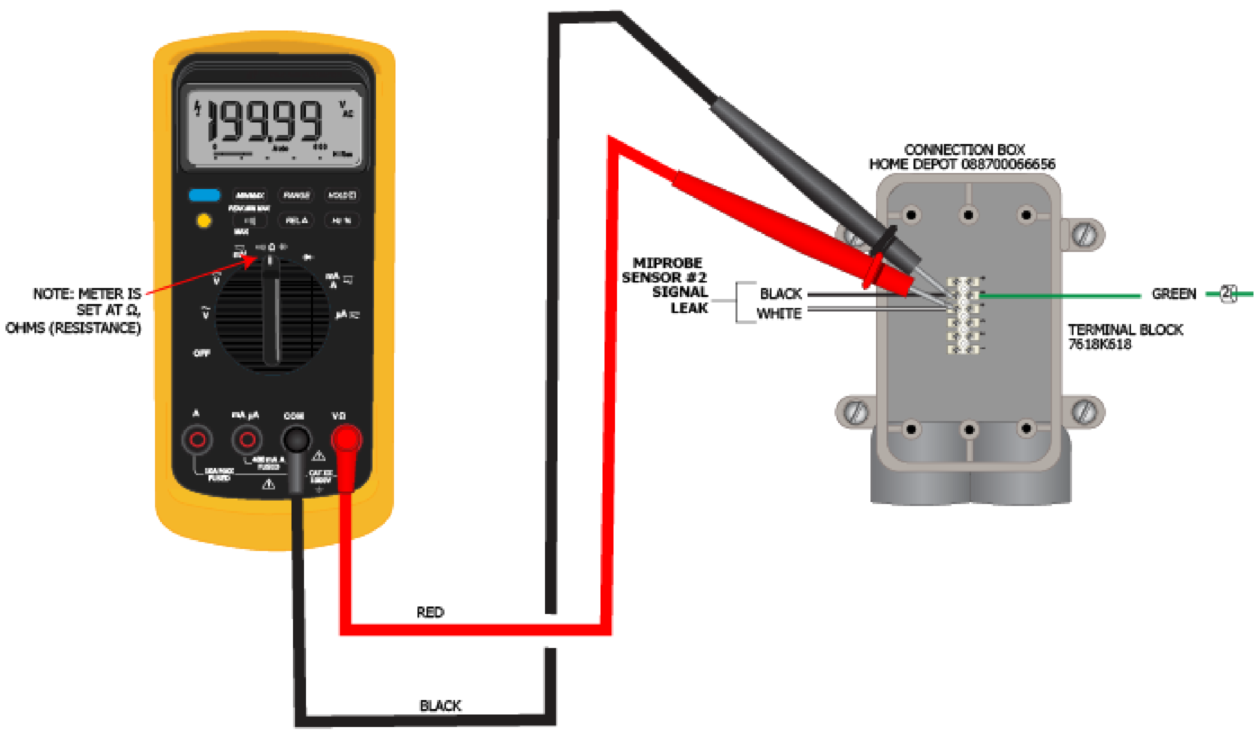


Figure 36: Measurement of Microbial Sensor Leaks: Resistance

4.0 TROUBLESHOOTING

Reserved

Appendix A

M*i*ProbE Sentry Operating Specifications:	
Power	0.06 watts (Typical) 1.8 watts (Transmitting)
Dimensions	4” x 8” x 8” Controller Housing
Temperature	32° F - 149° F (Internal)
Humidity	1% - 99% Non-condensing

Sensor Configurations:	
MiProbE Sensors	1 to 8
Temperature	1 to 8
Optional Potentiometric Sensors	1 to 3
Optional 4-20mA Sensors	1 to 3

Optional Components:	
Solar Panel	12V 270mA Output
Lithium Ion Battery	12.8V 6.4Ahr

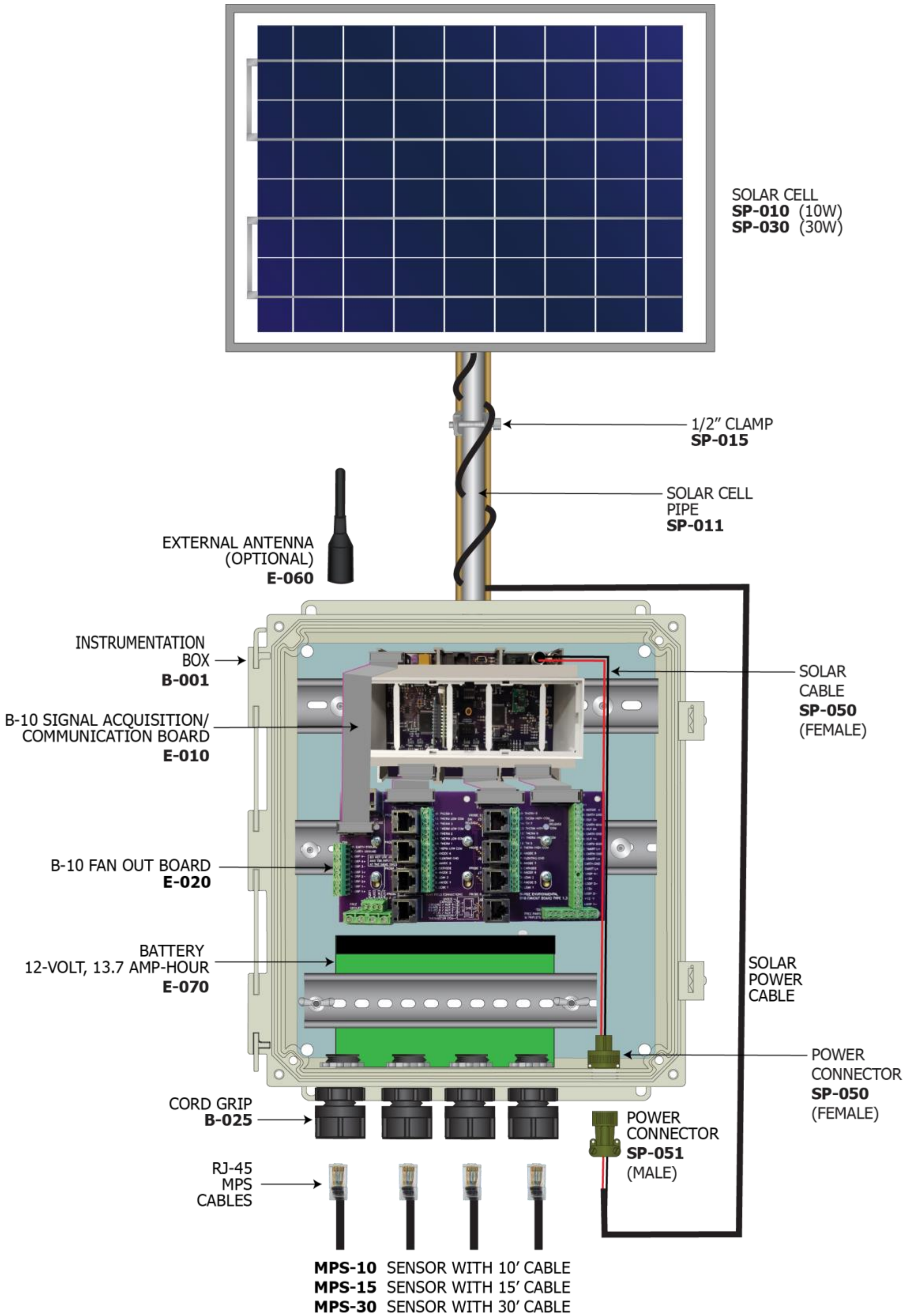
:	
Basic Internet Access and Web Browser	

