EmNet, LLC
121 S. Niles Ave., Suite 22,
South Bend, IN 46617
574.855.1012
www.emnet.net

DRAFT Release Oct 31, 2019
Service Manual

BLU-X Radar (Model B) Service Manual

1 Table of Contents

2 Legal Statements

2.1 FCC

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

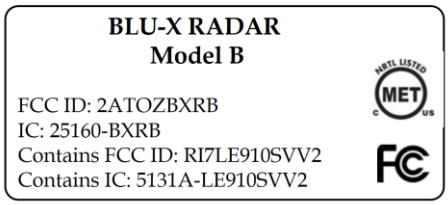
NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTE: This device complies with part 15 of the FCC rules: Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device. This device meets the FCC Radiofrequency Emission Guidelines and is certified with the FCC as:

FCC ID: 2ATOZBXRB

The FCC ID is located on the outside of the enclosure, closest to where the pulse generator and radiating antennas are located. The location of the label is as follows:

The label is as follows:



NOTE: This equipment may only be operated indoors. Operation outdoors is a violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties.

2.2 Antenna care/ unauthorized modifications

Use only the supplied integral radar antennas. Unauthorized antenna modifications or attachments could damage the unit and may violate FCC regulations. Only professional service personnel are authorized to open the enclosure.

2.3 ISED

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

The term “IC” before the equipment certification number only signifies that the Industry Canada specifications were met.

IC: 25160-BXRB

This Class A digital apparatus complies with Canadian ICES-003.

L'utilisation de ce dispositive est authorisée seulement aux conditions suivantes: (1) il ne doit pas produire de brouillage et (2) l'utilisateur du dispositif doit étre prêt à accepter tout brouillage radioélectrique reçu, meme si ce brouillage est susceptible de compromettre le fonctionnement du dispositif.

Le terme « IC » avant le numéro de certification de l'équipement signifie seulement que les spécifications d'Industrie Canada ont été respectées.

IC: 25160-BXRB

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

2.4 Responsible Party

(North America)
Emnet, LLC – a Xylem Brand
121 S. Niles Avenue
South Bend, IN 46617
USA
www.emnet.net

3 Overview

3.1 Guideline

This procedure and guide provides detailed instructions on how to service and install the BLU-X Radar device.

4 Training and Qualifications

4.1 Requirements

The skills required to complete this work are:

- Knowledge of electrical wiring and safety
- Minor hardware installation (bolts and nuts)

5 Related Documents

Reference Letter	Part Number	Description
Ref.A	Battery_cable_illustrated_drawing.pdf	Diagram for battery cable connector
Ref.B	Chasqui_radar_connection_illustrated_drawing.pdf	Diagram for Telecom Board radar connector

6 Safety

There are some potential hazards which could damage equipment or cause risk of injury

- Static discharge to electronic equipment
- Battery discharge and fire
- Pinching
- Working near a confined space

Do not service the device while the radar is operating. Disconnect the battery from the electronic circuitry when servicing equipment.

