SOLO RED Installation and User Guide

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Revision Date: May 2, 2022

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Software Release Level and Date

RELEASE LEVEL	DATE	COMMENTS
700N036-079-001	1/19/2022	

Version History

VERSION	DATE	EDITOR	CHANGES
1.0	Sept 17, 2021	S Van Skike	Initial version
1.1	Nov 10, 2021	S Van Skike	General Updates
1.2	Dec 14, 2021	S Van Skike	General Updates
1.3	Jan 4, 2022	S Van Skike	Wiring diagrams, alarms
1.4	Jan 31, 2022	S Van Skike	SW version history added
1.5	May 2nd, 2022	S Van Skike	Antenna working distance

01. GENERAL INFORMATION

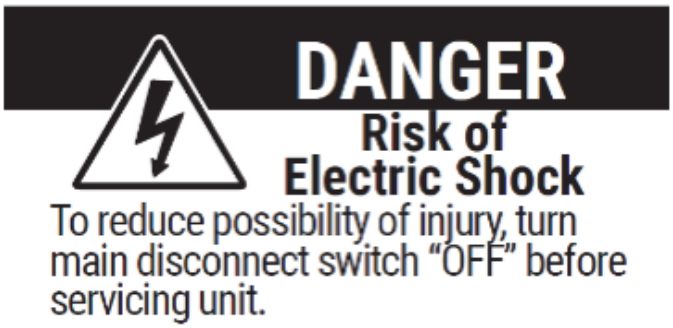
Public Safety Notes

The Cel-Fi SOLO RED shall be installed in accordance with following Model Building and Installation Codes:

- Standard for the Installation, Maintenance, and Use of Emergency Services
- Communications Systems, NFPA 1221
- National Electrical Code, NFPA 70
- Fire Code NFPA 1
- Life Safety Code, NFPA 101

Opening and Safety Notes

Electric Shock
Opening any of the SOLO RED components may result in electric shock and cause severe injury.



Exposure to RF

Working with the equipment while in operation may expose the technician to RF electromagnetic fields that exceed FCC rules for human exposure. Visit the FCC website at www.fcc.gov/oet/rfsafety to learn more about the effects of exposure to RF electromagnetic fields.

Please maintain a minimum safe distance of at least 65 cm while operating near the donor antenna, and at least 20 cm while operating near the server antennas. The safe distance may be reduced if a lower antenna gain is used. Also, the donor antennas should be mounted outdoors on a permanent structure.

Hot Surface

In certain conditions, the equipment may become hot and may cause minor injuries if handled without any protection.

Warranty
Opening or tampering with any of the SOLO RED components voids all warranties.

Lithium batteries

The battery may explode if it's replaced by an incorrect type. Dispose of used batteries according to local regulations.

Note: The RA uses an internal lithium ion battery to maintain RA LED alarms states after BBU main battery power backup capacity has been exhausted. This battery does not require maintenance and is not user replaceable.

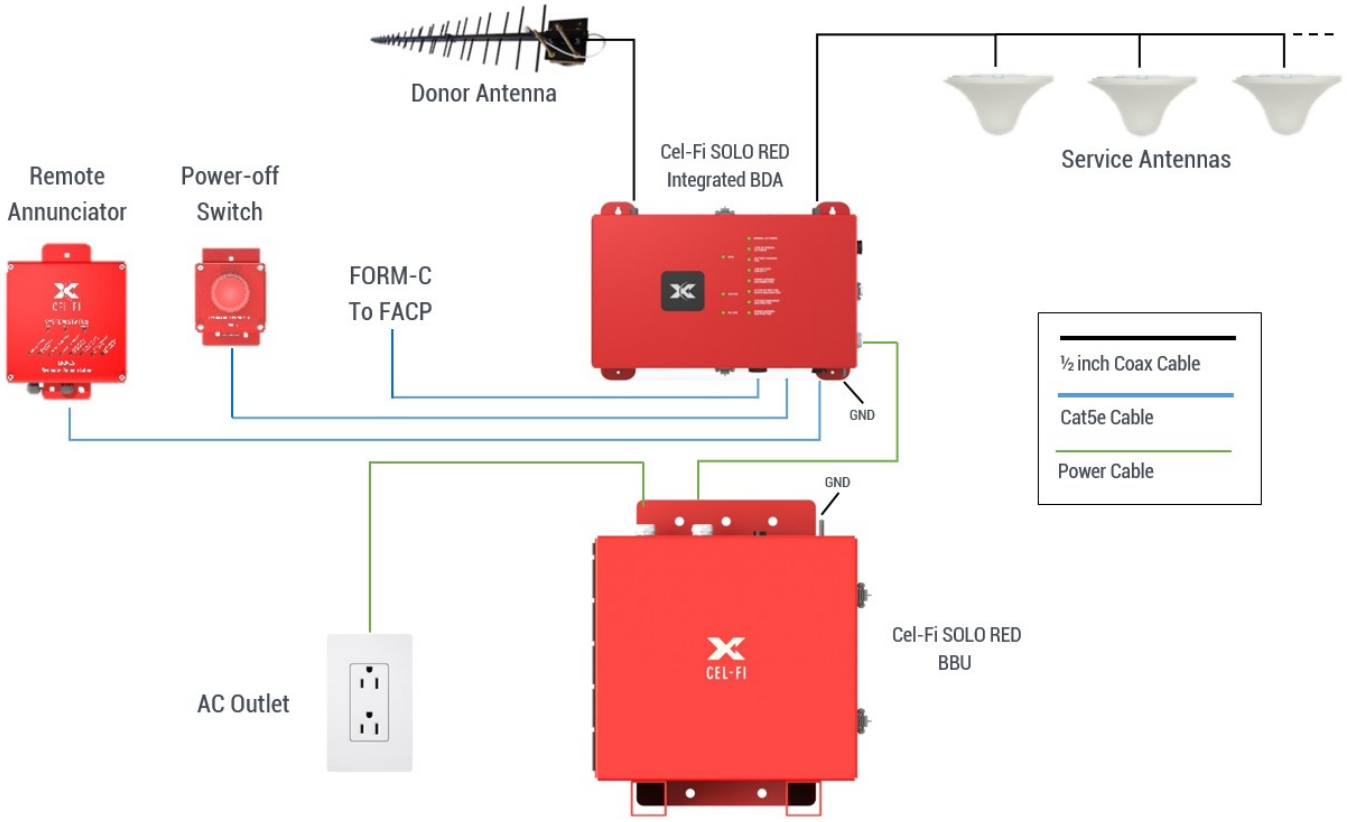
Ethernet instructions

This equipment is for indoor use only. All cabling should be installed indoors.

02. INTRODUCTION

During an emergency incident, every minute is critical. First responders need to be able to communicate with each other inside and outside of any structure at any time. Nextivity's Cel-Fi SOLO RED is a lower power Public Safety solution designed to provide complete-code compliant radio coverage to higher performance standards in less time, for buildings typically up to 238,000 ft^2. For larger buildings, refer to the more powerful QUATRA RED system.

This guide also refers to additional tools and resources, such as the Cel-Fi WAVE PRO Mobile app, and the COMPASS RED device. This guide only explains their usage as they pertain to SOLO RED. For more information on how your business may benefit from these resources, please refer to the product page on cel-fi.com.



System Overview

SOLO RED takes off-air signals from a 700/800 MHz LMR donor antenna, and boosts them for retransmission through local service antennas that may be optionally monitored. 12 hour backup power is supplied to the system by a Cel-Fi Battery Backup Unit (BBU), or a suitable BBU from another manufacturer. There is a WAN connection to the internet that enables powerful cloud management and effortless diagnostics through the Cel-Fi WAVE Portal, and the WAVE PRO cell phone app is used to upload the system configuration and enable many additional features and tools to make installation faster and more comprehensive. Optional accessories include an RA, EPO switch, active (monitored) service antennas, and the COMPASS RED site survey tool. The system automates many traditional install complications, helping to ensure faster system deployment and certification, and the system is unconditionally network safe and prevents oscillations (No Noise Guarantee).

SOLO RED Architecture

Cel-Fi SOLO RED is a modular solution with the following components:

- Cel-Fi SOLO RED ERCES Integrated PS BDA – Class A
- Cel-Fi SOLO RED ERCES Integrated PS BDA – Class B
- Cel-Fi SOLO RED Battery Backup Unit (BBU)
- LPDA-R (resistive sense monitored donor antenna)
- WAVE Portal (cloud based monitoring and diagnostics)
- WAVE PRO app (iOS or Android local GUI)
- Optional: Cel-Fi RED Remote Annunciator (RA)
- Optional: Cel-Fi RED Emergency Power-Off switch (EPO)
- Optional: Cel-Fi RED Active [service] Antenna (AA)
- Tools: COMPASS RED (works with the WAVE PRO app)

Cel-Fi by Nextivity recommends the use of Category cable (CAT5e or superior) when connecting optional RA and EPO accessories (provides power and data for the accessory).

Multiple QUATRA/SOLO/GO RED systems may be installed together to form a more extensive solution, and linked to a single Site address in the WAVE Portal for remote cloud management.

Cel-Fi SOLO RED provides a sophisticated network-safe design that has been engineered to minimize the embedded effects of signal amplification.

Note: There is no technical limitation to the number of Cel-Fi systems or solutions that may be installed at a site.

Main Features

- SOLO RED is a complete LMR capable system
- SOLO RED consists of one LMR BDA and one BBU
- Conducted DL power is 27 dBm (½ watt) for each 700/800 MHz LMR band simultaneously
- Compatible with the Cel-Fi RED Active (service) Antenna and diagnostics
- Class A device with up to 56 channels, 12.5kHz filter bandwidth
- Class B device with up to 28 channels, 100kHz, 150kHz filter bandwidth configurable
- System delay – approx. 35us@12.5kHz, 15us@100kHz, 13.6us@150kHz
- Automatic setting of uplink (UL) and downlink (DL) gain during the commissioning phase
- Industry best Talk-In and Talk-Out performance due to real-time, slot-to-slot gain control
- System can detect and report Time Delay Interference (TDI) from other systems in the area (optimize MOQ)
- Up to 100 dB gain
- Remote Management through the Cel-Fi WAVE portal
- Remote diagnostics reduces site visit time and costs
- High Site direction and distance automatically calculated
- Downlink gain automatically set to 20dB isolation per NFPA 1221 (plus override option)
- Near real-time uplink (UL) automatic gain control (AGC)
- Uplink AGC and gating can respond in <1.2ms to changing inputs levels, making the SOLO RED system very robust against the near-far effect
- Built-in Grid testing (DL/UL) without support from the dispatch center (using COMPASS RED).
- NEMA 4 Rated, Listed to UL 2524

Ordering Info

Cel-Fi SOLO RED is available in two different radio configurations. BBU and accessories sold separately.

Model Number	Product Description
L41-7E	Cel-Fi SOLO RED ERCES Integrated PS BDA – Class A, 700/800MHz LMR
L41-7EB	Cel-Fi SOLO RED ERCES Integrated PS BDA – Class B, 700/800MHz LMR
F44-00	SOLO RED BBU
F42-10R-100	Cel-Fi RED Remote Annunciator Panel
F42-10E-100	Cel-Fi RED Emergency Power-Off Switch
F42-10A-100	Cel-Fi RED monitored Server Antenna
A11-V43-101	Indoor Omni Antenna N-F connector
A32-V32-201	Wideband Directional Donor Antenna with resistor
A62-V44-200	LPDA-R Donor Antenna with resistor
C21-200-100	Optional QUATRA RED Donor Antenna Sensor (resistor)
K03-100-100	COMPASS
K03-100-120	COMPASS RED (add on to COMPASS)

NOTE: For more information about battery charging and capacity, please see Appendix B – Rechargeable Standby Power Calculations.