Appendix B

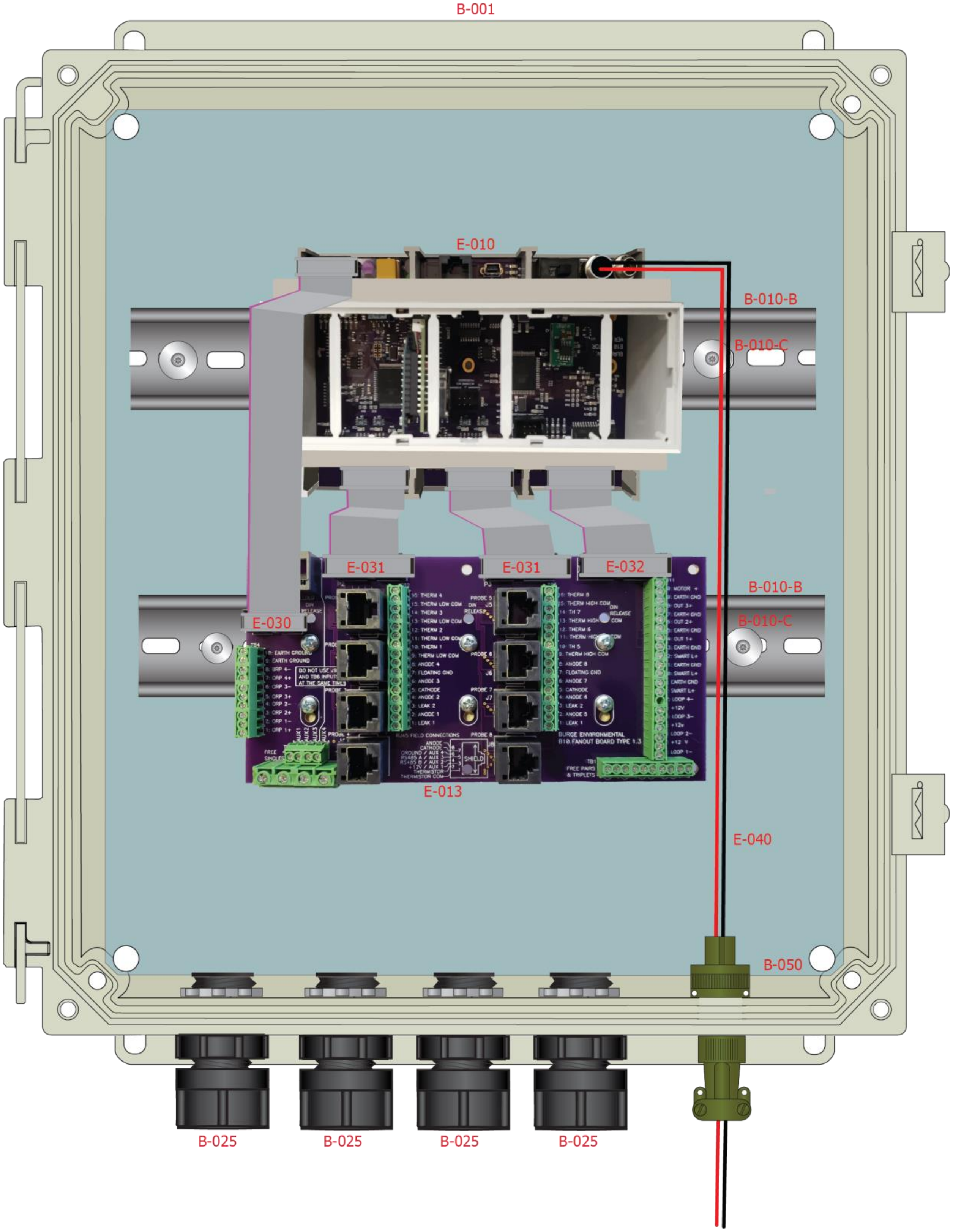
Parts List

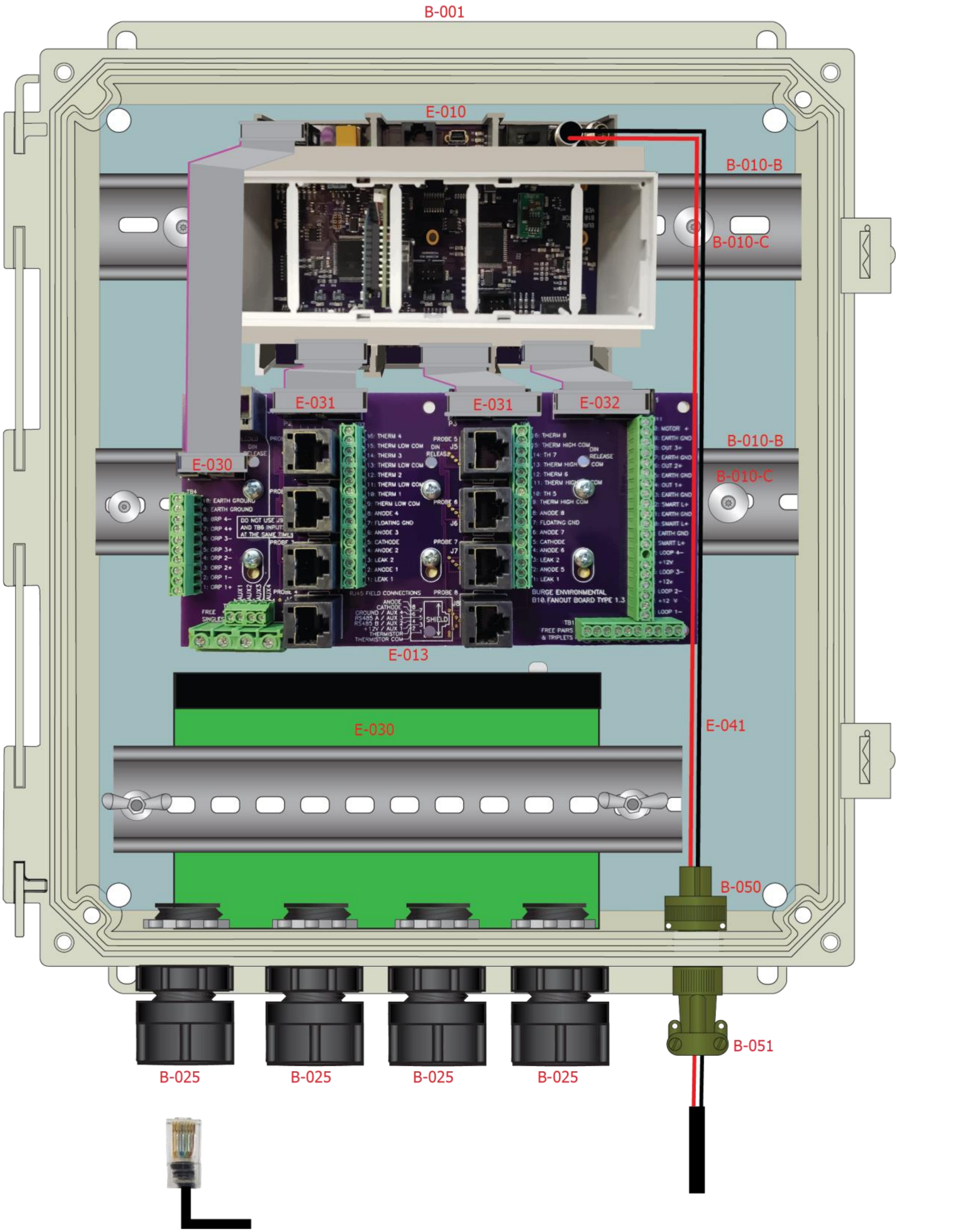
This section will illustrate the main subassemblies of the MiProbe and the locations of the parts located within the subassemblies.