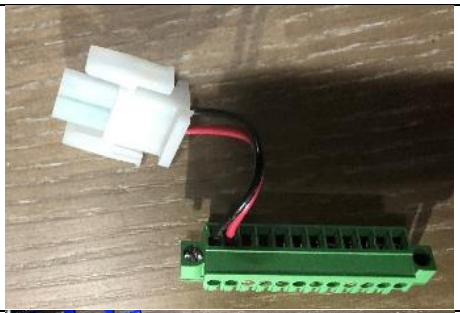
7 Tools and Consumables

Consumables		
Quantity	Part	Description

Tools		
Quantity	Part	Description

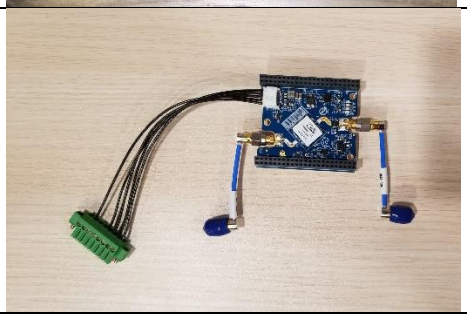
8 Assembly

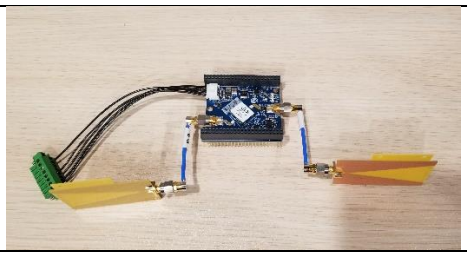
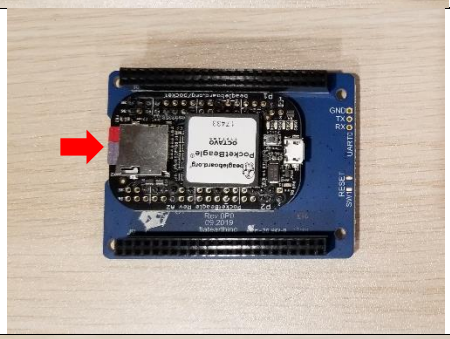
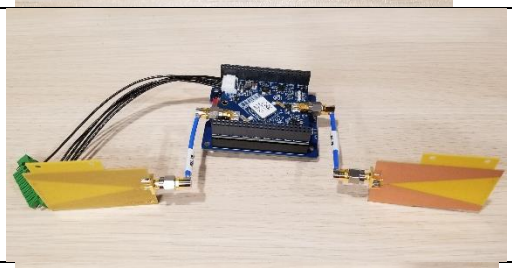
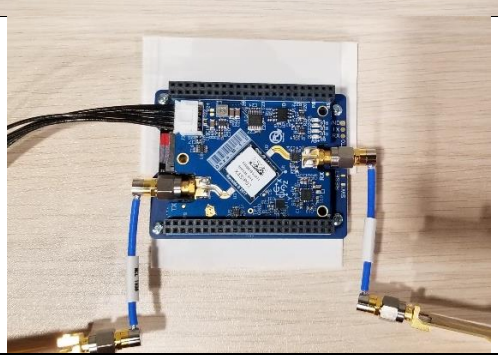
8.1 Connector wiring and assembly:

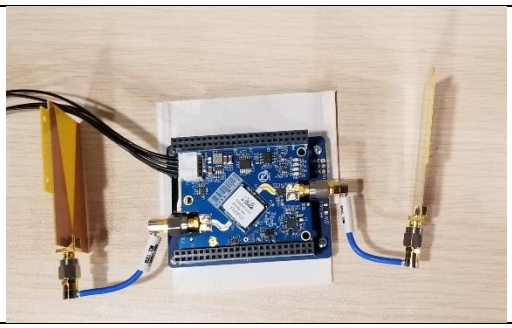
No.	Description	Illustration
	Obtain one Molex connector, contacts, and insulated wiring, then assemble connector, contacts and wiring according to document *Ref.A*.	[no image]
	Connect positive (red) cable to position 11 and negative (black) cable to position 12 on 12-pin JST connector as shown at right. Screw down the terminals. This is the Telecommunications Board battery connector.	
	Obtain one 5-pin JST connector with pigtails and one 8-pin Telecommunications Board connector, then connect the stripped wires from the JST to the 8-pin Telecommunications Board connector according to according to document *Ref.B*. Screw down the terminals. This is the	

	Telecommunications Board radar connector.	

8.2 Assembly of radar sensor module:

No.	Description	Illustration
	Take out radar PCB and place on a clean low-static surface.	
	Attach radar antenna cables to the radar PCB using the ends with the straight connectors (not the right-angle connectors). Tighten the connector “finger tight” and then snug lightly using a small crescent wrench. Careful, as it is very easy to break the PCB traces.	
	Obtain previously assembled Telecommunications Board radar connector.	
	Insert connector housing into the radar PCB receptacle.	

	Attach the right-angle antenna cables to the radar antennas; tighten the connector “finger tight” and then snug lightly.	
	Remove microSD card from packaging. Program microSD using duplicator.	[no photo, see microSD programming document]
	Place compute board on the benchtop with the SD card slot facing left (pictured is a compute board and a microSD card)	
	Install pre-programmed micro-SD card into micro-SD slot on the Compute Board PCB.	
	Carefully seat Radar Board PCB cape onto Compute Board PCB, taking note of the correct orientation of the PCBs with respect to each other.	
	Attach the Compute Board and Radar Board assembly to the plastic carrier using four #4 thread forming screws.	

	Carefully bend the antenna cables so that they are in approximately the final installation position.	