03. INSTALLATION

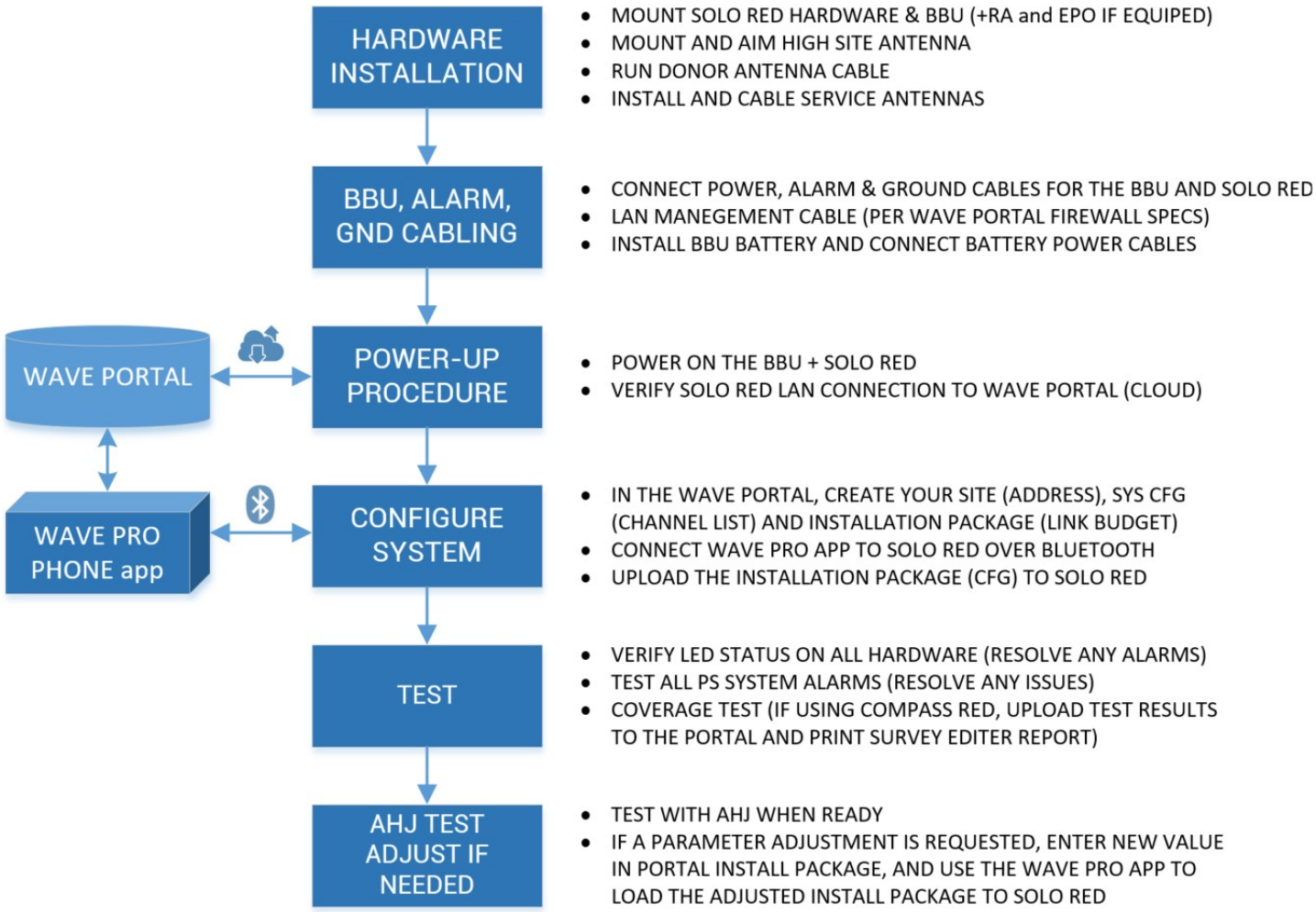
Installation Area

All the components of the SOLO RED solution are NEMA 4 rated once installed. However, during installation or maintenance, appropriate measures must be taken to prevent water or debris damage to open units or cable connections.

The installation location for the product must be well ventilated. The equipment has been designed to operate at the temperature range and humidity level as stated in the product specifications. The mounting surface must be able to support the weight of the equipment.

Direct sunlight exposure to the equipment should be avoided. Provide additional shelter if necessary.

Installation Overview



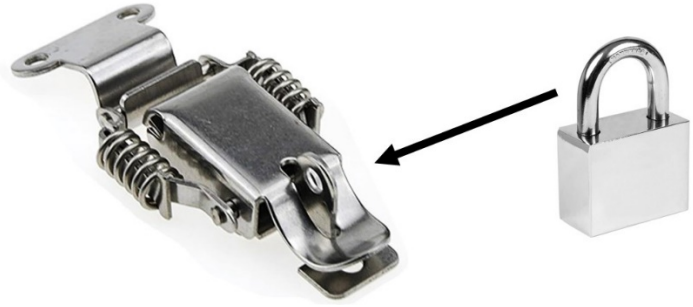
Unpacking and Package Contents (all units)

When receiving any SOLO RED component, perform the following checks:

- Inspect the shipping container for damage before unpacking the unit.
- Look for any physical damage to the equipment.
- Check that all the items listed in the packing list are included.
- The SOLO RED is supplied with waterproof Ethernet fittings and mounting hardware. Ethernet cables are user supplied.

Lockable Housing Doors

The BDA and BBU housings may be locked with padlocks for security.



Mounting SOLO RED ERCES BDA and BBU

The BDA is the centerpiece of the SOLO RED system. The BDA serves as the RF amplifier, and it processes all alarming, service configuration, and system control functions. The installation procedure described in this manual is identical for CLASS A or CLASS B models.

BDA Mounting

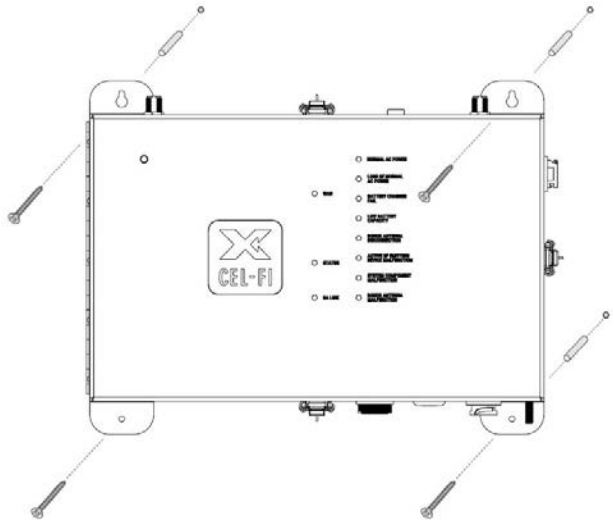
SOLO RED may be used with a SOLO RED 12VDC BBU, or another vendor's 12VDC Public Safety BBU that is UL2524 rated. If from another vendor, please follow their installation instructions. Either BBU type will require you to connect the Loss of AC Power and Battery Charger Fail alarm wires between the BBU and SOLO RED as indicated in this manual.

The Cel-Fi SOLO RED BBU is designed to be wall-mounted. Mounting accessories, including screws and anchors, for common material types (drywall, plywood, etc.) are included in the standard kit.

The SOLO RED BDA has four (4) metal mounting fins with four (4) mounting holes; two on the top, and two on the bottom.

Caution: Make sure the area behind any mounting surface is free of electrical wires or other dangerous elements before drilling.

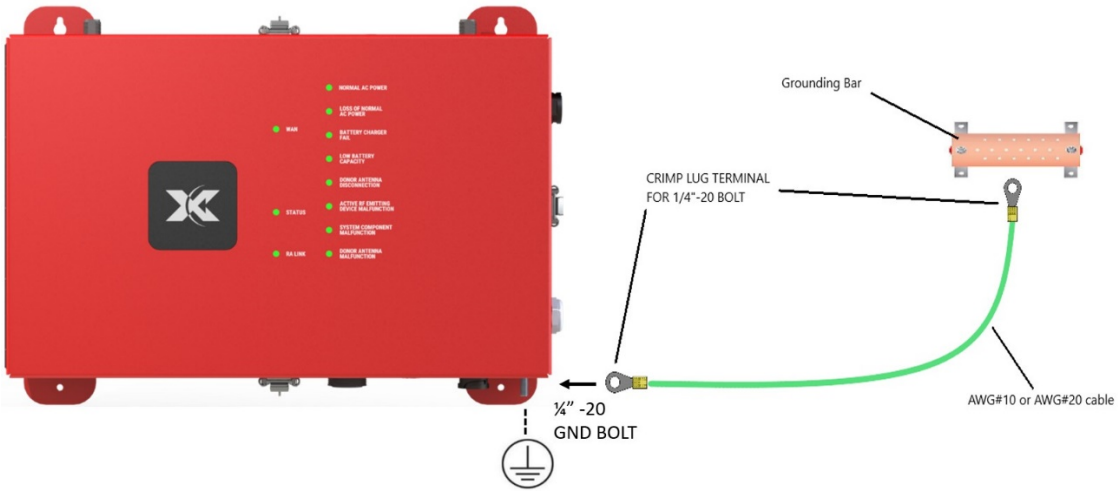
1. See the Appendix for unit dimensions.
2. Determine where and how the BDA will be mounted, with consideration for wall support, door clearance, and clearance for all conduit and waterproof cable connections.
3. Hold the unit level in place and mark the four mounting screw locations.
4. Using a drill, drill holes for the wall anchors.
5. Hammer in the wall anchors.
6. Place the BDA against the wall anchors and affix all anchor screws.
7. NOTE – The top two mounting fins have key-hole screw holes, allowing the unit to be lifted into place if the top two screws are loosely installed first.



BDA Wall Mounting

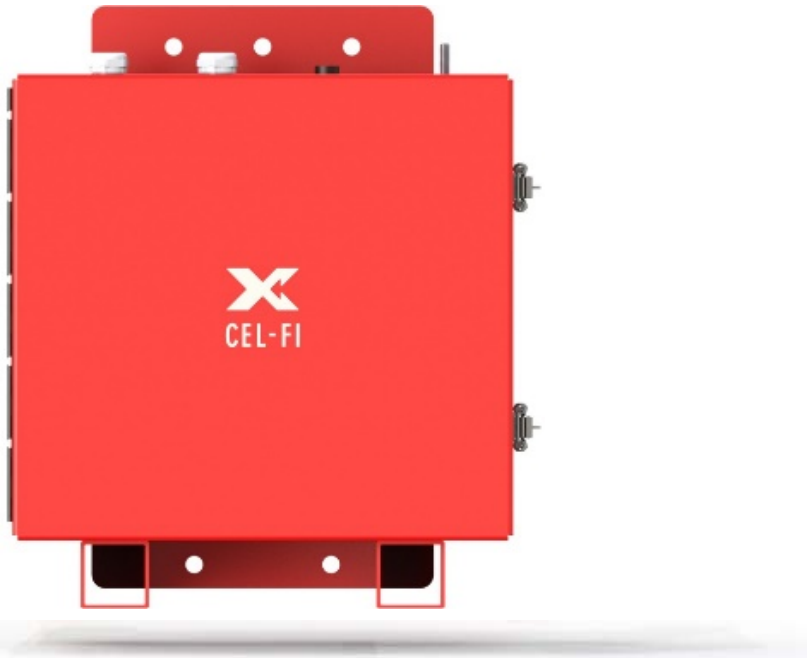
BDA Grounding

Connect a suitable green grounding cable between the GND bolt (1/4in x 20) on the underside of the BDA, and a suitable grounding bar. The door of the BDA is grounded to the BDA housing through the door piano hinge.



Mounting the Battery Backup Unit (BBU)

The BBU provides 12 hour, 12 VDC backup power to the BDA through an Electrical Metallic Conduit (½ inch IMC). 24 hour backup options are also available. The BBU also receives EPO shut-down signals from the BDA, and the BBU sends alarm signals to the BDA.



The SOLO RED BBU is UL2524 listed as a component of the SOLO RED System. Using the SOLO RED BBU ensures UL2524 compliance. However, a suitable BBU from another vendor may be used, if it meets the following requirements:

- UL2524 (If UL2524 is required for the SOLO RED installation)
- Terminal block power DC wiring through ¾ inch Intermediate Metal Conduit (IMC) for power cable connections from the BBU to the BDA.
- The BBU must report the following alarms (N.O. or N.C.) to the BDA, through ½ inch metal electrical conduit.

    - Loss of AC Power
    - Battery Charger Failure
- EPO shutoff signals from the BDA (O.C. or S.C.)

Note: Even though this manual explains how to install and wire the battery inside the BBU, the unit doesn't include the battery. Please refer to the "BBU Model & Battery Selection Chart" for battery selection.

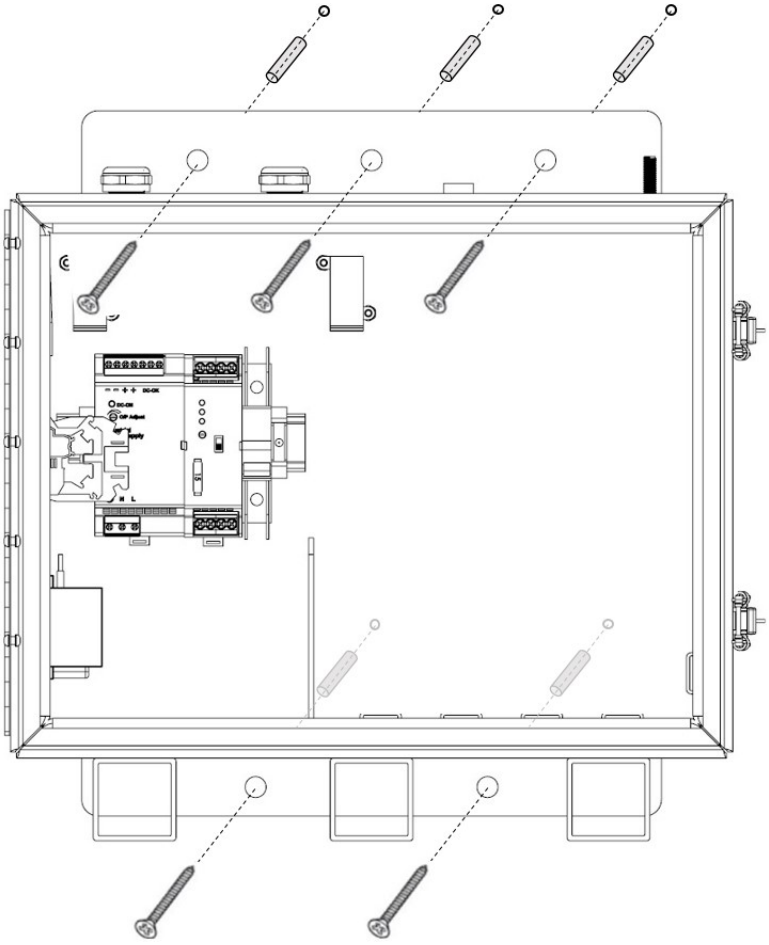
SOLO RED BBU Mounting

The Cel-Fi SOLO RED BBU with battery installed is heavy and should be on the floor with the back side secured against a wall. Leveling feet or casters should be used, or a non-conductive material to insulate the unit from the floor. Mounting accessories, including screws and anchors, for common material types (drywall, plywood, etc.) are included in the standard kit.

The SOLO RED BBU has metal mounting fins with mounting holes; three on the top, and two on the bottom.