Series 100: Instrumentation Box

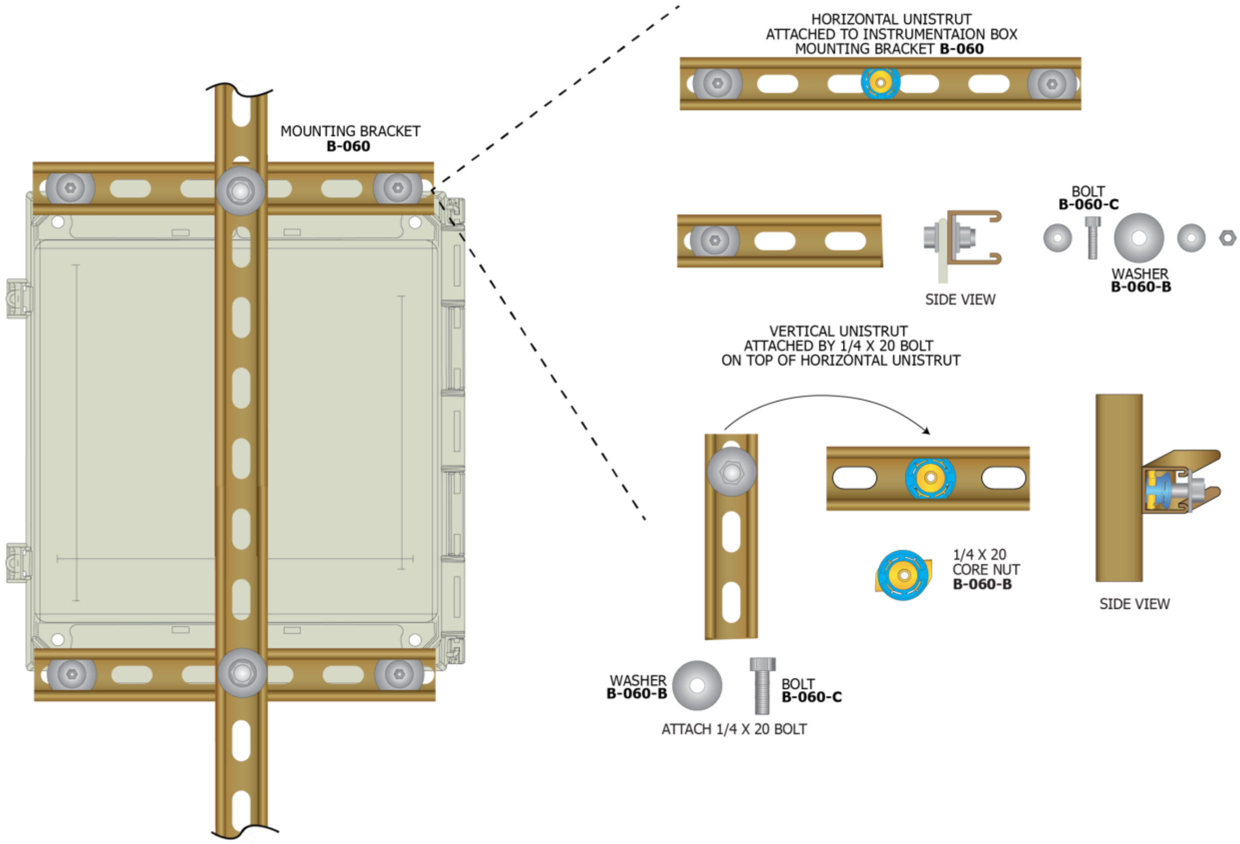


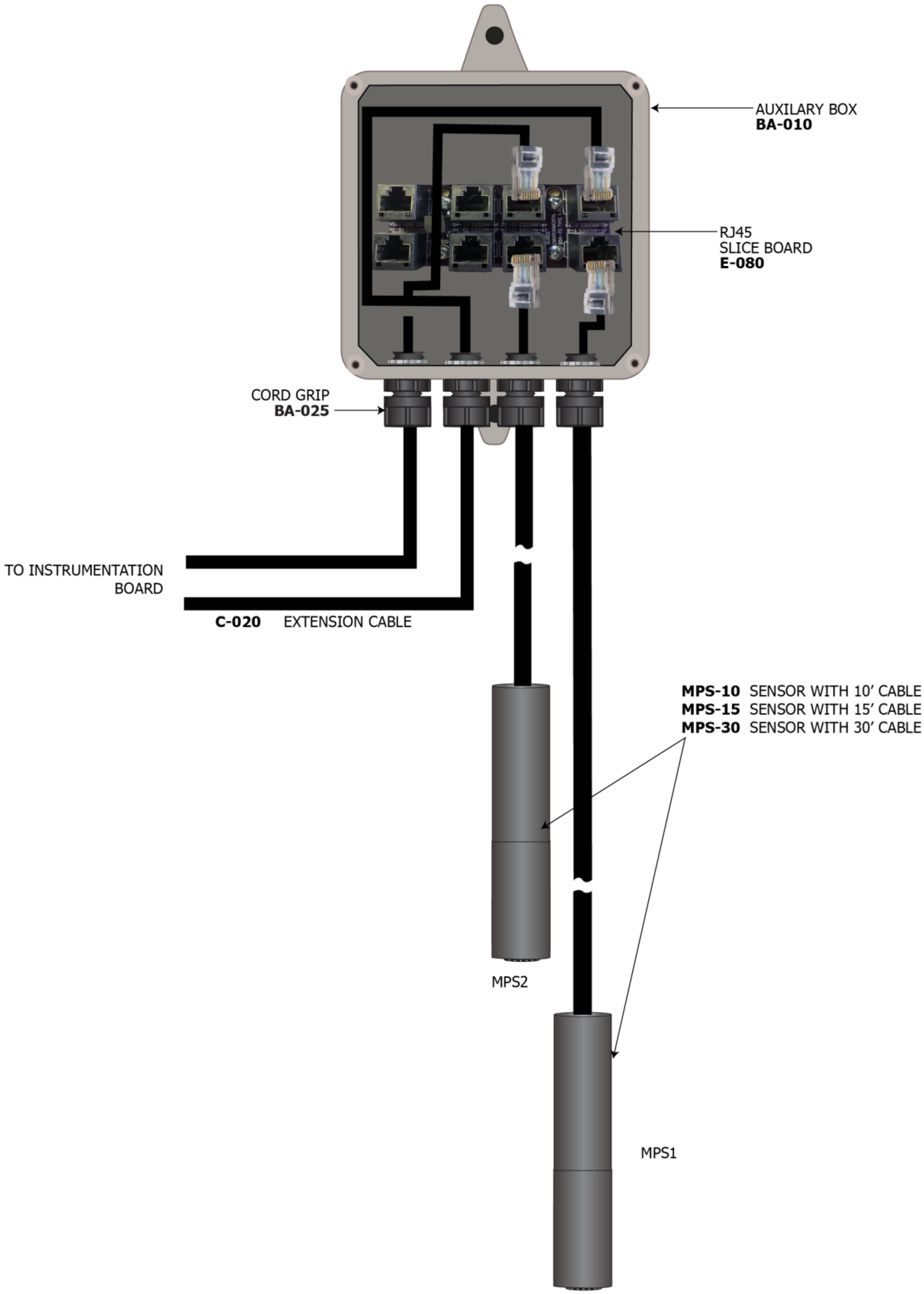
SOLAR CELL
SP-010 (10W)
SP-030 (30W)
1/2" CLAMP
SP-015
SOLAR CELL
PIPE
SP-011
EXTERNAL ANTENNA
(OPTIONAL)
E-060
INSTRUMENTATION
BOX
B-001
B-10 SIGNAL ACQUISITION/
COMMUNICATION BOARD
E-010
SOLAR
CABLE
SP-050
(FEMALE)
B-10 FAN OUT BOARD
E-020
BATTERY
12-VOLT, 13.7 AMP-HOUR
E-070
SOLAR
POWER
CABLE
POWER
CONNECTOR
SP-050
(FEMALE)
CORD GRIP
B-025
POWER
CONNECTOR
SP-051
(MALE)
RJ-45
MPS
CABLES
MPS-10 SENSOR WITH 10' CABLE
MPS-15 SENSOR WITH 15' CABLE
MPS-30 SENSOR WITH 30' CABLE