Assembly of antenna and batteries in enclosure:

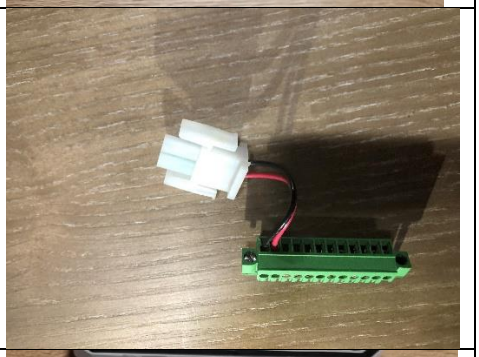
No.	Description	Illustration
	Obtain enclosure. Orient enclosure with hinge on right side. Do not remove clear protective film from outside of enclosure. Open enclosure face-up. Empty enclosure of any contents. Slide jig (shown in blue) into enclosure. The jig is a guide used to position the cellular antenna.	
	Remove cellular antenna from packaging and unbundle one length of cable to lengthen SMA cable by appx. 6 inches. Rebundle remaining cable with twisty-tie.	[need photo of antenna by itself]
	Peel backing from antenna bar and install cellular antenna against back plane of enclosure in the jig slot.	
	Remove jig. Antenna cable should remain bundled with a twisy-tie.	

	Chassis is composed of four parts: Battery chassis, Telecommunications chassis, and Radar Chassis (which itself is two parts: Left and Right Arms). Battery chassis is shown	
	Install battery chassis (over antenna), sliding down the rails on the side of the enclosure. Ensure that antenna is correctly positioned to pass cable through antenna cable management chamber before fully inserting the interposer.	
	Inspect the battery packs to make sure that there are no tabs extending outside the battery pack or other signs of non-uniformity. Place two (2) battery packs upside-down into the Bottom interposer, being careful to thread the wiring through the cable management channels. The indication that the battery pack is upside-down is that the cables for the pack will exit the pack at the bottom of the enclosure, not the top.	
	Install third pack and then connect the battery packs in parallel using the integrated battery connectors. Pack all but one of the cables into the battery cable management chamber.	
	Gather Telemetry Chassis and Left and Right arms of the Radar Chassis	

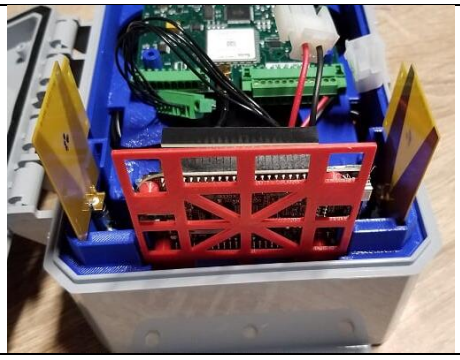
	Slide Telemetry Chassis onto Left and Right arms of the Radar Chassis	
	Slide the Telemetry and Radar assembly into the enclosure using the rails on the side of the enclosure to hold the assembly in place.	
	Set the Telemetry Chassis down, being careful to pass both the free battery cable and the antenna cable up through the slots in the Chassis. Inspect the interface between the Telemetry Chassis and Battery Chassis. The seam between the two pieces should be flush.	

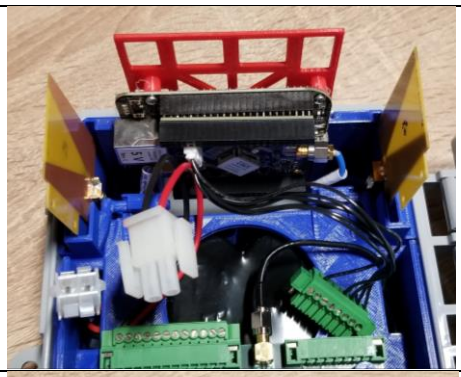
8.3 Installation of Telemetry unit (Telecommunications Board) in Enclosure :

No.	Description	Illustration
	Attach the Telecommunications Board to the top of the Top battery interposer, taking note to first place the edge of the board between the retaining clip and the shelf near the edge of the enclosure before sliding the two large holes in the board down the posts.	