Caution: Make sure the area behind any mounting surface is free of electrical wires or other dangerous elements before drilling, and only install the battery after the BBU is securely mounted.

1. See the Appendix for unit dimensions.
2. Determine where and how the BBU will be mounted, with consideration for base and wall support, door clearance, and clearance for all top connections.
3. Hold the unit against the wall and use a pencil or similar marker to mark the top and bottom anchor points.
4. Using a drill, drill holes for the wall anchors.
5. Hammer in the wall anchors.
6. Place the BBU against the wall anchors and affix all anchor screws.



BBU Wall Mounting

Notes:

- *The unit mounting procedure is for concrete walls only*
- *The weight of the unit may require two people to manipulate the unit*
- *The unit must be installed horizontally with the housing base supports on the bottom*

BBU Battery Install

Once the BBU cabinet is mounted and secured, follow these steps to install and connect the 12-volt battery.

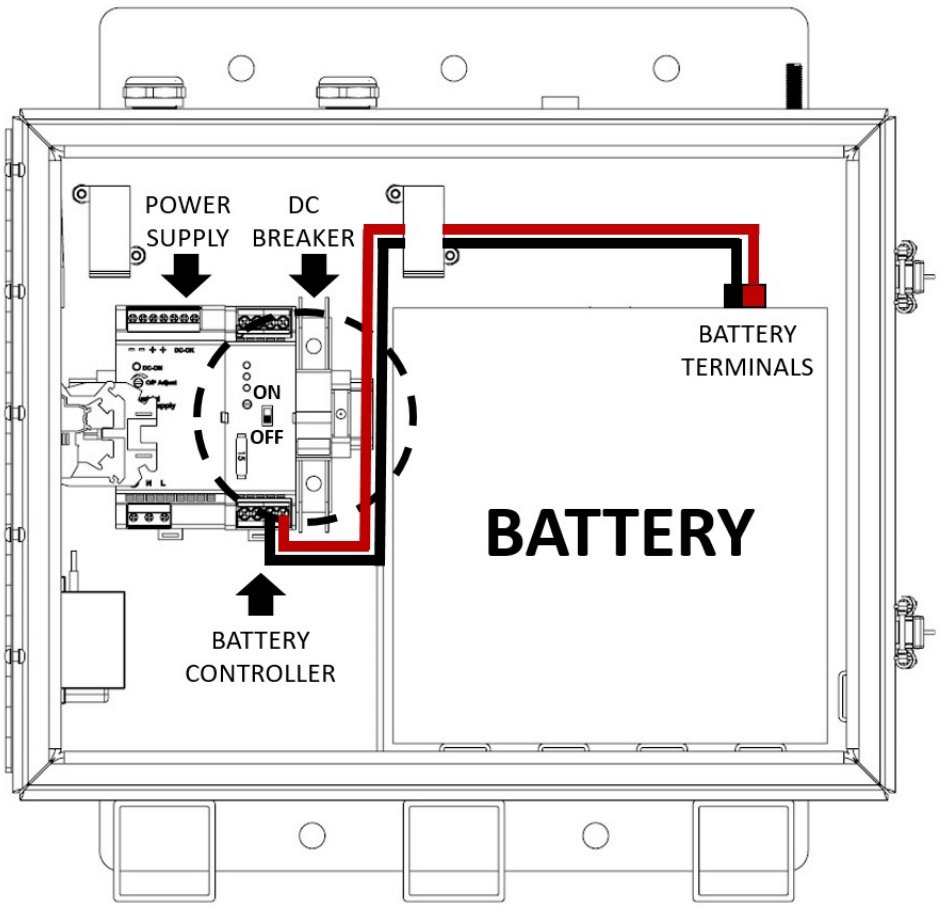
A UL 1989 listed 80 AH battery shall be used (for 12 hour battery backup). The following battery is approved:

Capacity	Manufacturer Part Number
80 Ah	NPD-12-80

Caution: Batteries can discharge at a high dangerous current rate if the terminals are shorted. Always leave battery terminal protective covers attached until they must be removed to connect wire leads. If opening the BBU to perform maintenance, always cover any exposed battery terminals or wiring.

1. Make sure that the Battery Controller and DC breaker are in the OFF (down) position (see figure).
2. Place the battery inside the enclosure with the terminals towards the right side of the unit.
3. Connect battery cables from the Battery Controller to 12-volt battery terminals, as shown below.

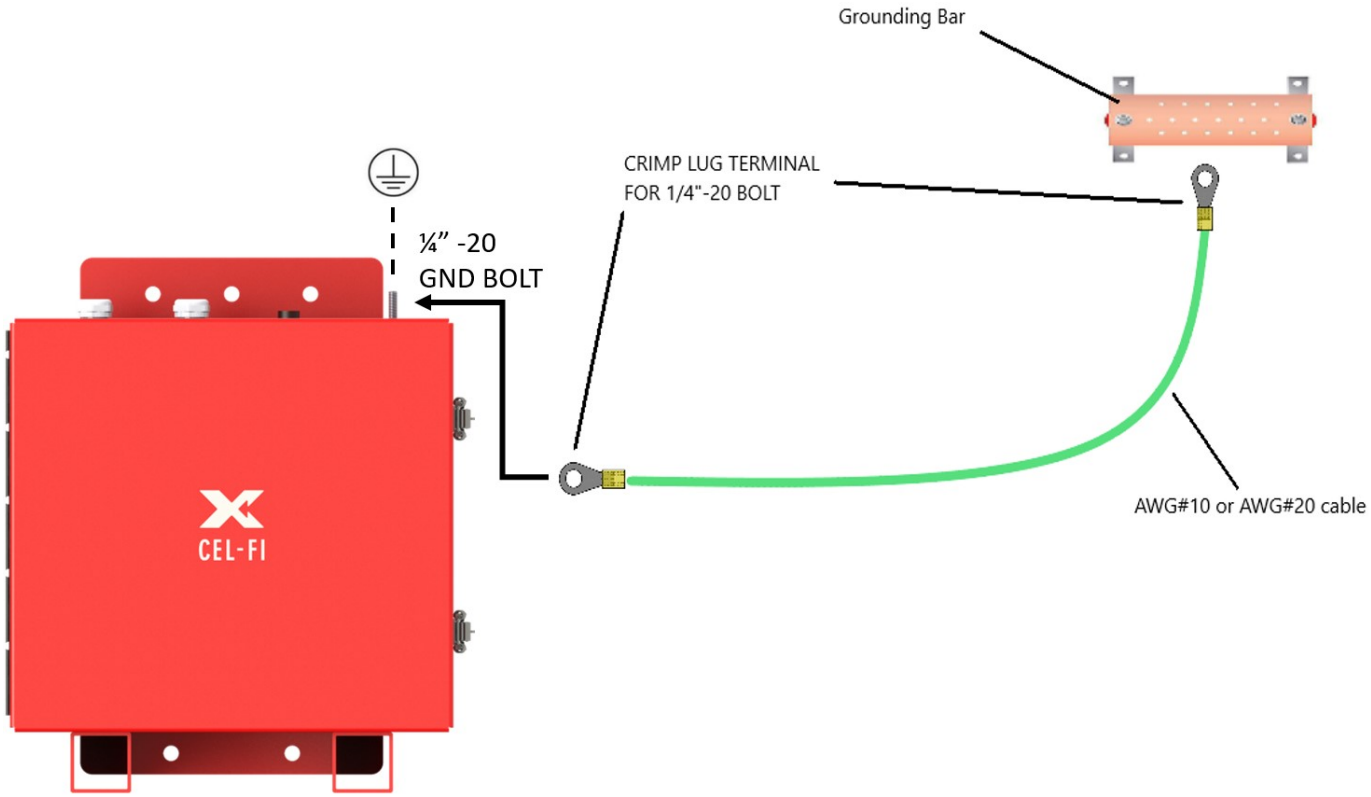
NOTE 1 – The DC breaker controls DC power to the external BDA.
NOTE 2 – The Battery Controller ON/OFF switch controls power to the Battery Controller and Power Supply. Both switches must be in the OFF position to completely power down the BBU (and the AC Mains breaker feeding the BBU if input power is also to be disabled).



Battery connection scheme

BBU Grounding

Connect a suitable green grounding cable between the GND bolt (1/4in x 20) on the top right side of the BBU, and a suitable grounding bar. The door of the BBU is grounded to the BBU housing through the door piano hinge.



Mounting the Optional Remote Annunciator Panel (RA)

Cel-Fi's QUATRA RED Remote Annunciator Panel provides automatic supervisory signals for malfunctions of the ERRCS. It includes FORM-C dry relay contacts compatible with any fire alarm control unit (open or short circuits). The RA is connected to and powered by the Ethernet cable that connects it to the BDA.

RA Ports

The image below shows the RJ45 port to connect the Remote Annunciator (RA) with SOLO RED (BDA) using an Ethernet cable, and the Form-C 24-pin cable for connecting with the Fire Alarm Control Panel.

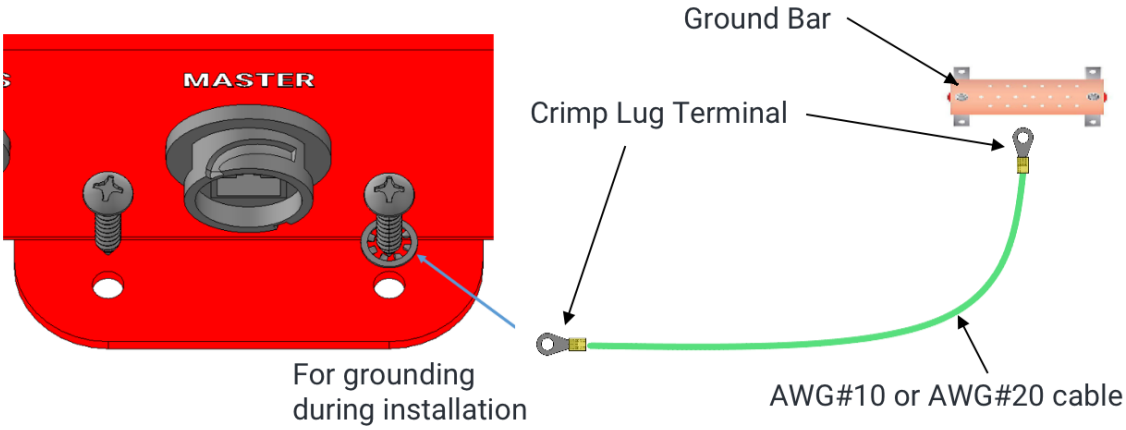
RA Mounting

The Remote Annunciator is designed to be wall-mounted. Mounting accessories, including screws and anchors, for common material types (drywall, plywood, concrete) are included in the standard kit. The QUATRA RED RA has two (2) secure mounting tabs, one on each top/bottom side.

Caution: Make sure the area behind any surface is free of electrical wires or other dangerous elements before drilling.

1. See the Appendix for unit dimensions.
2. To mount the RA, first determine a suitable location on the wall for the unit.
3. Holding the unit level against the wall, mark all three screw anchor points.
4. Drill pilot holes for the wall anchors or screws.
5. Hammer in the wall anchors if using them.
6. Secure the RA against the mounting holes or anchors with the supplied screws.

RA Grounding



Mounting the Emergency Power Off Switch (EPO)

Cel-Fi's QUATRA RED Emergency Power Off Switch (EPO) can instantaneously shut down the ERRCS from a single point, and it can be installed in any location acceptable to the authority having jurisdiction.

EPO Port

The RJ45 port on the EPO connects to SOLO RED (BDA) with an Ethernet cable.

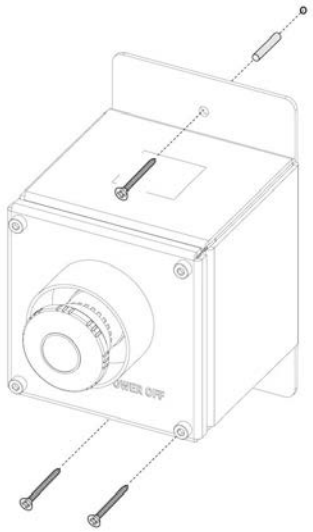
EPO Mounting

The Emergency Power-off Switch (EPO) is designed to be wall-mounted. Mounting accessories, including screws and anchors, for common material types (drywall, plywood, concrete) are included in the standard kit.

The SOLO RED EPO has two (2) secure mounting tabs, one on each top/bottom side.

Caution: Make sure the area behind any surface is free of electrical wires or other dangerous elements before drilling.

1. See the Appendix for unit dimensions.
2. To mount the EPO, first determine a suitable location on the wall for the unit.
3. Holding the unit level against the wall, mark all three screw anchor points.
4. Drill pilot holes for the wall anchors or screws.
5. Hammer in the wall anchors if using them.
6. Secure the EPO against the mounting holes or anchors with the supplied screws.



EPO Grounding

The EPO does not require earth grounding.