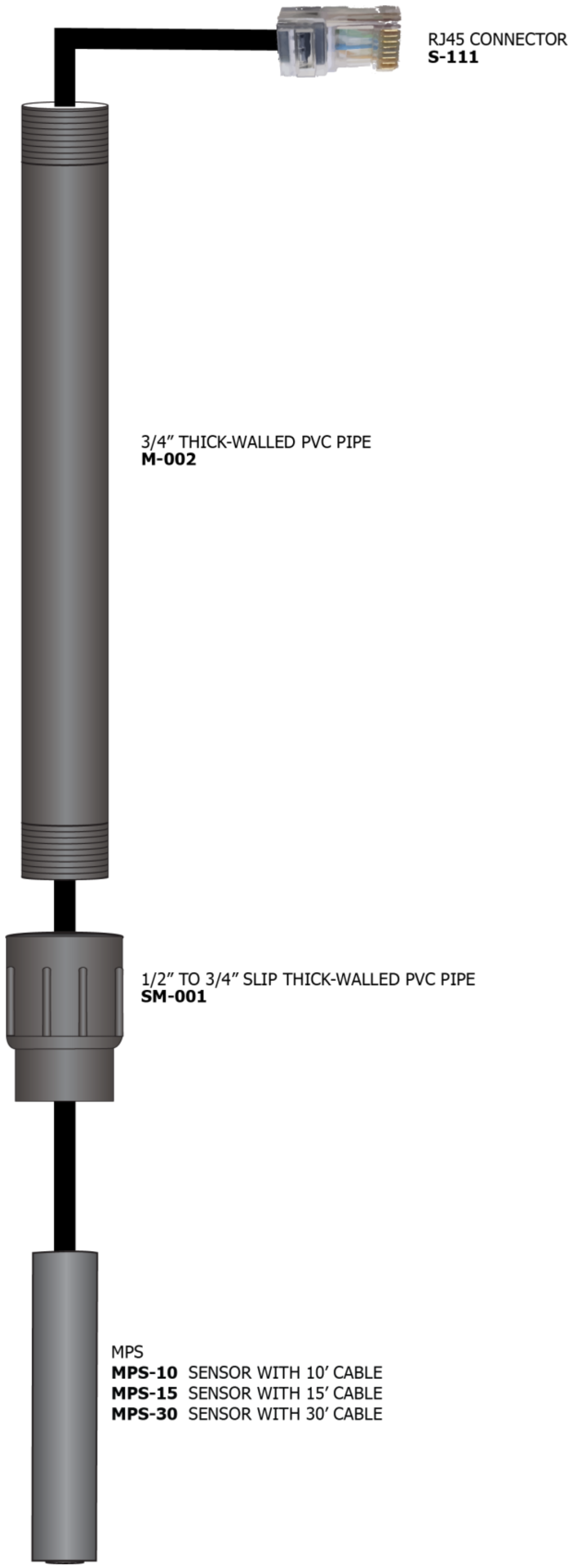

B-001
E-010
B-010-B
B-010-C
E-031
E-031
E-032
B-010-B
E-030
B-010-C
E-013
E-040
B-050
B-025
B-025
B-025
B-025

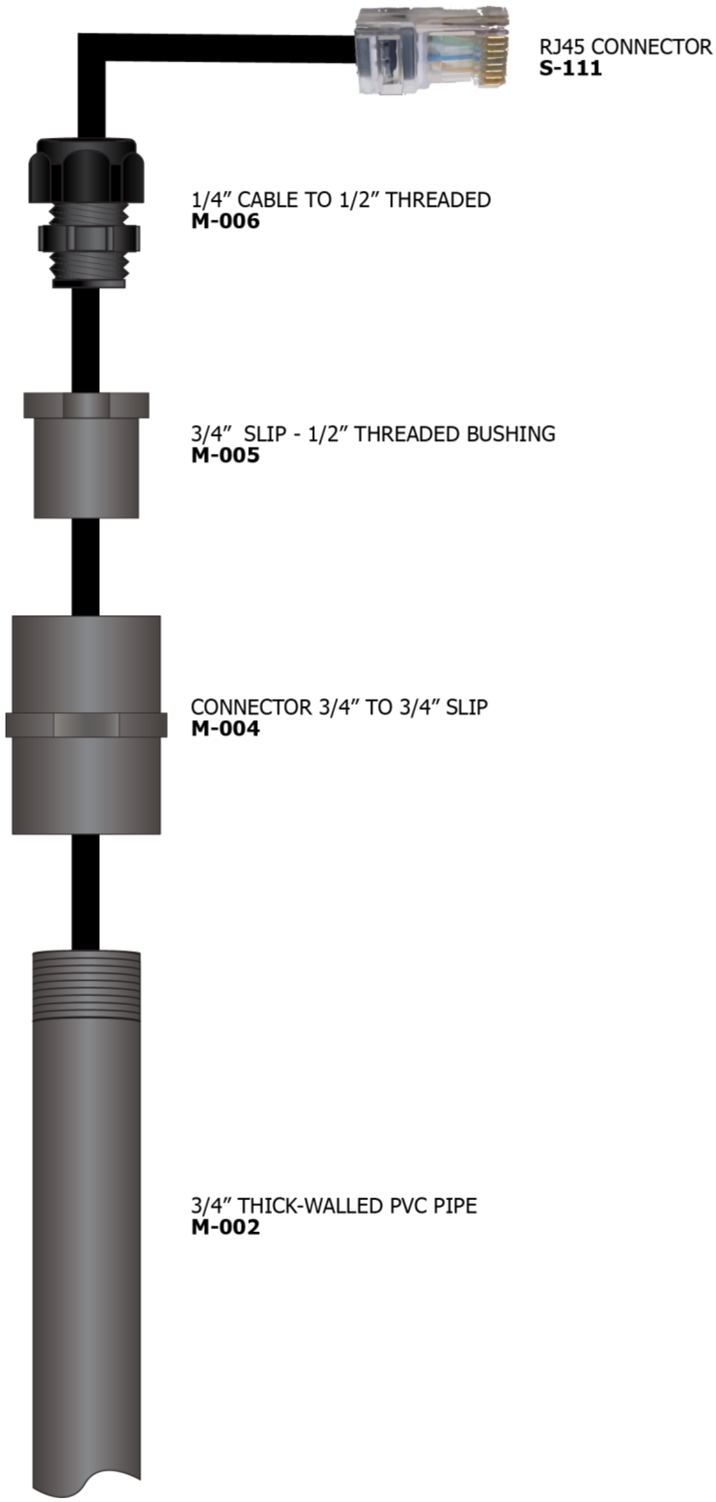


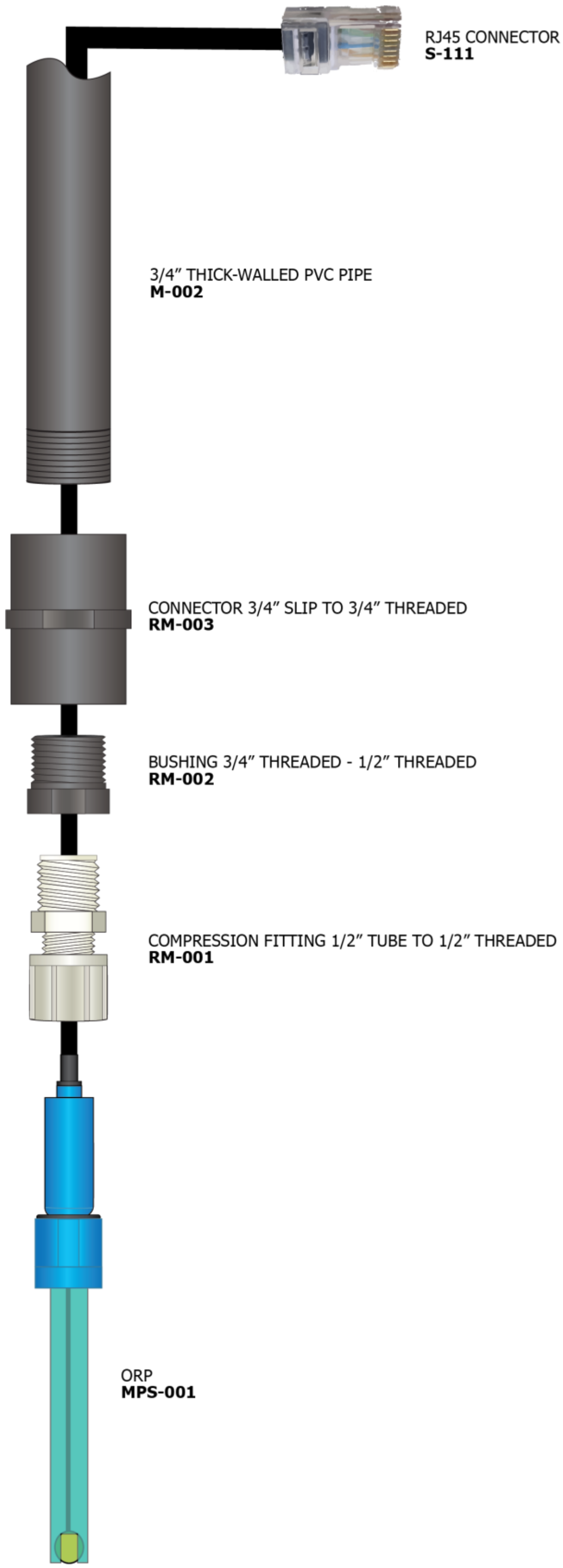
B-001
E-010
B-010-B
B-010-C
E-031
E-031
E-032
E-030
B-010-B
B-010-C
E-013
E-030
E-041
B-050
B-051
B-025
B-025