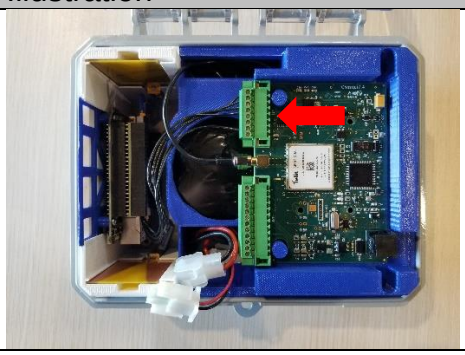
	Attach cellular antenna to Telecommunications Board.	
	Obtain the previously assembled 12-pin Telecommunications Board battery power connector.	
	Attach 12-pin terminal strip to Telecommunications Board. Do not screw in terminals	

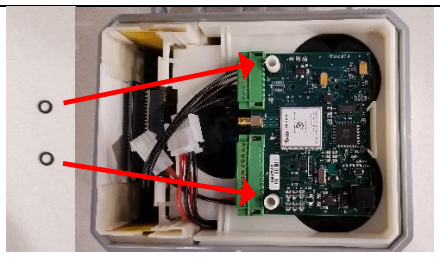
8.4 Installation of Radar Sensor Module into Chassis:

	Align radar carrier into sleeve on Radar Chassis, near enclosure wall. Position the antennas in the slots so they are ready to slide in.	

	Slide the carrier and electronics into the radar interposer, being careful to correctly position the radar antennas. Do not bend the antenna cables using tight radii; this could degrade performance of the cables.	
	Push the radar carrier and the antennas down together until antennas stop moving into unit (tip of radar antennas will be flush with top of chassis	
	Inspect radar antenna cables for issues then push the radar carrier down until it is flush with the radar chassis.	

8.5 Final assembly:

No.	Description	Illustration
	Connect the 8 pin connector to the Telecommunications Board. Do not screw in terminals.	

	Install two rubber o-rings on the posts to hold the Telecommunications Board in place	
	Lift the top piece and insert desiccant packets into antenna cable management area and into rear of enclosure, behind battery management area.	
	Orient enclosure and label on benchtop as shown. Remove any dust or debris from inside of enclosure lid.	
	Peel label from backing and attach to inside of enclosure lid using a tool such as squeegee. It is recommended that the label is applied as the backing is removed instead of removing the entire backing before adhering to lid. This reduces the formation of bubbles.	
	Tuck the power cables so that the enclosure can be shut. Close the lid of the enclosure and ensure that contents are correctly positioned, that clasp is latched and that seal is seated correctly. Do not remove the clear protective film from the outside of the enclosure.	
	Place Identification Label on the side of the enclosure.	

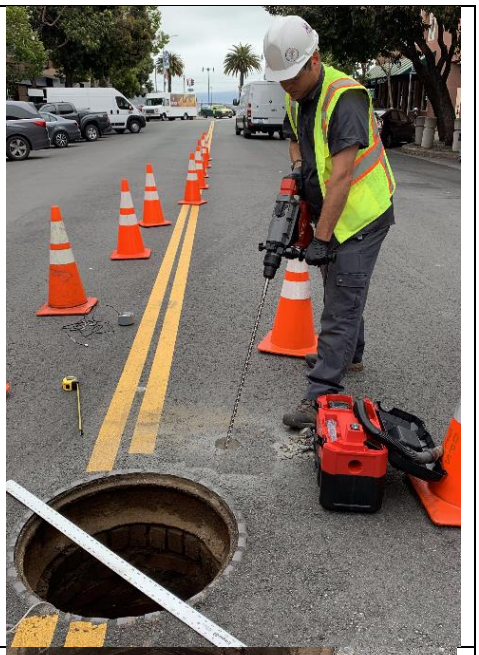
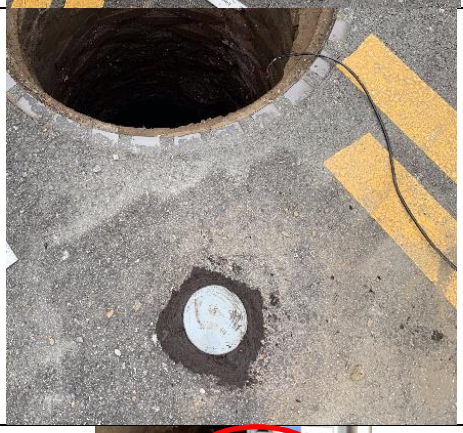
9 Site Installation

9.1 Site assessment

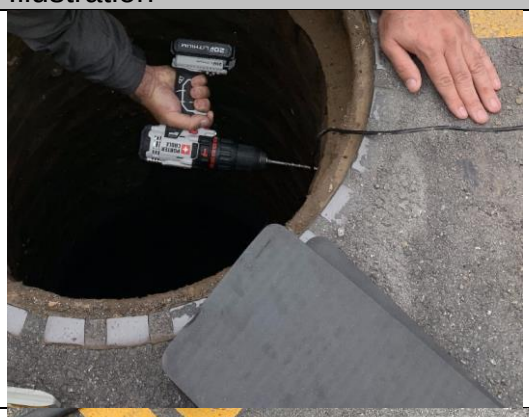
No.	Description	Illustration
	Monitoring site should have clear view of water surface between 2-30 feet from top of manhole. There should be no inflows at higher elevations that would cause cascading	
	There should be no inflows at higher elevations that would cause cascading.	