EPO Operation

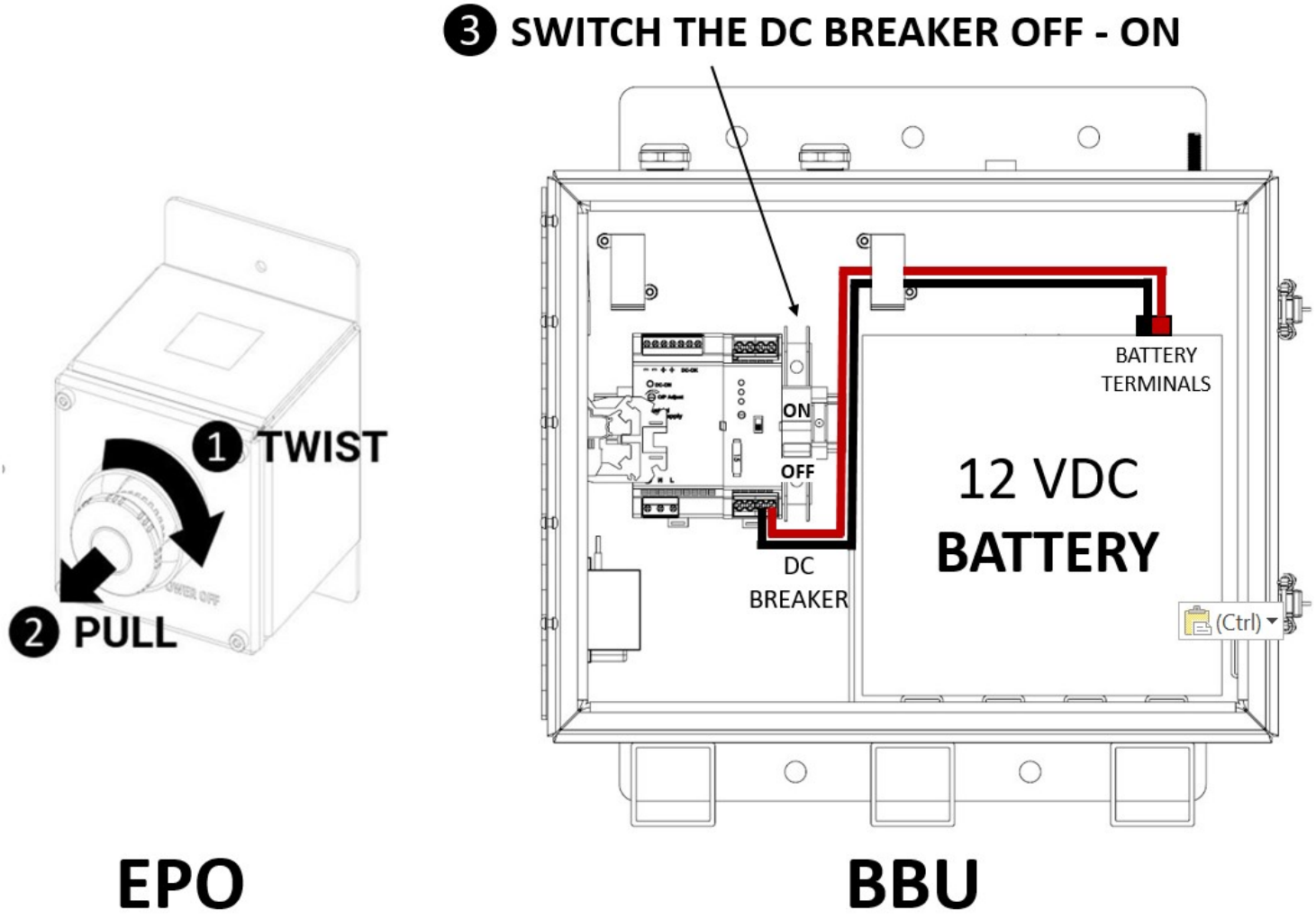
In an emergency, it might be necessary to shut down all the radio communication systems.

To turn the system OFF

Locate the EPO, open the protective button cap, and press the button to automatically turn-off all SOLO RED components. This causes the BBU internal DC breaker to trip.

To turn the system ON

To turn the system back on, twist the EPO button clockwise while pulling it out to the ON position, and close the protective button cap. Then open the BBU front door panel and switch the DC breaker OFF and then ON.



04. DONOR AND SERVICE ANTENNAS

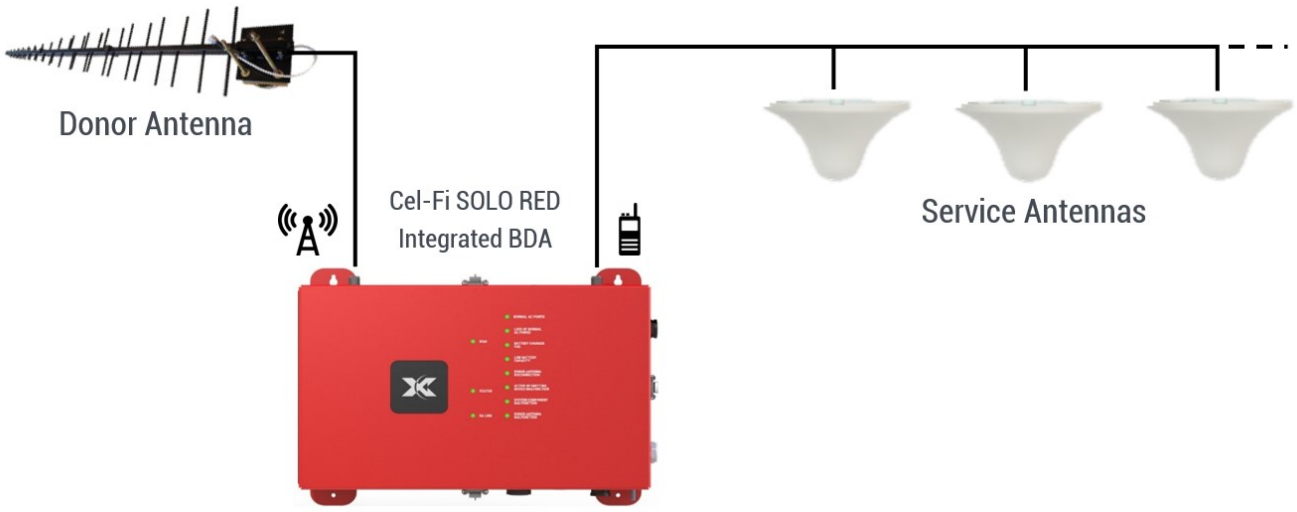
Install, Cable and Aim the Donor Antennas

Cel-Fi SOLO RED has two RF ports (N-type female) on the top of the housing. One port is to be connected to the outdoor donor antenna which is pointed at the High Site to receive 700/800 MHz LMR signals. The other port is to be connected to the service antennas providing in-building LMR service. Each of these ports is labeled. The RF connections must be made using cables with an impedance of 50 ohms.

IMPORTANT: Use Cel-Fi donor antennas exclusively with SOLO RED. We can't guarantee optimal operation of the unit if a different antenna model is used.

The approved donor antenna models from Cel-Fi are:

BEST - Cel-Fi LPDA-R Antenna (Model Number A62-V44-200)
GOOD - Cel-Fi DIRECTIONAL-R Antenna (Model Number A32-V32-201)



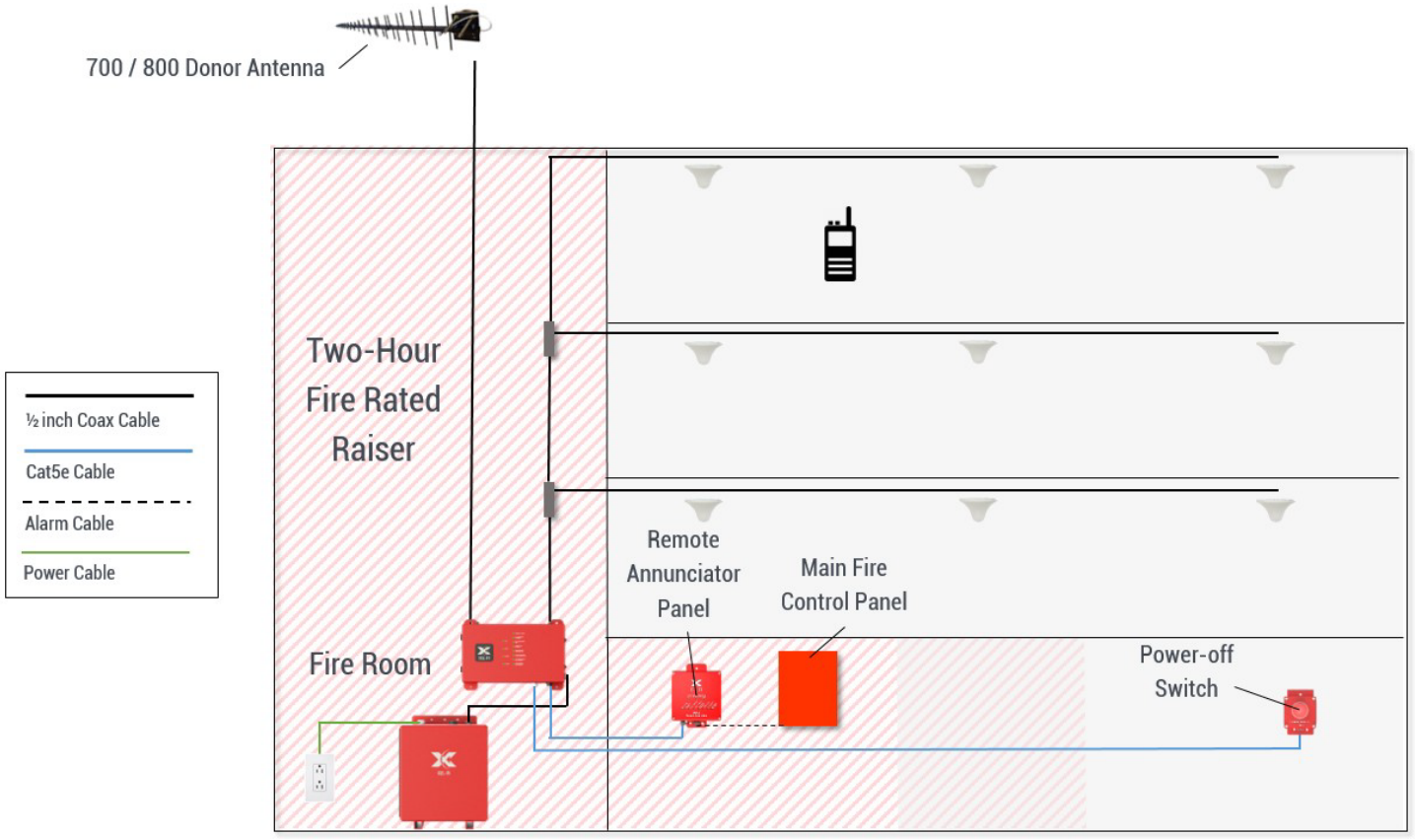
The LMR donor antenna is aimed towards the 700/800 MHz LMR High Site serving the address (GPS Lat/Long) as dictated by the AHJ or Radio Shop.

Install and Cable the Service Antennas

IMPORTANT NOTE: If you intend to use the system's build-in Uplink (talk-out) Grid Test feature with greater accuracy, the service antennas must also operate at 462.675 MHz (FRS Channel 20).

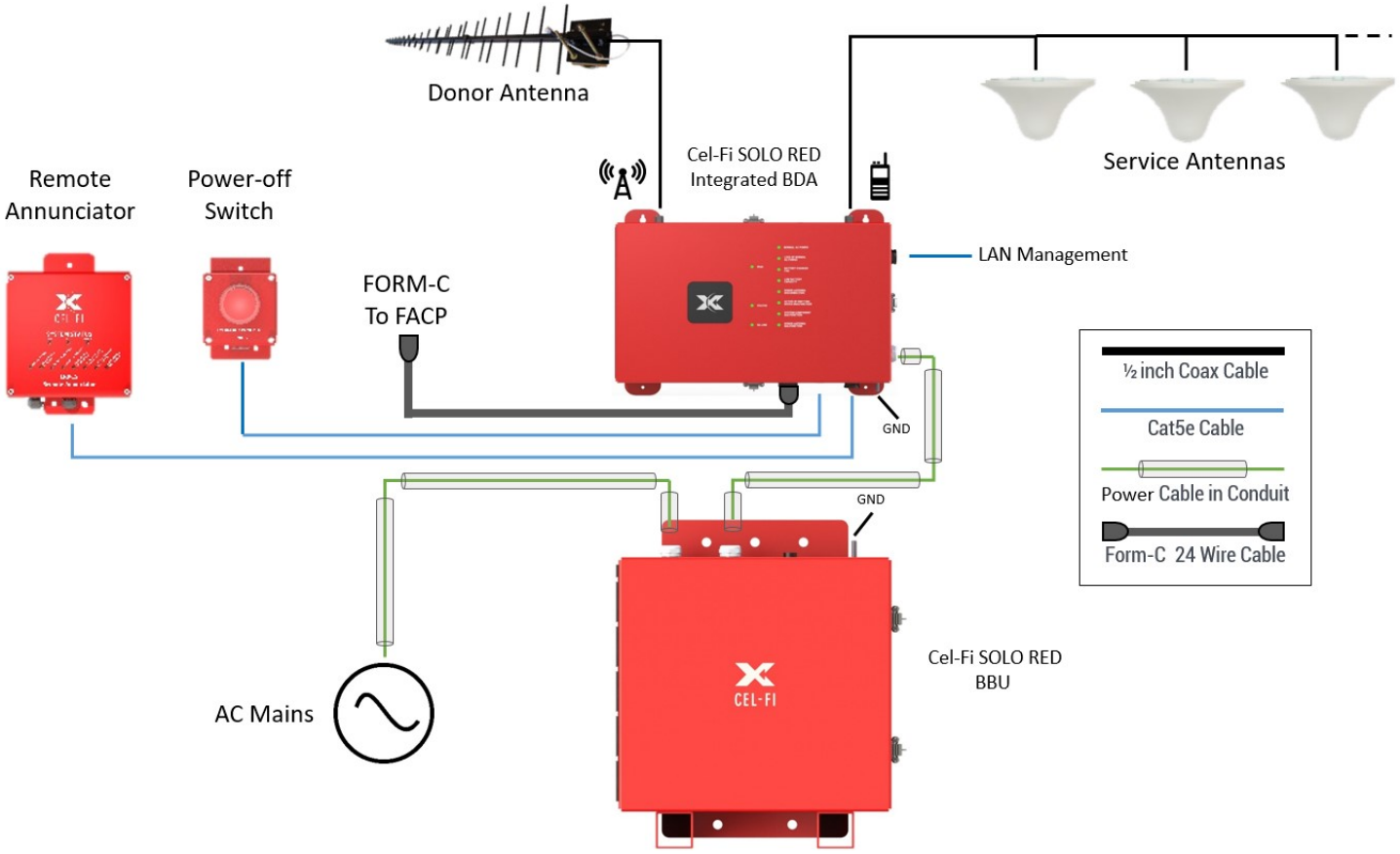
SOLO RED hardware must remain in 2 Hour fire rated spaces and is coaxially cabled to service antennas throughout the areas to be covered. Details about service antenna installation and cabling go beyond the scope of this document, but the following rules must be observed:

1. Cables and antennas must be 50 ohms.
2. Donor and Service antennas must be rated to 2 watts minimum input power @ 50 ohms.
3. To prevent damage, the BDA should not be powered up unless the RF ports are terminated into 50 ohm loads or cables.