B-025
B-025

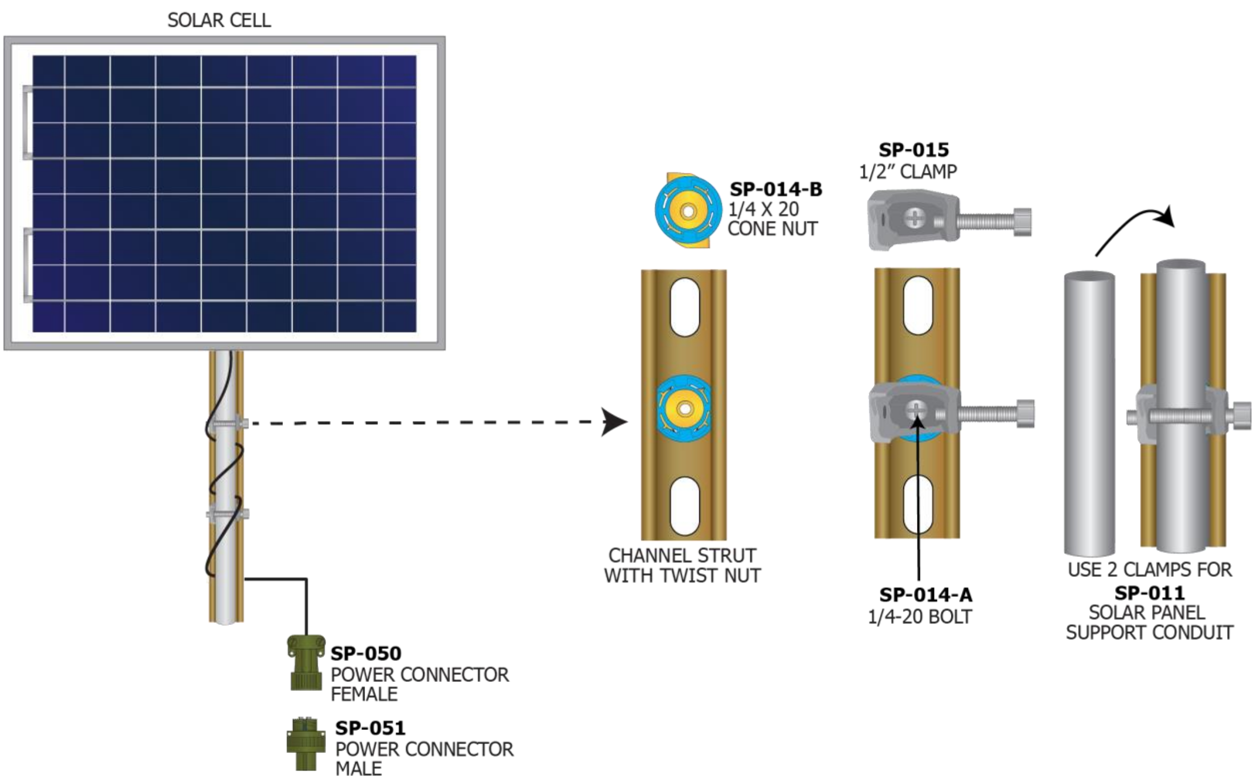

MOUNTING BRACKET
B-060
HORIZONTAL UNISTRUT
ATTACHED TO INSTRUMENTAION BOX
MOUNTING BRACKET B-060
SIDE VIEW
BOLT
B-060-C
WASHER
B-060-B
VERTICAL UNISTRUT
ATTACHED BY 1/4 X 20 BOLT
ON TOP OF HORIZONTAL UNISTRUT
1/4 X 20
CORE NUT
B-060-B
SIDE VIEW
WASHER
B-060-B
BOLT
B-060-C
ATTACH 1/4 X 20 BOLT