9.2 External Antenna Installation (Optional)

No.	Description	Illustration

	To install an external in-road antenna, first core into pavement and directional drill into the manhole casting to pass the antenna cable into the manhole.	
	Pass the antenna cable through the hole and epoxy the antenna into the pavement.	
	Connect the cable to the port on the BLU-X Radar unit.	

9.3 Support Bar Installation

No.	Description	Illustration
	To install the support bar, first drill holes for the first bracket.	
	Bolt first bracket into the side of the manhole.	
	Bolt second bracket directly across from the first and ensure the bar fits across the manhole properly.	

9.4 Radar mounting and Installation

No.	Description	Illustration

	Connect the radar support clamps to the support bar.	
	Slide pin on first bracket into the hole on the wider end of the support bar while support bar is at approximately 90 degrees to the horizontal.	

	Set the opposite, thinner side of the bar into the groove on the second bracket. Make adjustments as necessary to ensure box is level.	

10 Configuration

10.1 Parameter Adjustment

There are a number of parameters that are used to configure the radar for different site conditions. These are changed by editing a json configuration file located on the micro-SD card which is inserted in the Compute Board. At the time of writing, the parameters that the installer will need to update are:

- p-04: (0.0 to 20.0) Distance (in meters) to start measuring, referenced to the lid of the enclosure.
    - This value is distance offset. It is used to push out the start distance for the measurement range. This is useful for deep manholes where the 10 meter sampling range will not reach the invert of the manhole or the minimum expected dry weather level.
    - Note that increasing this value will increase the deadband by the same amount.
- p-06: (1.0 to 30.0) Total manhole height (in meters).
    - This is measured from the top of rim to the invert of the channel (farthest distance that is viewable from the manhole chimney).
    - If the manhole has a channel that is not centered then, for example, the distance to the invert of the channel should be provided even if it is not directly underneath the radar as long as it is viewable from the top of the manhole. The measurement should be reported as vertical,

which is most commonly perpendicular to the rim of the manhole. If it is measured at an angle to the top of manhole, then simple trigonometry should be used to determine the vertical distance to that point instead of the distance measured at angle.

- p-07: (0.0 to 20.0) this is the distance (in meters) from the manhole rim to the lid of the enclosure when installed.
    - This is most easily determined by measuring the vertical distance from the top of rim to the support bar and then adding the distance from the center of the bar clamps to the tip of the enclosure
- P-11: (1 or 0). This is a boolean value to determine if the LEDs should show radar sampling sequence using 4 LEDs (value = 1) or if only a single red LED should be illuminated to show that the radar is on (value = 0).
    - This should normally be set to 0 unless the service technician is performing any troubleshooting on the device.
    - Setting this value to 1 will decrease the battery life of the BLU-X Radar.