05. HARDWARE CABLING

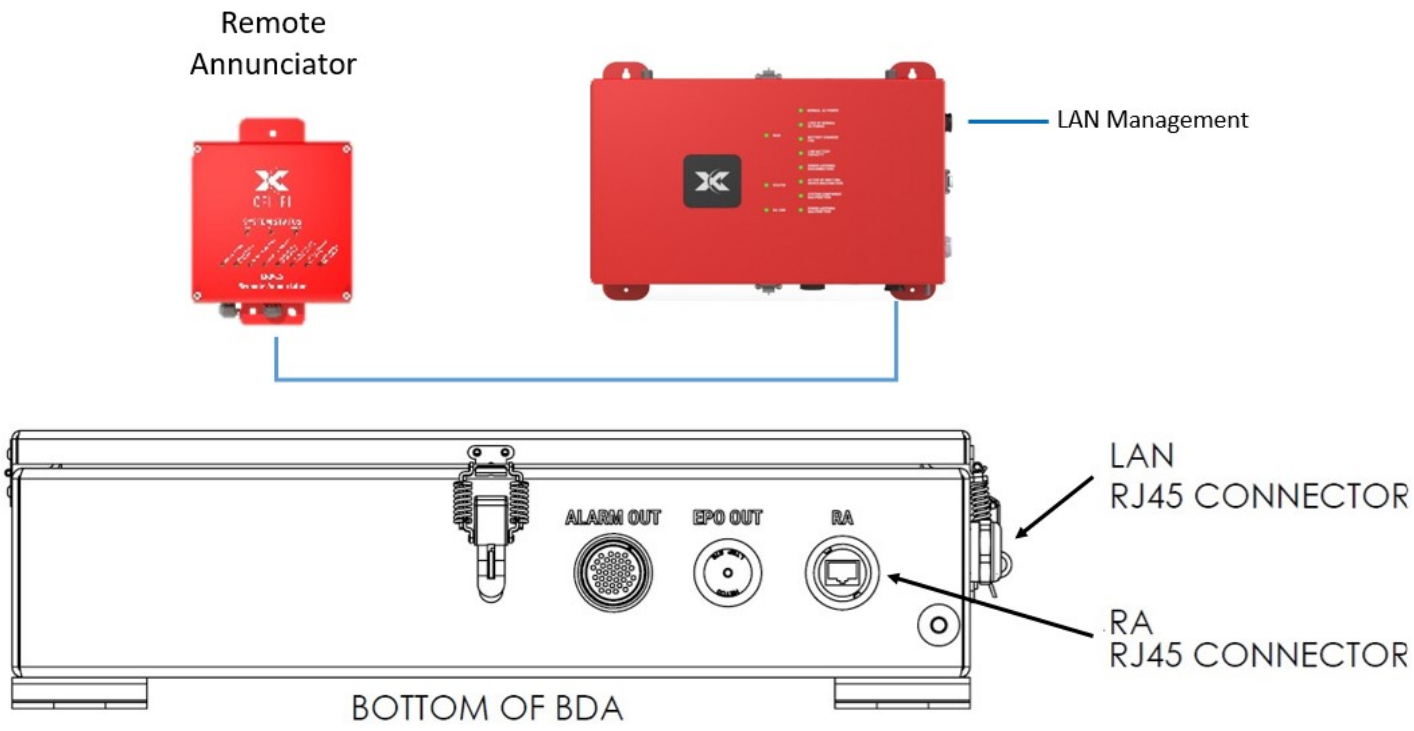
The wiring diagram below illustrates wiring for the entire system, including optional Remote Annunciator (RA) and Emergency Power Off (EPO) cables.



WAN and RA Ethernet Cabling

The BDA includes two RJ45 Ethernet cable ports to connect the BDA to the optional Remote Annunciator (RA), and to connect the BDA to the WAVE Portal remote network management system in the cloud (WAN port). The WAN port connection is optional, but highly recommended and is intended to be permanent, as it enables remote monitoring and diagnostics. Please refer to Appendix F – NMS (Portal) Firewall Settings for more information.

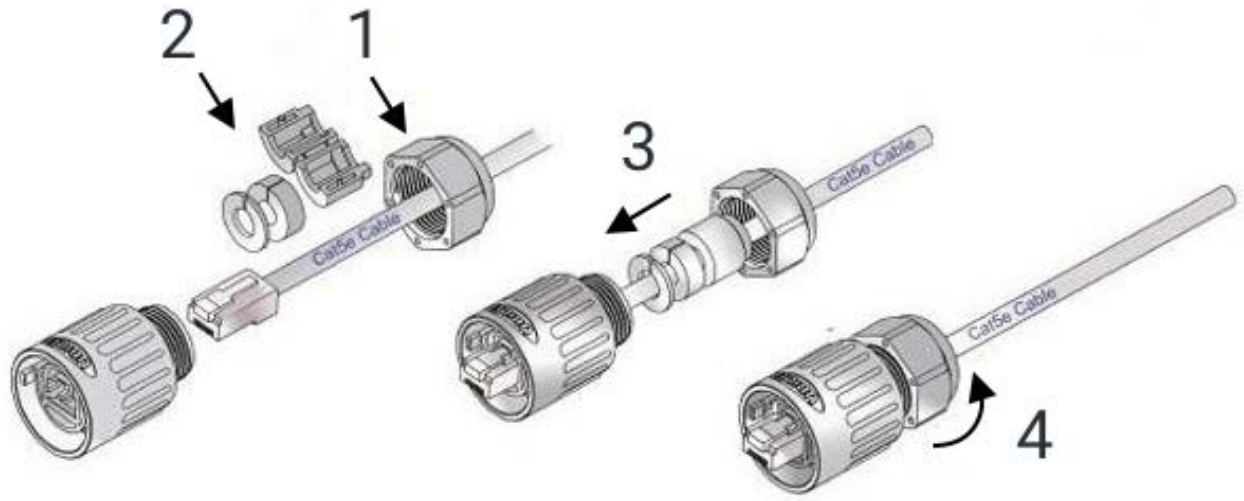
Ethernet cables and RJ45 connectors are not supplied with the system. However, waterproof RJ45 inline connector assemblies are provided in order to waterproof the cable end connectors (see instructions below).



Waterproof RJ45 Ethernet Connector Adapters

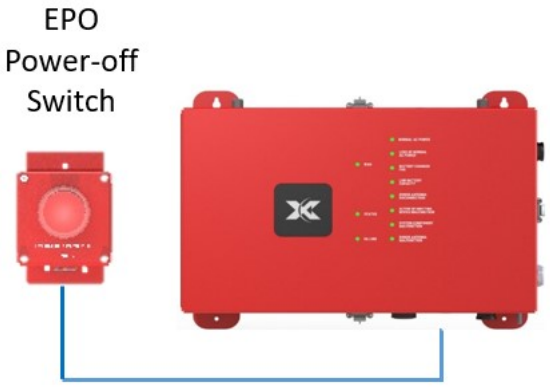
Use a CAT5e or better cable (24 AWG minimum) to connect the WAN and RA to the BDA. Once the Ethernet cables are connected, follow the instructions below to waterproof the connections at either end of each cable.

1. Pass the cable thru the screw-on cap
2. Insert the cable into the split sleeve and washers
3. Push the screw-on cap and washers in the receptacle
4. Apply on the screw-on cap a maximum mating torque of 4.1 - 6.1 in-lbs.



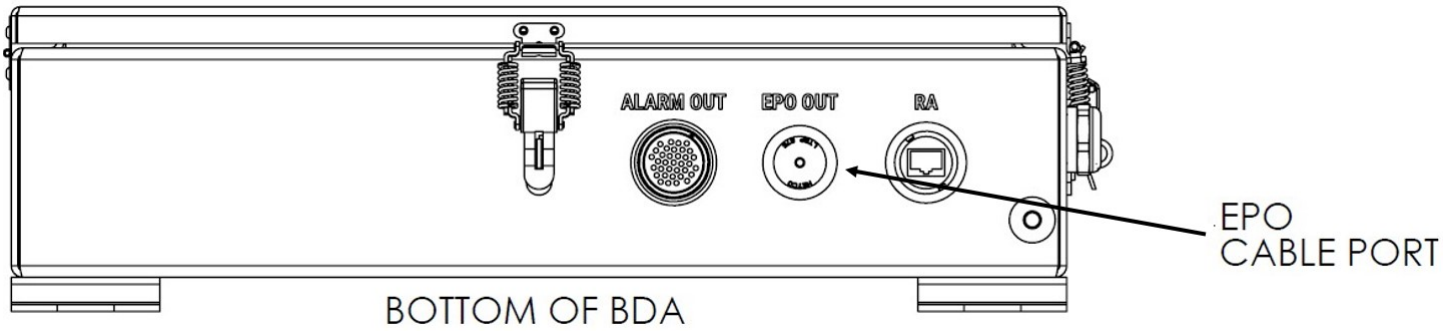
EPO Ethernet Cabling

The optional EPO switch also uses an Ethernet cable to connect it to the BDA, however the EPO switch does not use Ethernet signaling. It is merely a wired relay connection.

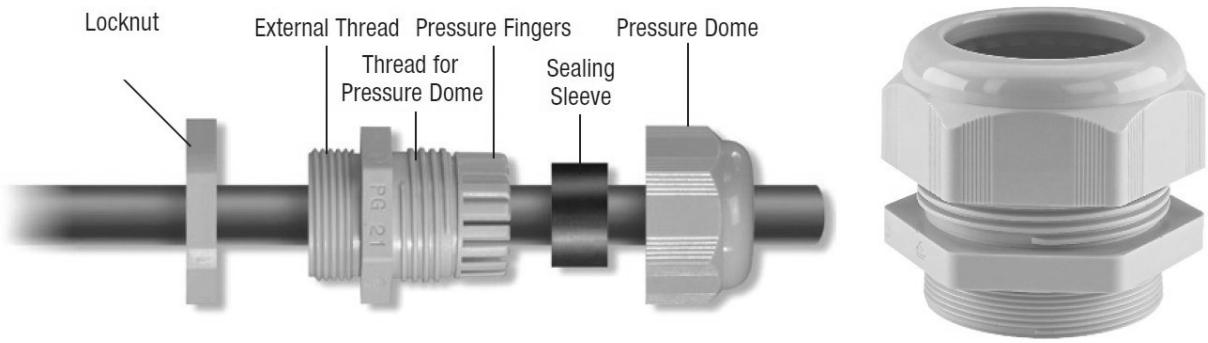


For the EPO switch end of the EPO cable, connect a standard RJ45 connector and waterproof the connector using the supplied RJ45 waterproof connector assembly, as illustrated in the previous section.