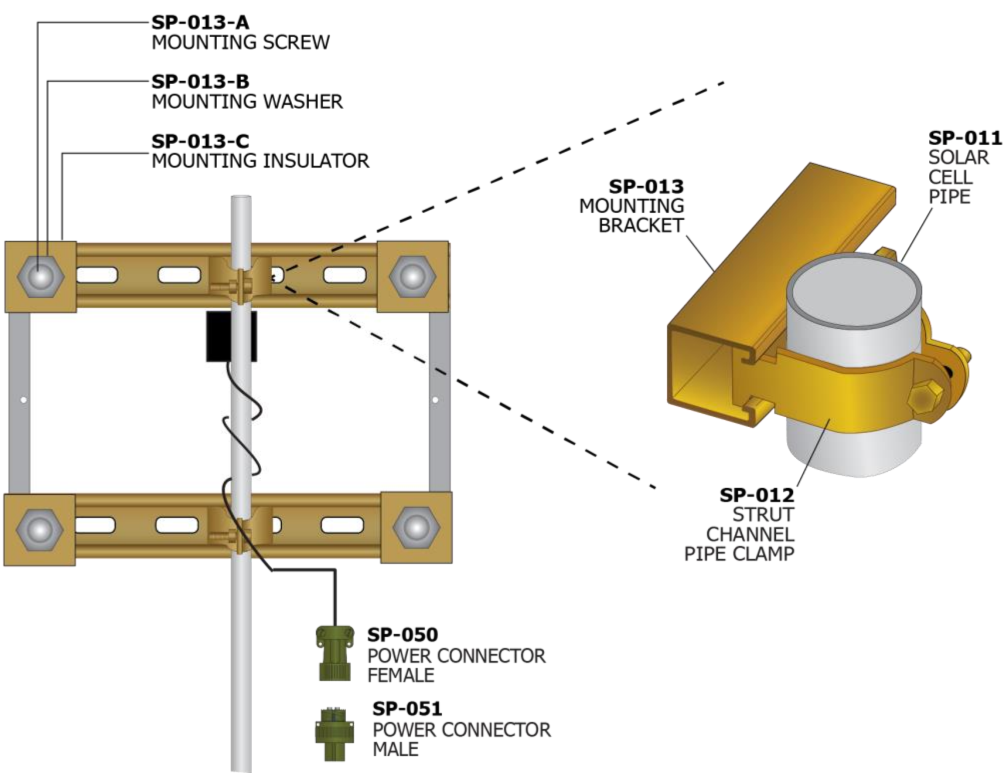

AUXILARY BOX
BA-010
RJ45
SLICE BOARD
E-080
CORD GRIP
BA-025
TO INSTRUMENTATION
BOARD
C-020 EXTENSION CABLE
MPS-10 SENSOR WITH 10' CABLE
MPS-15 SENSOR WITH 15' CABLE
MPS-30 SENSOR WITH 30' CABLE
MPS2
MPS1

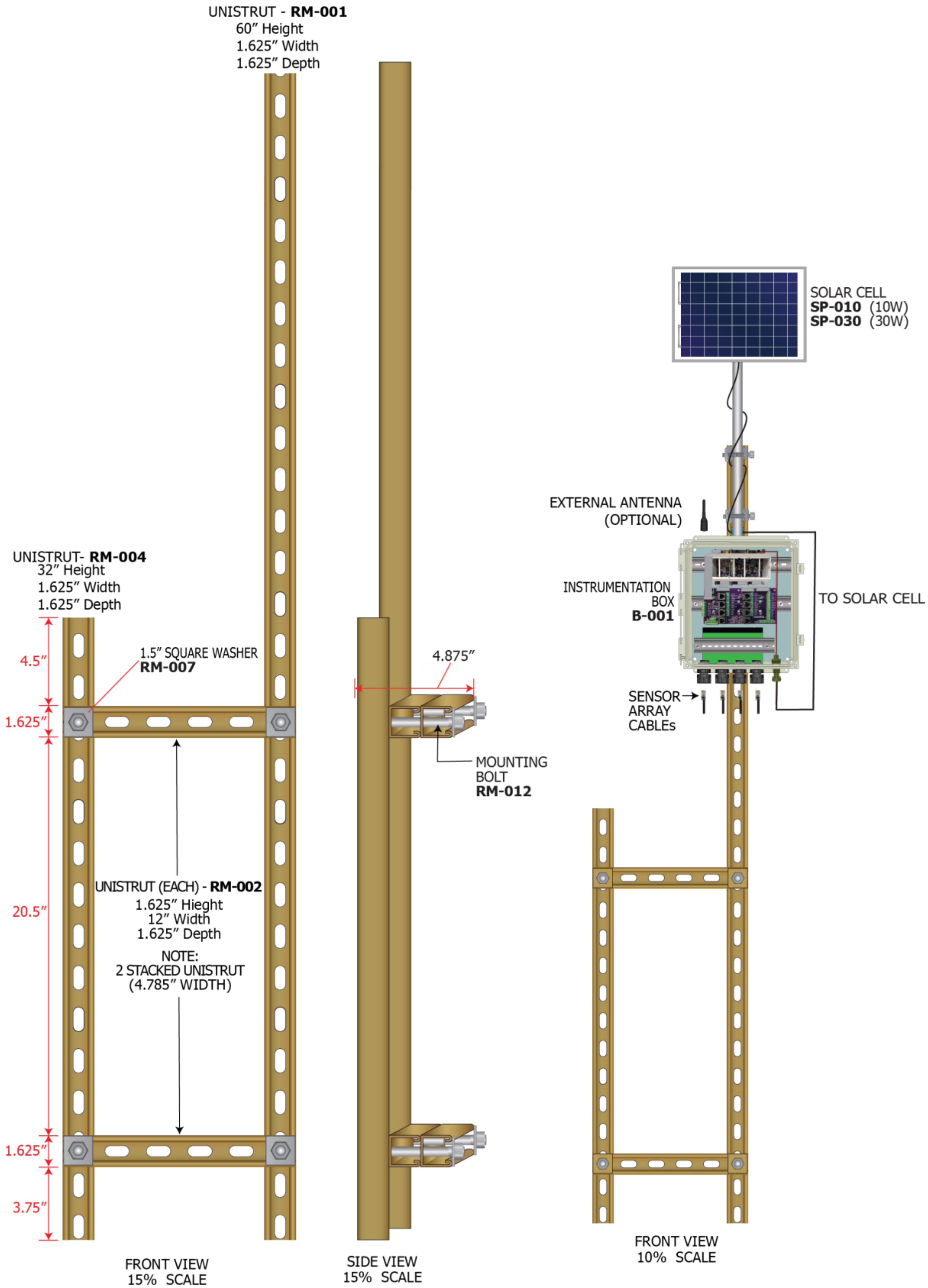

RJ45 CONNECTOR
S-111
3/4" THICK-WALLED PVC PIPE
M-002
1/2" TO 3/4" SLIP THICK-WALLED PVC PIPE
SM-001
MPS
MPS-10 SENSOR WITH 10' CABLE
MPS-15 SENSOR WITH 15' CABLE
MPS-30 SENSOR WITH 30' CABLE