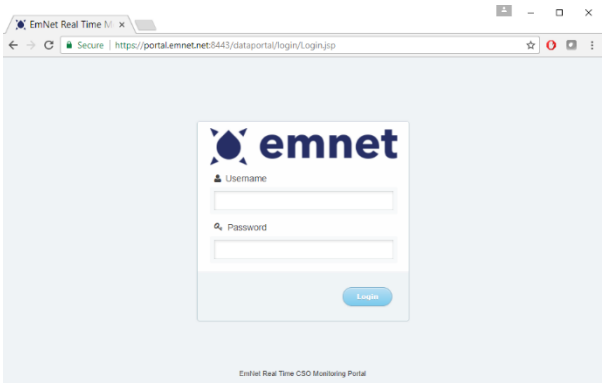
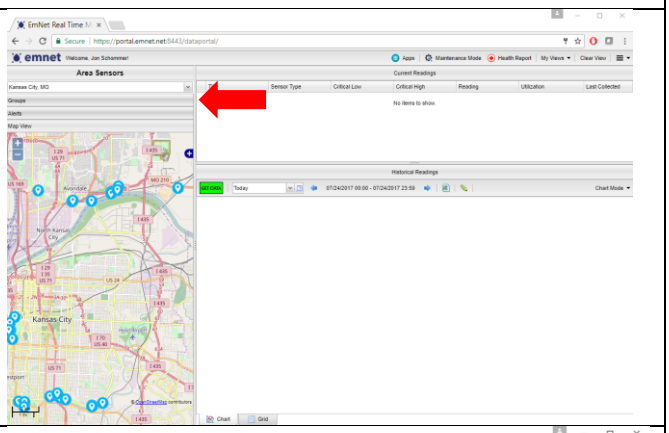
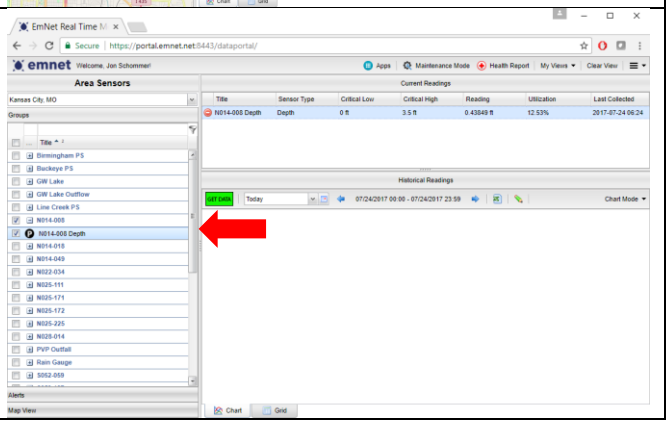
11 Establishing Communication with EmNet Engineering Site

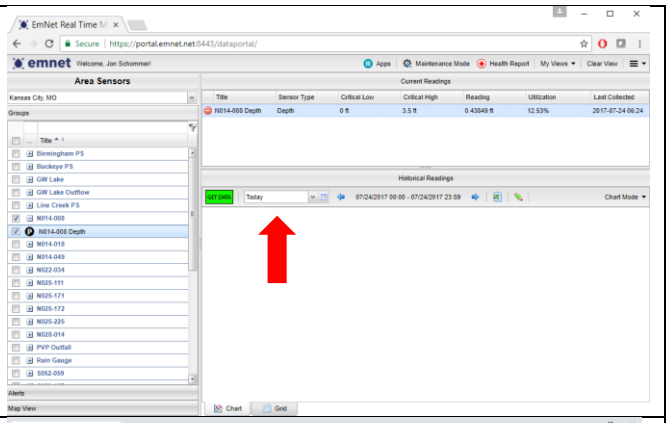
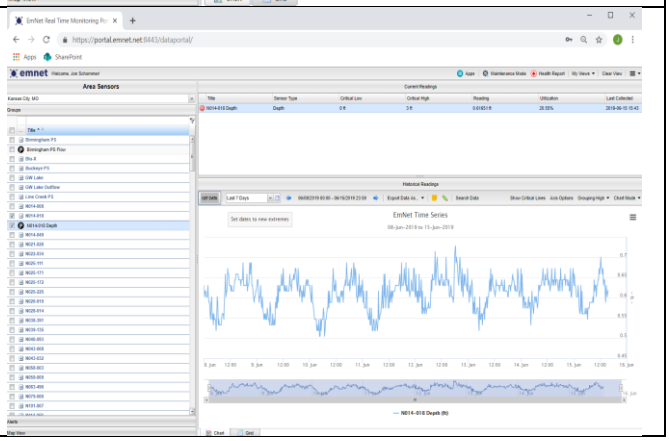
In order for the BLU-X Radar to communicate with the BLU-X website, the telemetry board for the radar needs to be properly configured with the following information:

- Node ID.
    - This is used to let the data collection system know which device is talking.
    - Each device has a unique Node ID.
    - The Node ID is currently defined well in advance to deployment so it does not need to be edited by service personnel unless troubleshooting.
    - It is recommended that, if the service person has a concern about the node ID setting, he/she contacts the Field Service Manager at EmNet for support
- Data upload interval.
    - This value can be set through the terminal menu or using a remote command.
    - The setting refers to the number of measurements to hold before uploading them to the server.
    - If, for example, measurements are made every 5 minutes but the system should upload every hour, the data upload interval would be set to 12.
    - It is recommended that, if the service person has a concern about the data upload interval, he/she contacts the Field Service Manager at EmNet for support

12 Monitoring

12.1 Logging into BLU-X Website and Viewing Data from Monitoring Site

No.	Description	Illustration
	Navigate to portal.emnet.net. Log in using a username and password provided by EmNet.	
	From the landing page go to the groups tab to find a list of sites by name.	
	Select site in the drop-down menu. The site name and basic information can be viewed in the top right window.	