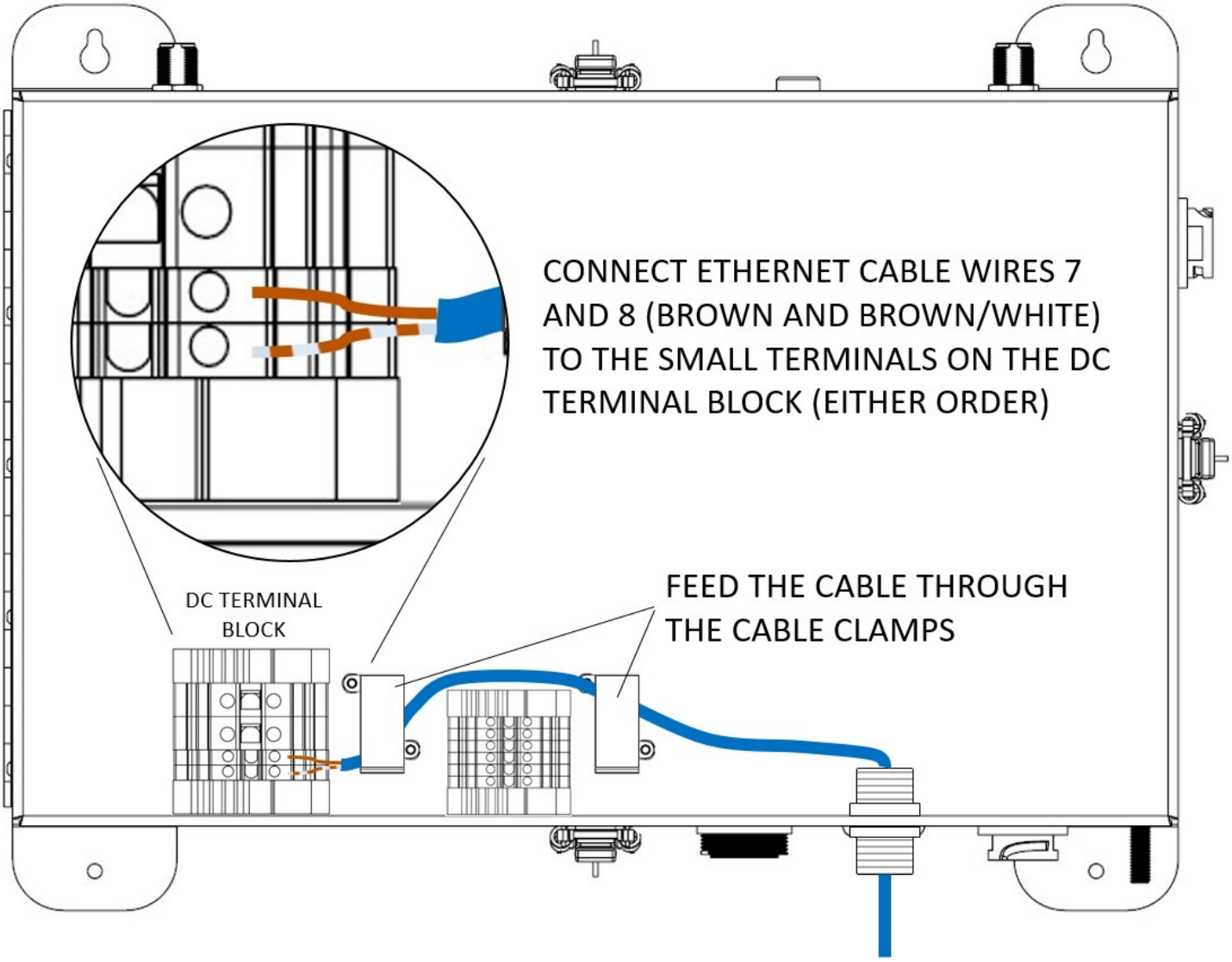
For the BDA end of the EPO cable, hardwire the cable to the BDA as instructed below (this allows the use of 3rd party EPO switches, and the EPO OUT cable hole supports ½ inch conduit if desired):



1. The EPO cable will pass into the housing and be secured with the supplied water-tight gland shown below.
2. Locate and remove the “EPO OUT” cable port plug on the bottom of the BDA housing.
3. Insert the threaded gland barrel into the housing hole from the outside of the BDA housing, and secure it internally with the locknut. The Pressure Fingers should be outside the housing.
4. Slide the Pressure Dome and Sealing Sleeve onto the cable, and feed the cable into the housing through the barrel about 18 inches.
5. Slide the Sealing Sleeve into the Pressure Fingers and secure with the Pressure Dome.
6. The barrel nut and Pressure Dome should be snug and the cable should not move. Do not over-tighten.

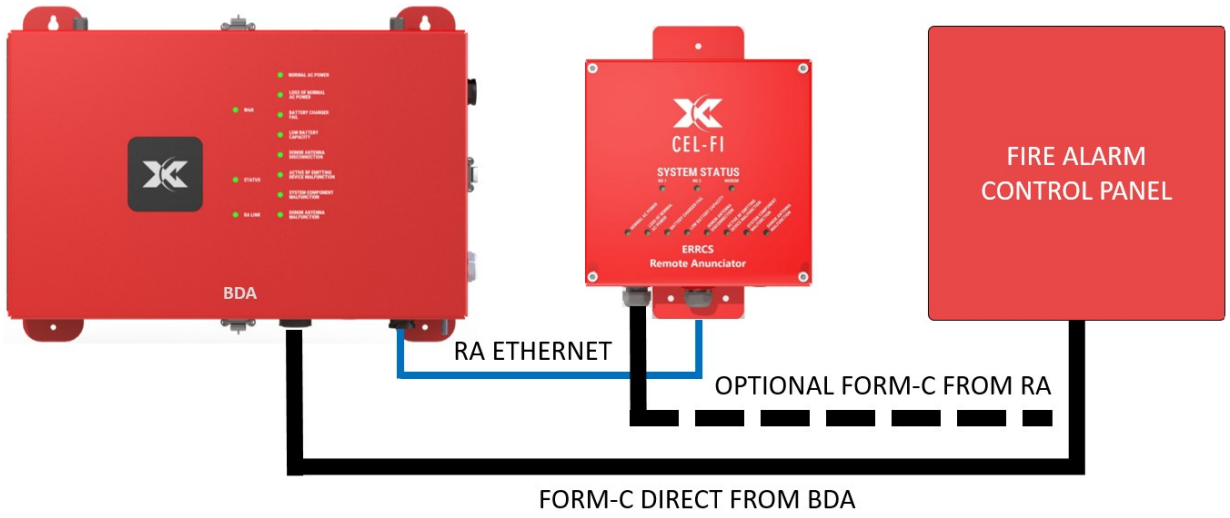


1. Route the EPO cable through the two cable clamps to the larger DC Terminal Block.
2. Strip ½ inch of wire insulation from wires 7 and 8 (the brown and brown/white wires) and screw securely into the two small terminal block ports.
3. The unused cable wires should be cut back to the cable jacket and may be protected with electrical tape. They are unused and not connected on the EPO Switch end of the cable.

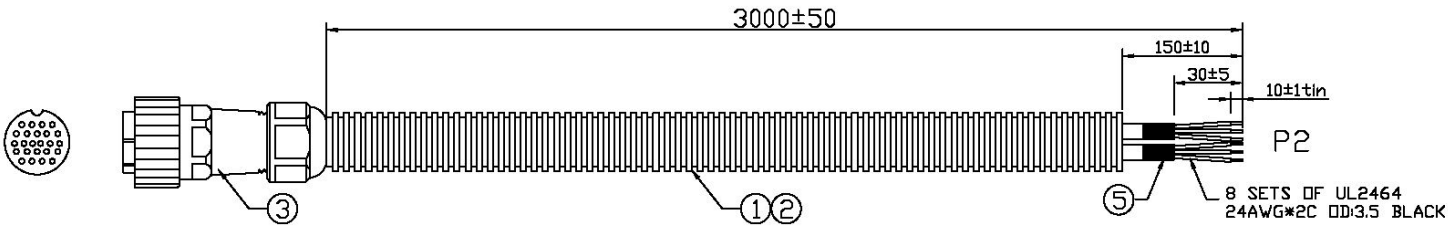


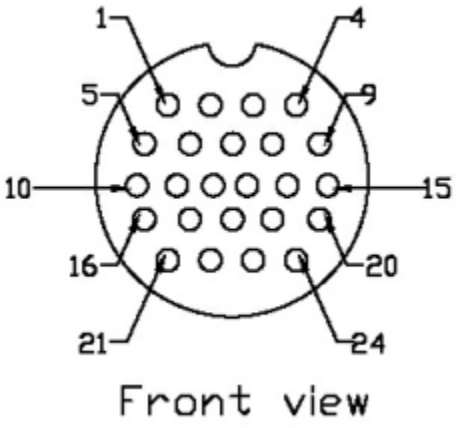
Fire Alarm Control Panel Cabling

Both the SOLO RED BDA and the optional Remote Annunciator use a Form-C cable to connect to the Fire Alarm Control Panel.

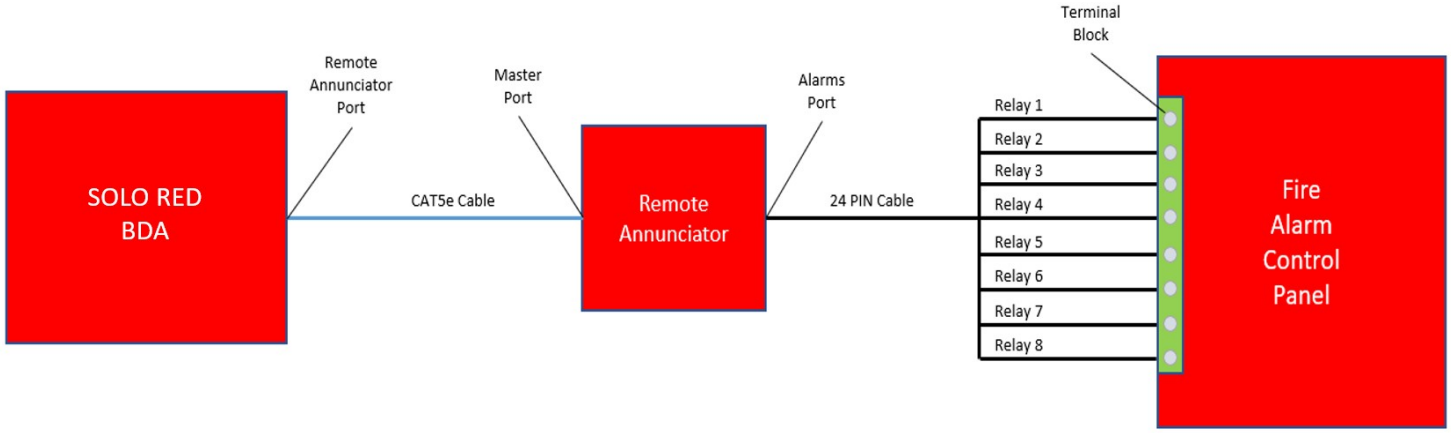


The included Form-C 24-pin cable may be used with the RA or the BDA to send alarm signals to the building Fire Alarm Panel. The cable has three pins per alarm. The first one is a normal-close signal, the second one is a common signal, and the third is a normal-open signal. Choose the appropriate signal according to the type of fire alarm control panel in the building.





1. When not using an RA, connect the Form-C cable from the ALARMS OUT port on the BDA to the Fire Alarm Control Panel.
2. When using an RA, connect an Ethernet cable between the MASTER port on the RA and the RA port on the BDA, using waterproof RJ45 inline connectors. Then connect the Form-C cable from the ALARMS port on the RA to the Fire Alarm Control Panel.
3. Choose the appropriate pins (normal-open / common / normal-close) to set up the alarms in the Fire Alarm Control Panel.



Alarm Cable Wire Chart

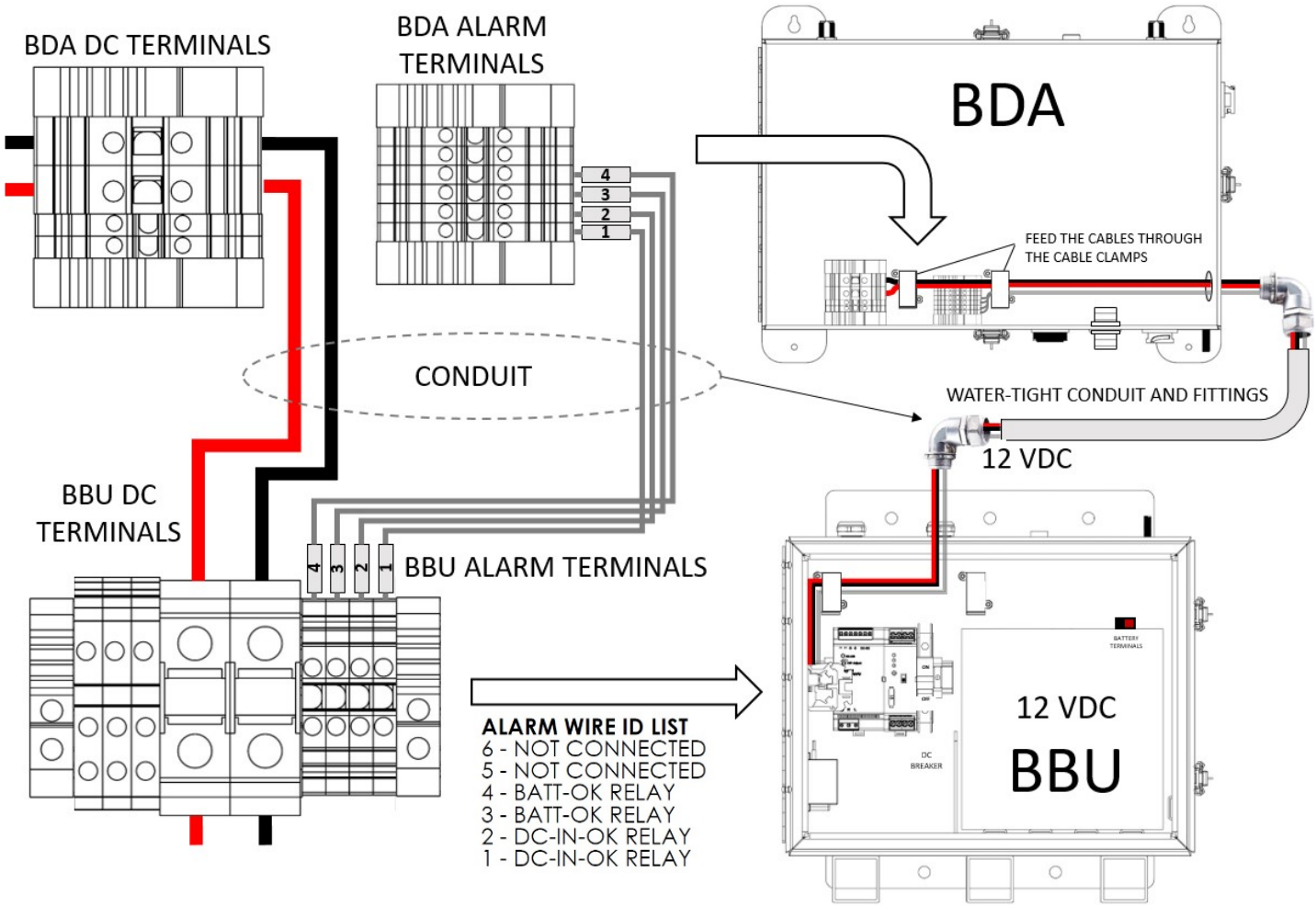
Alarm	Conductor Set	Wire #	Color	Pin #
Donor Antenna Malfunction	Red	**1**	Black	1 – Open
			White	2 – Comm
			Red	3 – Closed
System Component Malfunction	Blue	**2**	Black	4 – Open
			White	5 – Comm
			Red	6 – Closed
Active RF Emitting Device Malfunction	Yellow	**3**	Black	7 – Open
			White	8 – Comm
			Red	9 – Closed
Donor Antenna Disconnection	Gray	**4**	Black	10 – Open
			White	11 – Comm
			Red	12 – Closed
Low Battery Capacity	Green	**5**	Black	13 – Open
			White	14 – Comm
			Red	15 – Closed
Battery Charger Fail	White	**6**	Black	16 – Open
			White	17 – Comm
			Red	18 – Closed
Loss of Normal AC Power	Black	**7**	Black	19 – Open
			White	20 – Comm
			Red	21 – Closed
Normal AC Power	Orange	**8**	Black	22 – Open
			White	23 – Comm
			Red	24 – Closed

BBU to BDA Power and Alarm Connections

DC power wires, alarm wires and conduit are not supplied with the system. Use ½ inch water-tight conduit and fittings to route DC power and BBU alarm wiring to the BDA. These BBU alarms are for Loss of AC Power and Battery Charger Fail. All other alarms are triggered within the BDA.