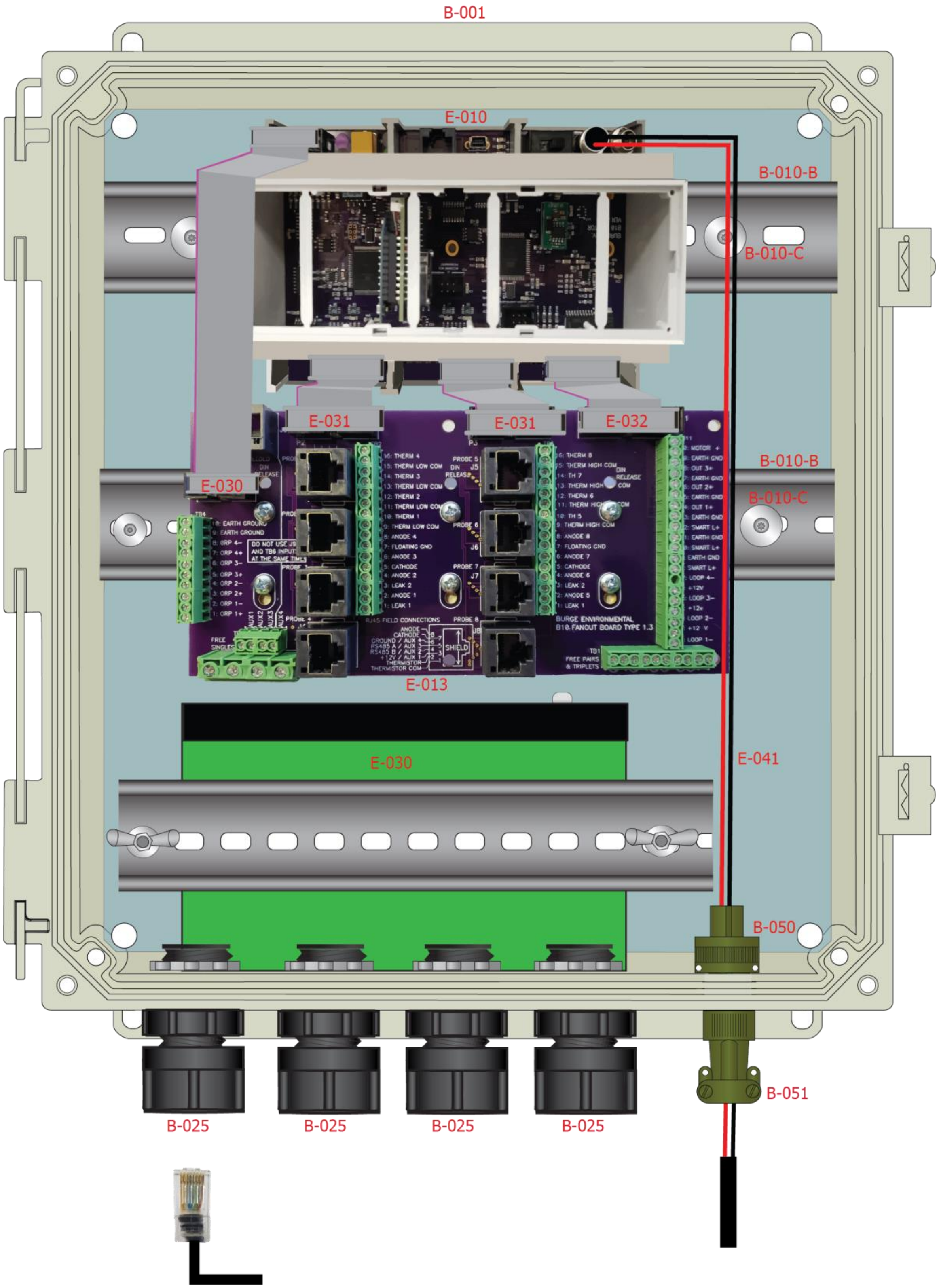

RJ45 CONNECTOR
S-111
1/4" CABLE TO 1/2" THREADED
M-006
3/4" SLIP - 1/2" THREADED BUSHING
M-005
CONNECTOR 3/4" TO 3/4" SLIP
M-004
3/4" THICK-WALLED PVC PIPE
M-002


RJ45 CONNECTOR
S-111
3/4" THICK-WALLED PVC PIPE
M-002
CONNECTOR 3/4" SLIP TO 3/4" THREADED
RM-003
BUSHING 3/4" THREADED - 1/2" THREADED
RM-002
COMPRESSION FITTING 1/2" TUBE TO 1/2" THREADED
RM-001
ORP
MPS-001