	Select the date/time of interest in the Historical Readings bar and click the green “Get Data” button to plot the timeseries data for the selected site.	
	Data will be plotted in the lower right window.	

13 Uninstallation

No.	Description	Illustration
	Lift thin end of support bar from bracket until support bar is at approximately 90 degrees to the horizontal. Then slide opposite end of support bar out of bracket.	

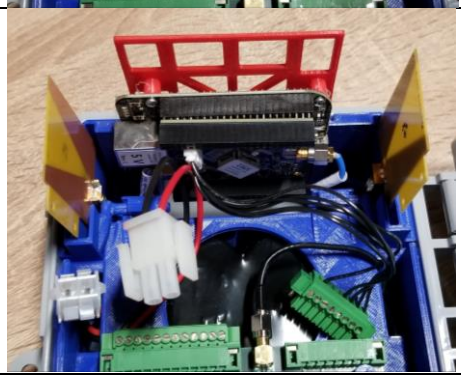
14 Disassembly

14.1 Power and Radar Cable detachment:

No.	Description	Illustration

1	Open box and disconnect power cable by squeezing Molex connector clips and pulling the two connectors apart.	
2	Disconnect the 8 pin connector from the Telecommunications Board by pulling out from slot	

14.2 Removal of Radar Sensor Module from Chassis:

No.	Description	Illustration
1	Begin lifting the radar carrier plate up and out of chassis. It is possible that the antennas will not move, work slowly.	
2	Slide antennas out on left and right side until they move freely. Then continue to slide out the radar carrier plate with one hand. Use the other hand to assist in the removal of the two antennas, as needed.	

14.3 Removal of Telemetry unit (Telecommunications Board) from Enclosure:

No.	Description	Illustration

	Remove 12-pin terminal strip from Telecommunications Board.	
	Detach cellular antenna from Telecommunications Board.	
	Slide the Telecommunications Board up and out of the top battery interposer.	

14.4 Removal of Batteries from Enclosure:

No.	Description	Illustration
1	Slide the Telemetry and Radar assembly up and out of the enclosure and set aside.	

4	Remove battery packs and safely discard, following all legal requirements.	
6	Remove Battery Chassis by sliding up and out of enclosure	

15 Troubleshooting

15.1 Identifying an issue

In order to identify an issue, please view the LEDs on the telemetry board. The enclosures are equipped with optically transparent enclosure lids. The LEDs can be observed through the lid without opening the enclosure. It is recommended not to open the enclosure unless it is deemed necessary because it can introduce foreign contaminants and moisture into the enclosure.

If troubleshooting the radar, the service technician will most likely want to edit the radar LED setting so that the radar uses all the LEDs instead of a single red service LED which indicates that the radar is on. Please see the section titled “Configuration” for more information on how to do this. If troubleshooting only the telecommunications portion of the BLU-X Radar, then it is likely that no configuration changes are necessary.

To assist in troubleshooting, always have a known, properly functioning BLU-X Radar to perform equipment substitutions. It is often easier and faster to swap parts than it is to troubleshoot in the field. Lastly, consider performing an RMA to have the device investigated at a testing facility. The ease of installation and unit replacement can make this a best solution in cases where there are safety-, time-, and/or other-constraints.

Most issues are easily identified, such as:

- Low voltage Battery packs – as indicated by values on the Blu-X portal or by issues in LED sequence.

- Moisture in the enclosure - evident without opening the enclosure by looking through the optically transparent lid. If the enclosure is opened, look for pools, droplets on surfaces, and corrosion of metal surfaces and connectors.
- Damage to enclosure – as indicated by cracks in the enclosure, missing pieces of the enclosure
- Damage to internal components – as indicated by loose or broken pieces in the enclosure, etc.
- Cable connectivity issues – as indicated by frayed cables or loose or disconnected cables.