See the wiring diagram below for terminal block wire connections within the BDA and BBU. The minimum DC cable gauge is 12 AWG. The minimum alarm wire gauge is 24 AWG.

Strip ½ inch of wire insulation from the end of each wire to be connected. Insert each wire into the appropriate terminal block socket and tighten the set screw. A gentile pull on each wire should not cause it to separate from the terminal block socket.



BBU Power Requirements:

All external circuits intended to be connected to non power-limited wire shall contain either current-limiting or overcurrent protection to prevent fault currents in excess of the current rating for the gauge wire size permitted by the National Electrical Code, ANSI/NFPA 70, or as specified in the installation wiring diagram/instructions.

BBU Main Supply Circuit:

The BBU must be wired to AC mains using ½ inch water-tight conduit and fittings.

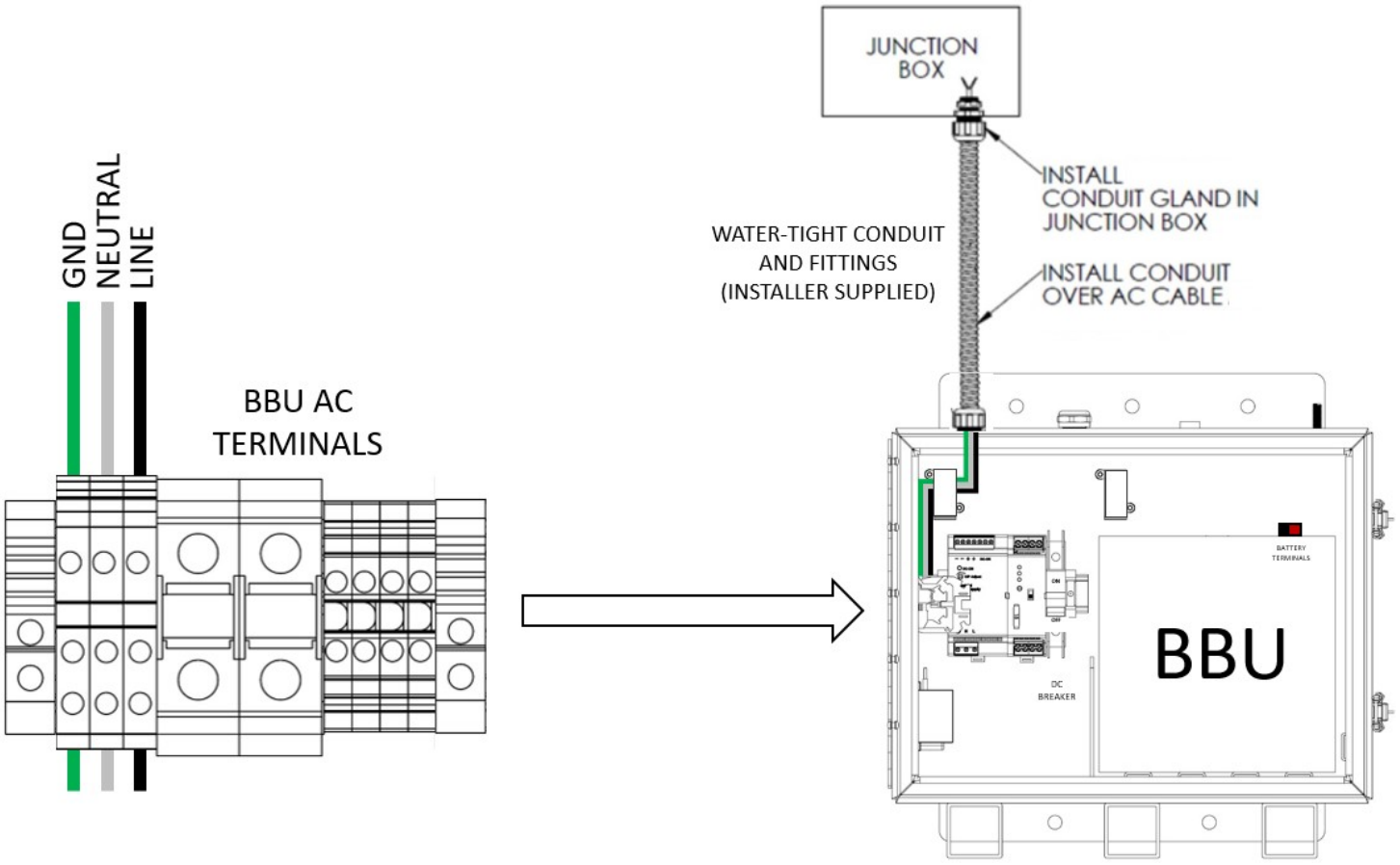
SOLO RED BBU INPUT POWER

VOLTAGE	125/230 VAC
CURRENT MAX	4.0/2.0A
FREQUENCY	50/60 Hz

Shut off AC main breaker panel power while wiring the BBU.

Follow the wiring diagram below for wiring AC power to the BBU. Feed the AC wires into the BBU housing using water-tight conduit. Pass the AC wires through the internal wire clamp to the terminal block as shown below.

Strip ½ inch of wire insulation from the end of each wire to be connected. Insert each wire into the appropriate terminal block socket and tighten the set screw. A gentile pull on each wire should not cause it to separate from the terminal block socket.



BBU Battery Charger

The current limit for the system is set to 12A with an output (and charging) voltage of 12-14VDC. The total current sourcing ability of the system is divided between the load and the battery charging function. At maximum average load, the maximum battery charging current is 6.8A.

Battery Type

A UL 1989 listed 80 AH battery shall be used (for 12 hour battery backup). The following battery is approved:

Capacity	Manufacturer Part Number
80 Ah	NPD-12-80

Battery Capacity

The battery backup system has been sized to provide 12 hours of backup capability per the requirements of UL2524. The information below shows that the reserved battery capacity exceeds 20% for the worst-case load conditions for all product configurations.

POWER CONSUMPTION	
Power to BDA	49.88 watts
Power to BBU	6.0 watts
Power to RA	3.60 watts
Active Antenna	2.50 watts
Total Power	**61.98 watts**
Total current from battery	**5.2 amps (@ 12 VDC)**
Standby time	12 hours
Required Ah battery	62 AH
Safety margin (per UL2524 47.11)	20%
Minimum Required battery	74.4 AH
Required battery selected	**80 AH**

BBU Power Output Circuit

The BBU has the following output power circuit:

Output	Min Wire Gauge	VDC (max)	Current (max)
BDA Power	12 AWG	+12 VDC	**5.2 Amps**

BDA Signal Output Circuits

The BDA has the following output signal circuits:

Output Ethernet	Min Wire Gauge	VDC	Current
WAN Ethernet (STD 10/100)	24 AWG	3.3 VDC	3.3 mA
Remote Annunciator Ethernet PoE	24 AWG	56 VDC	200 mA

BBU Signal Output Circuit

The BDA has the following output signal circuits:

Alarms Out	Min Wire Gauge	VDC	Current
Loss of AC Power alarm	24 AWG	3.3 VDC	3.3 mA
Battery Charger Fail alarm	24 AWG	3.3 VDC	3.3 mA

06. POWER-UP PROCEDURE

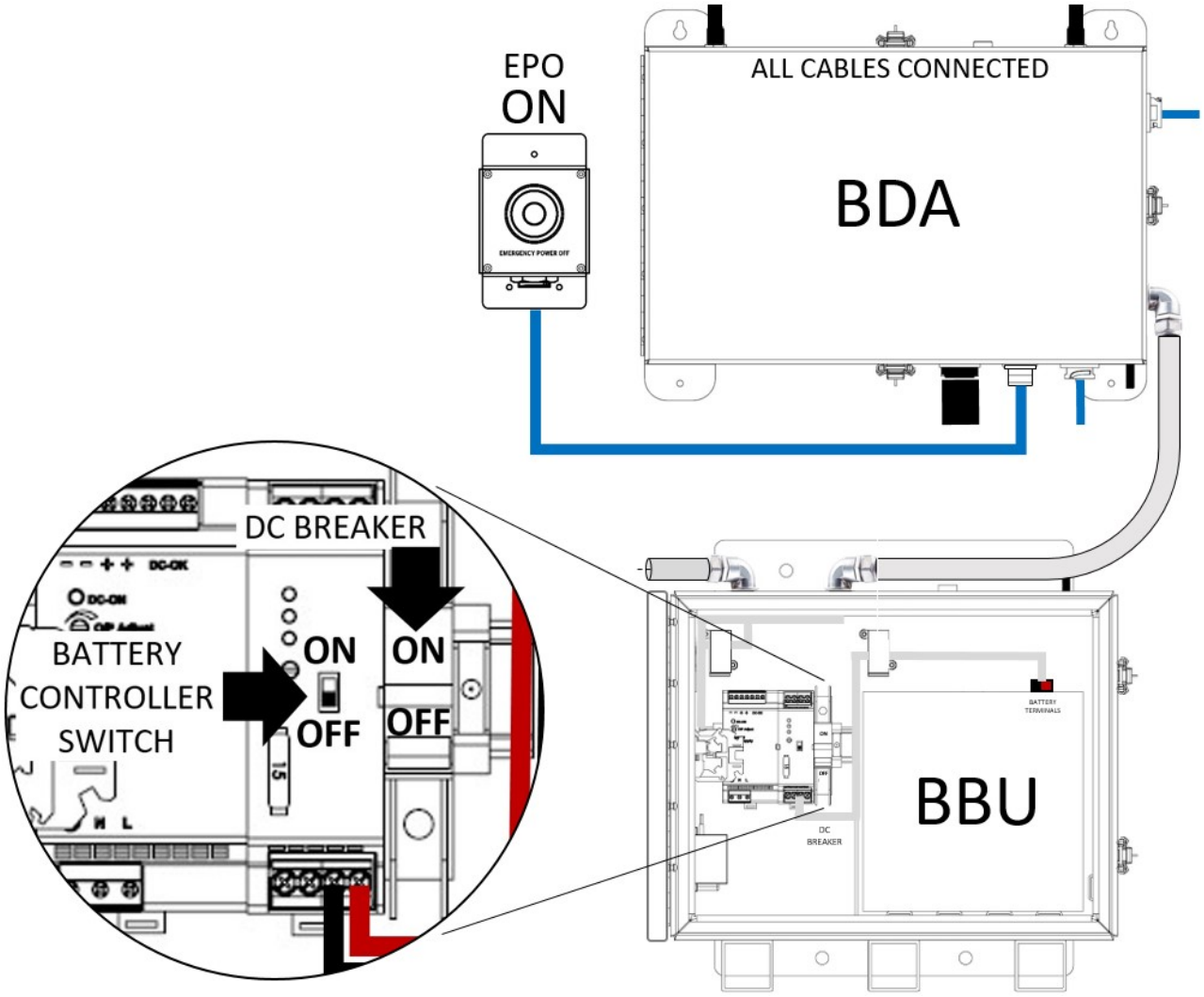
Before system start-up, all SOLO Red hardware should be installed and cabled. This includes all service antennas, and the LMR donor antenna which should have been aimed towards the High Site.

Note that the donor antenna must be a Cel-Fi Public Safety donor antenna, or a suitable 50 ohm LMR donor antenna with a QUATRA RED Donor Antenna Sensor 10k ohm resistor adapter.

Power ON the SOLO RED system

1. Power ON the AC Mains breaker to the BBU.
2. If EPO equipped, verify that the EPO Switch is on the ON position.
3. Open the BBU cabinet door panel and turn the TRACO POWER Battery Controller switch ON.
4. Turn the BBU DC breaker switch ON.
5. Temporarily close the BBU door panel and verify that the NORMAL AC POWER LED turns solid green (it may take a minute or two for any alarms to clear).
6. Verify battery voltage is approximately 12-14 VDC.
7. Close BBU and BDA doors and secure all door latches.

NOTE: The system interrogates and memorizes all system components upon power up. Always restart the system after adding or removing any Cel-Fi hardware components (RA, antennas, etc.).



Verify the Connection to the WAVE Portal

Once the BBU is powered up, the BDA will automatically connect to the WAVE Portal over the internet (WAN port).