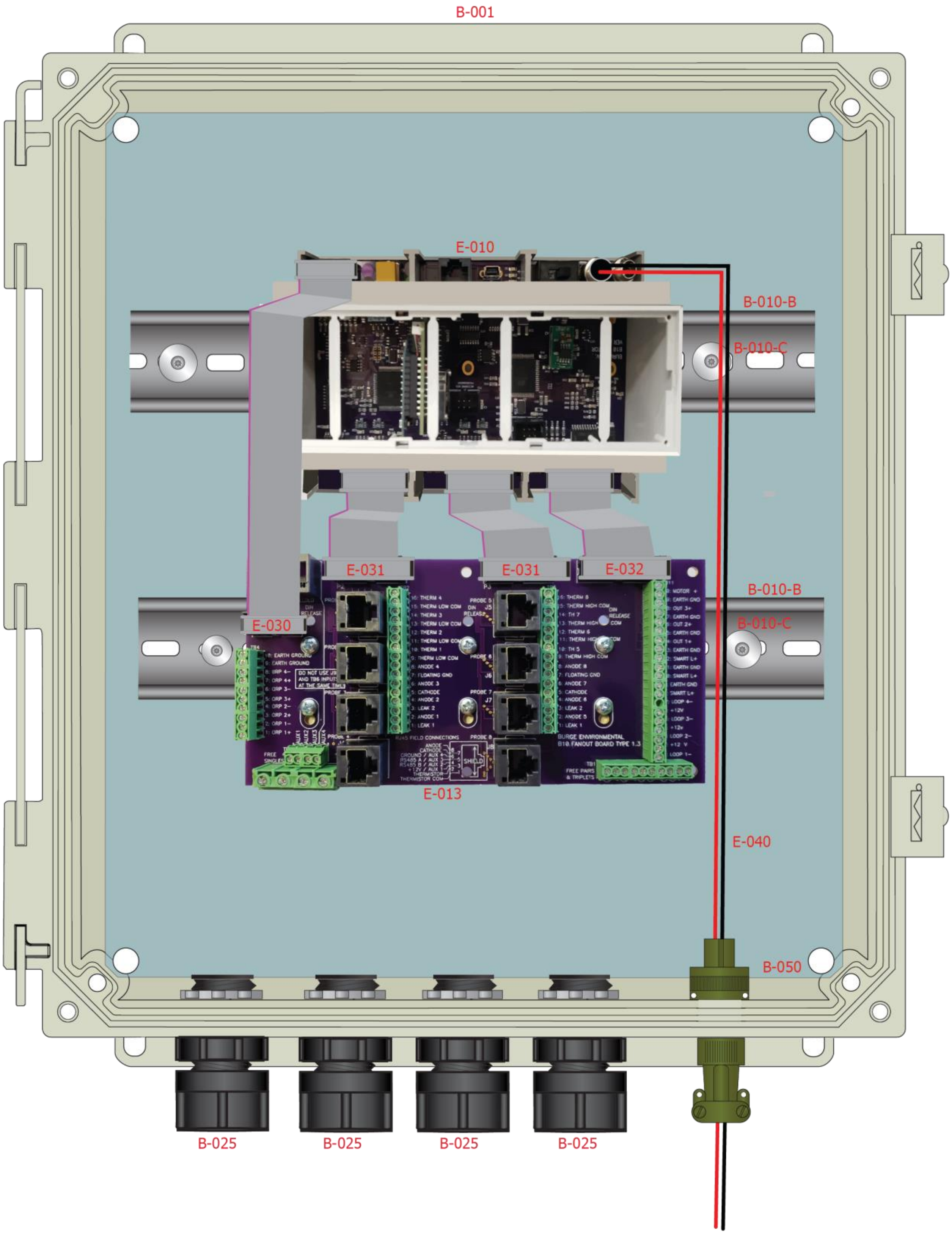

SOLAR CELL
SP-014-B
1/4 X 20
CONE NUT
SP-015
1/2" CLAMP
CHANNEL STRUT
WITH TWIST NUT
SP-014-A
1/4-20 BOLT
USE 2 CLAMPS FOR
SP-011
SOLAR PANEL
SUPPORT CONDUIT
SP-050
POWER CONNECTOR
FEMALE
SP-051
POWER CONNECTOR
MALE


SP-013-A
MOUNTING SCREW
SP-013-B
MOUNTING WASHER
SP-013-C
MOUNTING INSULATOR
SP-013
MOUNTING
BRACKET
SP-011
SOLAR
CELL
PIPE
SP-012
STRUT
CHANNEL
PIPE CLAMP
SP-050
POWER CONNECTOR
FEMALE
SP-051
POWER CONNECTOR
MALE


UNISTRUT - **RM-001**
60" Height
1.625" Width
1.625" Depth
UNISTRUT- **RM-004**
32" Height
1.625" Width
1.625" Depth
4.5"
1.625"
20.5"
1.625"
3.75"
1.5" SQUARE WASHER
RM-007
UNISTRUT (EACH) - **RM-002**
1.625" Hieght
12" Width
1.625" Depth
NOTE:
2 STACKED UNISTRUT
(4.785" WIDTH)
4.875"
MOUNTING
BOLT
RM-012
FRONT VIEW
15% SCALE
SIDE VIEW
15% SCALE
SOLAR CELL
SP-010 (10W)
SP-030 (30W)
EXTERNAL ANTENNA
(OPTIONAL)
INSTRUMENTATION
BOX
B-001
TO SOLAR CELL
SENSOR
ARRAY
CABLEs
FRONT VIEW
10% SCALE


B-001
E-010
B-010-B
B-010-C
E-031
E-031
E-032
E-030
B-010-B
B-010-C
E-013
E-030
E-041
B-050
B-051
B-025
B-025
B-025
B-025

Series 200: Instrumentation Box


B-001
E-010
B-010-B
B-010-C
E-031
E-031
E-032
B-010-B
E-030
B-010-C
E-013
E-040
B-050
B-025
B-025
B-025
B-025

Appendix C

Tool List

1. Fluke Meter
2. Small Flathead screw driver
3. Small Phillips head screw driver
4. ¾-inch wrench
5. 7/16-inch wrench
6. 7/16-inch nut driver
7. Wire strippers
8. Cable Puller
9. 1-Inch Hole Saw
10. 1-¾-Inch Hole Saw
11. Step drill
12. Channel locks
13. Needle nose pliers
14. Solder iron and solder
15. Hack saw
16. Hammer (for mounting stakes)

Material List

1. Tube of silicon rubber (aquarium sealant)
2. Fast-acting PVC (Blue) cement and primer
3. 1/8-inch and ¼-inch heat shrink tubing
4. Electrical wire numbering booklet
5. Heat shrink tubing
6. Wiring, 20 gauge
7. ½-inch PVC electrical conduit and fittings
8. ¾-inch PVC electrical conduit and fittings
9. Strut channel
10. Cable ties (small and large)
11. Coaxial cable

Appendix D

Underground System • Material List

Assembly	Part name	Number	Part Number	Supplier	Cost/each
Connector Box #1					
	Small Box	1	088700066656	Home Depot	5.09
	45^0 sweeps	2	088700012684	Home Depot	0.64
	Terminal block, 5 position		7618K618	McMaster-Carr	2.60
	½-inch female slip to ½-inch female threaded	1	088700000049	Home Depot	0.30
	Cord Grip, .25-inch to ½-inch Pipe	1	7489K17	McMaster-Carr	6.87
Connector Box #1					
	Small Box	1	088700066656	Home Depot	5.09
	45^0 sweeps	2	088700012684	Home Depot	0.64
	Terminal block, 5 position			McMaster-Carr	
	½-inch female slip to ½-inch female threaded	1	088700000049	Home Depot	0.30
	Cord Grip, .25-inch to ½-inch Pipe	1	7489K17	McMaster-Carr	6.87
Connector Box #3					
	Large box			Home Depot	
	½-inch Liquidtite compression fitting	2	78621015079	Home Depot	2.21
	45^0 sweeps	2	088700012684	Home Depot	0.64

	½-inch female slip to ½-inch female threaded	2	088700000049	Home Depot	0.30
	Terminal Block, 10 position	1	7618K917	McMaster-Carr	3.31
	Cord Grip ,0.13--0.19-inch to ½-inch Pipe	1	7489K16	McMaster-Carr	6.87
	Cord Grip, 2-conductor, 0.25-inch to ½-inch pipe trade	1	7807K34	McMaster-Carr	4.33
	½-inch Heavy wall PVC pipe T	1	4596K32	McMaster-Carr	3.76
	½-inch socket female to male threaded, heavy wall PVC	1	4596K854	McMaster-Carr	2.44
	½-inch fully threaded, heavy wall gray	1	4882K113	McMaster-Carr	0.67

Appendix E

Initial Microbial System Measurements

Initial Voltage Measurements: Power Supply

Power Supply	Red Lead	Black Lead	Voltage Observed	

Initial Voltage Measurements: Microbial Sensors

Microbial Sensor	**Red Lead**	**Black Lead**	**Voltage Observed**	
1	Reference	Anode 1		
2	Reference	Anode 2		
3	Reference	Anode 3		
4	Reference	Anode 4		
5	Reference	Anode 5		
6	Reference	Anode 6		
7	Reference	Anode 7		
8	Reference	Anode 8		

Initial Resistance Measurements: Thermistors

Microbial Sensor	**Red Lead**	**Black Lead**	**Resistance Observed**	
1	Reference	Therm 1		
2	Reference	Therm 2		
3	Reference	Therm 3		
4	Reference	Therm 4		
5	Reference	Therm 5		
6	Reference	Therm 6		
7	Reference	Therm 7		
8	Reference	Therm 8		

Initial Resistance Measurements: Microbial Sensors

	Microbial Sensor	Black Lead	Red Lead	Resistance Observed
1				
2				
3				

Initial Resistance Measurements: Cathode

Instrumentation Box	Cathode	Black Lead	Red Lead	Resistance Observed