15.2 Identifying an issue with the Radar Board

The following image shows the LEDs in a red circle:

The radar board has a characteristic pattern that indicates what the radar board is doing:

- ***Normal operation***: Red LED initially ON at power-up. All LEDs are then off until radar ranging begins. Once radar task starts, Red LED blinks at 1 Hz, the Blue LED blinks rapidly (not governed, just every time there is a radar measurement), and Green LED blinks when SD card is written to. When the radar task is finished, the Orange LED blinks (others are off) to indicate that it is ready to send data to the telemetry board.
- ***Error condition*** – If there is an error in the startup phase, it is possible that none of the LEDs turn on. It is likely that the software application is corrupted or not present. If there is an error at any subsequent point in the radar operation, the Orange/Green/Blue LEDs are on solid.
- ***Power failures*** – A power failure can take the form of a brownout or blackout. For a brown out, the device will perform most of its functions and then all the LEDs will turn off without completing the normal sequence and without showing an error indication. Test with a known power source to rule out this issue. A black out will result in the radar not running at all. Test with a known power source if this is of concern.
    - Note that the system contains brownout protection logic, where as soon as the system turns on, if it Identifies low battery power, it will not continue to operate and the LEDs will turn off. Additionally, a message will be sent to the server

where the measurement values will all show "-2.0" except for the battery voltage, which will be reported at the measured value.

- It is possible that the telemetry board will transmit data while the radar is not performing correctly. If there is a failure to communicate between the telemetry board and the radar board, then the telemetry board will report the following values to the server for the four monitored channels "-1,-1,-1,-1."

15.3 Identifying an issue with the Telecommunications Board

The following image shows the three service LEDs in one red circle and the single modem LED in a separate circle:

The Telecommunications Board has four LEDs on the top of the board (the side with the Telit modem). There are three service LEDs (Green, Amber, Red) located centrally on the board. There is also one modem LED, located directly adjacent to the modem, which turns on when the Telit modem is on. Note that this LED is also green. When troubleshooting the Telecommunications Board, watch the LEDs as the system cycles. The patterns should indicate if the system is or is not operating normally. If it is determined that the system is not operating normally and that this is due to an issue with the Telecommunications Board and not another component of the BLU-X radar, remove and replace the Telecommunications Board. Board replacement will require custom configuration. This is an advanced topic and it is recommended that the service technician contact the Field Services Manager for more information on how to configure the replacement board to properly communicate with the Radar Board and with the BLU-X server.

The LEDs patterns for the Telecommunications board differ, based upon the mode in which the board is operating. Please read through all the following before attempting to troubleshoot:

- ***First power on*:** The first time the board is powered on (person connects the molex cable to the Telecommunications Board) – The device gets the date form the cellular

network, turns off the modem, goes to sleep, waits 5 minutes to wakeup and enter normal operation:

- ***Normal operation***: Device successfully connects to network and gets the date
  - Wait 10 second (no LEDs are on)
  - Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
  - Amber status light is off, green status light is on for 3 seconds.
  - All lights turn off (system goes to sleep for 5 minutes before entering data collection mode (see below)).
- ***Device does not successfully connect to the network***
  - Wait 10 second (no LEDs are on)
  - Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
  - Amber status light remains on up to 60 seconds.
  - All lights turn off (system goes to sleep for 5 minutes before retrying network date/time acquisition).
- ***Failure of Telit modem***
  - Wait 10 second (no LEDs are on)
  - Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is off (indicating that modem is not active).
  - Amber status light turns off and red status light turns on for at least 3 seconds.
  - All lights turn off (system goes to sleep for 5 minutes before retrying network date/time acquisition).

- ***Data collection mode:*** When in data collection mode, the device wakes up every 5 minutes to take measurements from radar, save the data to the Telecommunications Board, and then sends the data up to the EmNet server:
  - ***Normal operation***: Device successfully reads from the radar, logs the data to the telecommunications device (Telecommunications Board), sends the data to the server, and receives a hash back from the server.
    - Green and amber status lights flash while polling the radar
    - Amber status light stops flashing and green status light turns solid to indicate writing data to memory
    - Green status turns off and amber light turns solid to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
    - Amber status light is off, green status light is on for 3 seconds to indicate successful transmission
    - All lights turn off (system goes to sleep for 5 minutes before the next reading).

- ***Device cannot read from radar***
  - Green and amber status lights flash while polling the radar
  - Red light flashes to indicate failure to receive data from radar.
  - The above two steps occur up to 4 times before aborting and moving on
  - Red light turns off and amber light turns solid to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
  - Amber status light is off, green status light is on for 3 seconds to indicate successful transmission
  - All lights turn off (system goes to sleep for 5 minutes before the next reading attempt).
- ***Device cannot write to memory***
  - Green and amber status lights flash while polling the radar
  - Amber status light stops flashing and red status light turns solid to indicate failure to write to memory
  - Red status light turns off and amber light turns solid to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
  - Amber status light is off, green status light is on for 3 seconds to indicate successful transmission
  - All lights turn off (system goes to sleep for 5 minutes before the next reading).