To access to the portal or request access, click on the appropriate link below:

- Portal access URL: https://wave.cel-fi.com/#/login
- Request portal access: www.cel-fi.com/account-request

Log onto the portal, select New Systems on the Dashboard tab, and search for your system by NU serial number. If you do not see your NU serial number, select **Request Access** from the Options menu on the Access tab, or contact your point of sale for assistance.

07. SYSTEM CONFIGURATION

Once you have all the SOLO RED components installed and energized, the next step is to configure and commission the system. Helpful tutorial videos of the process below may be found by selecting your product at https://www.cel-fi.com/support/

NOTICE TO USERS, INSTALLERS, AUTHORITIES HAVING JURISDICTION, AND OTHER INVOLVED PARTIES:

This product incorporates field-programmable software. In order for the product to comply with the requirements in the Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems, UL 2524 certain programming features or options must be limited to specific values or not used at all as indicated below.

Program feature or option	Permitted in UL 2524? (Y/N)	Possible Settings	Settings permitted in UL 2524
Channel, Isolation, Uplink Power	None	None	None

The general process to commission SOLO RED:

WAVE Portal (Refer to the Appendix section for Firewall Settings):

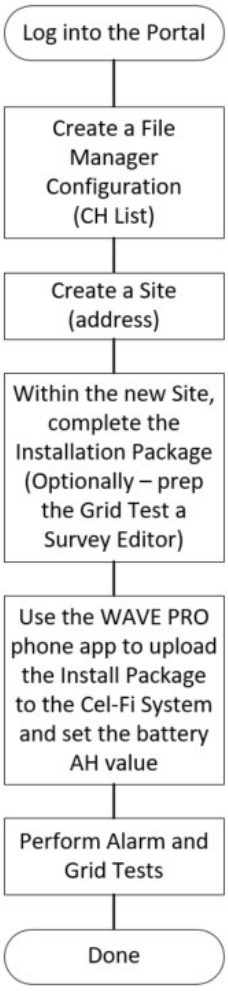
1. Create a channel list for the High Site in the File Manager tab of the portal
2. Create a Site (install address used for calculating UL power)
3. Within the newly created Site, complete the Install Package
4. OPTIONAL: From the Site page, select Options>Survey Editor and create floorplan grid layouts. These are only needed if you intend to use the COMPASS/COMPASS RED to perform Grid Tests of coverage.

WAVE PRO App:

1. Install the WAVE PRO App on your mobile phone and enable Bluetooth
2. Connect the app to the BDA over Bluetooth
3. Select the Install Package option, select the desired Install Package, and upload the Install Package to the system. The system will then calibrate.
4. Within the app, select Battery Capacity and input the battery AH capacity.
5. Your system is now fully operational.

Additional WAVE PRO app features:

- Aim donor antennas
- Run the battery capacity alarm test
- Upload edited Install Packages (for example if you needed to manually adjust the UL power)
- Perform DL Grid Tests using COMPASS RED
- Perform UL Grid Tests using an FRS radio



The WAVE PRO app is available for Android and IOS devices. Scan the QR codes below to download and install the app in your mobile phone.

Google Play

App Store

Detailed Commissioning Instructions

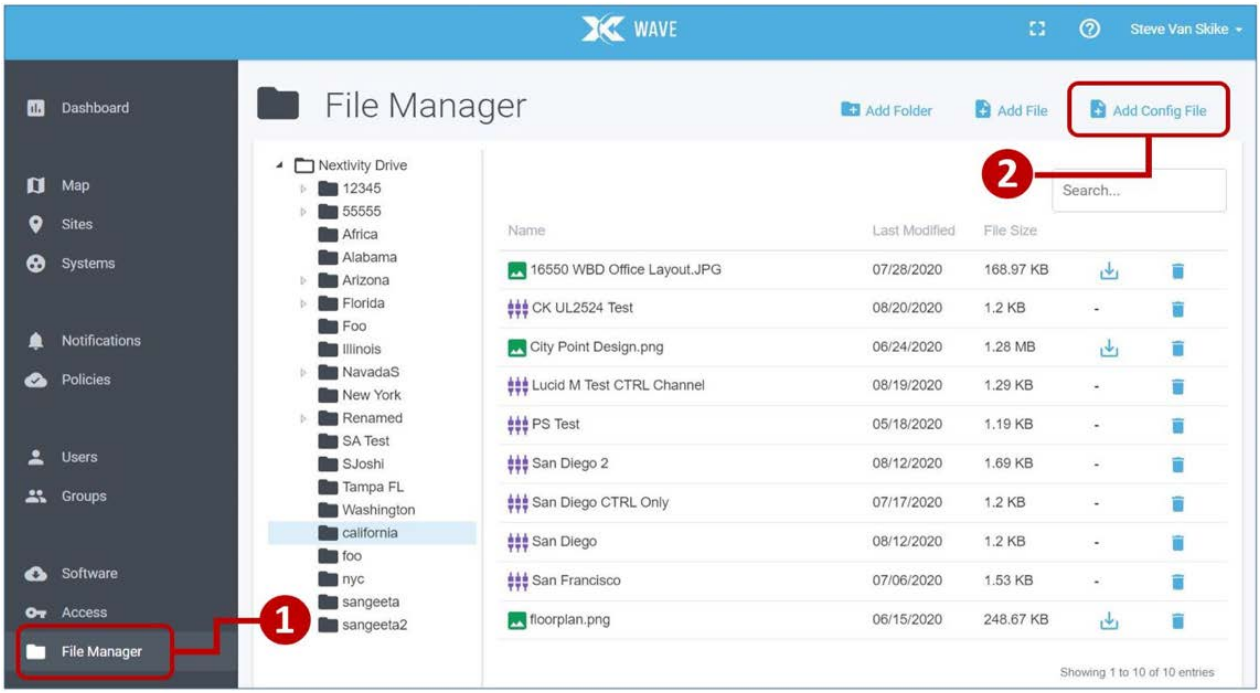
This section details the commissioning process using the WAVE Portal and WAVE PRO app.

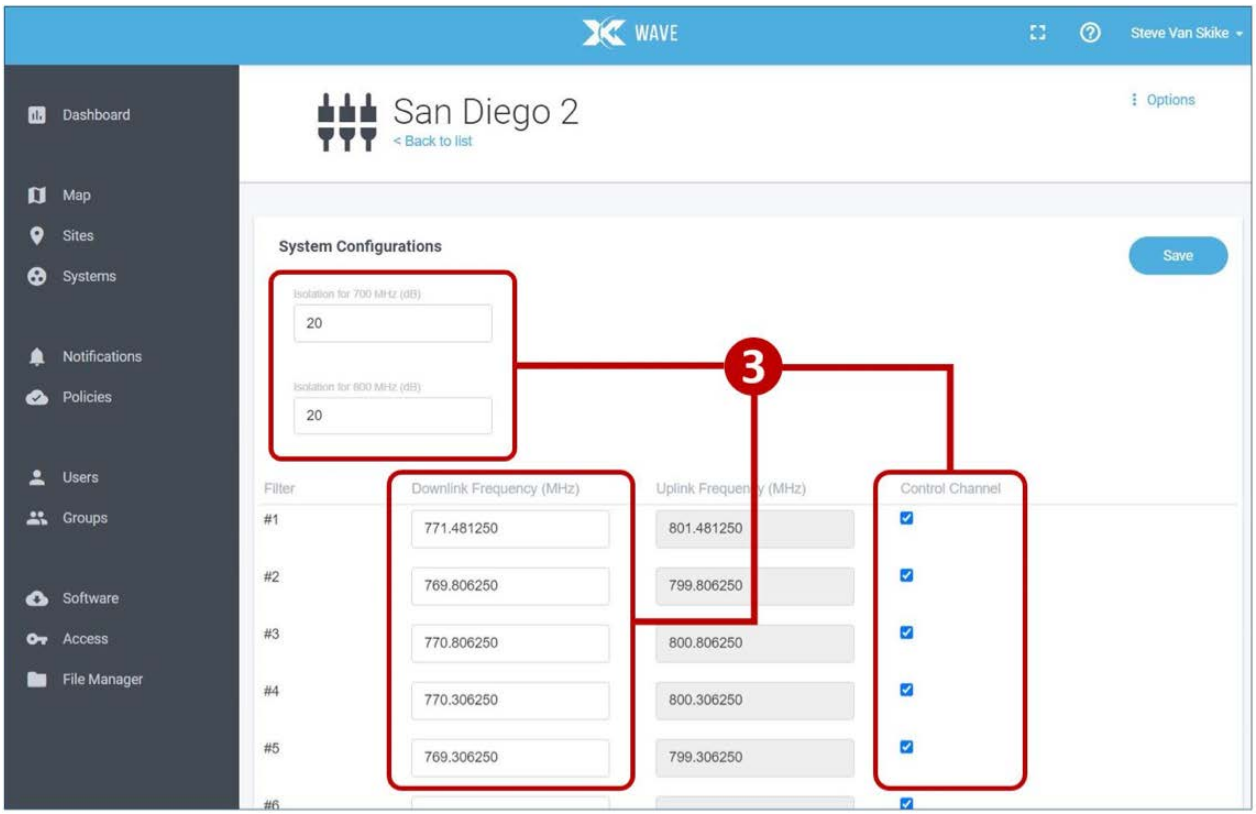
STEP 1 - Use the Portal File Manager to Create a Configuration file

The File Manager is where you create and manage High Site configuration files (LMR channels, Class A/B, and Isolation targets). This configuration file may be reused by other project sites within a jurisdiction. You may also save files such as documents and photos for your projects in the File Manager.

To create a configuration file:

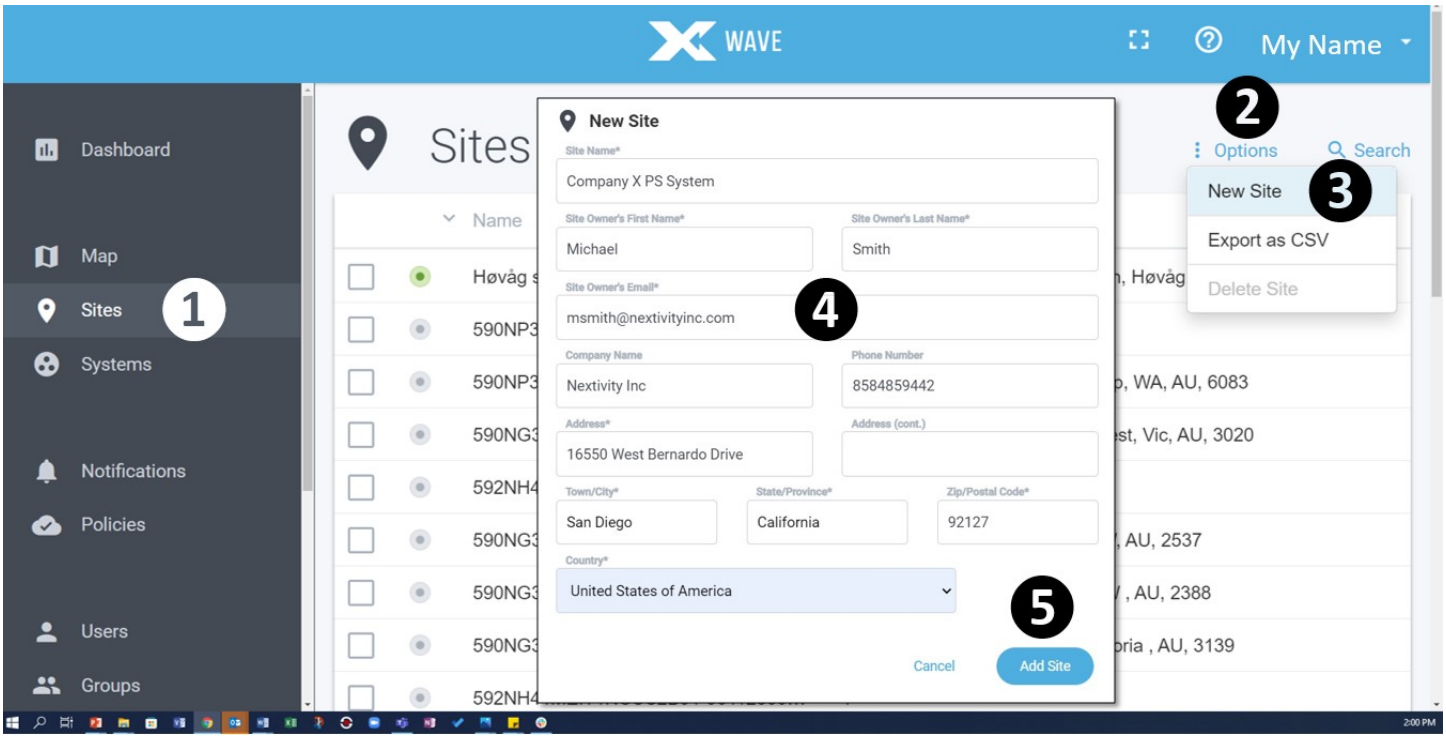
1. Click on the **File Manager** tab on the left edge of the portal screen.
2. Click on the **Add Config File** button, enter a name for the new config file, and click **Add** to save your file.
3. A new window will open for you to enter isolation values and frequencies according to the requirements in your area. Notice that only the **Downlink Frequency** box needs to be filled in, and mark the channels serving as control channels. If selecting Class B operation, please also select the desired **Filter Bandwidth** for each channel. Click **Save** to save the file.





STEP 2 – Create a Site

From the Sites tab, select **New Site** under the **Options** menu and add your new Site. The site address will be used by the system to calculate UL power and a donor antenna heading to the High Site.



STEP 3 – Create the Installation Package

The portal will take you to the newly created Site, or you can find it using the **Search** function on the Site page.

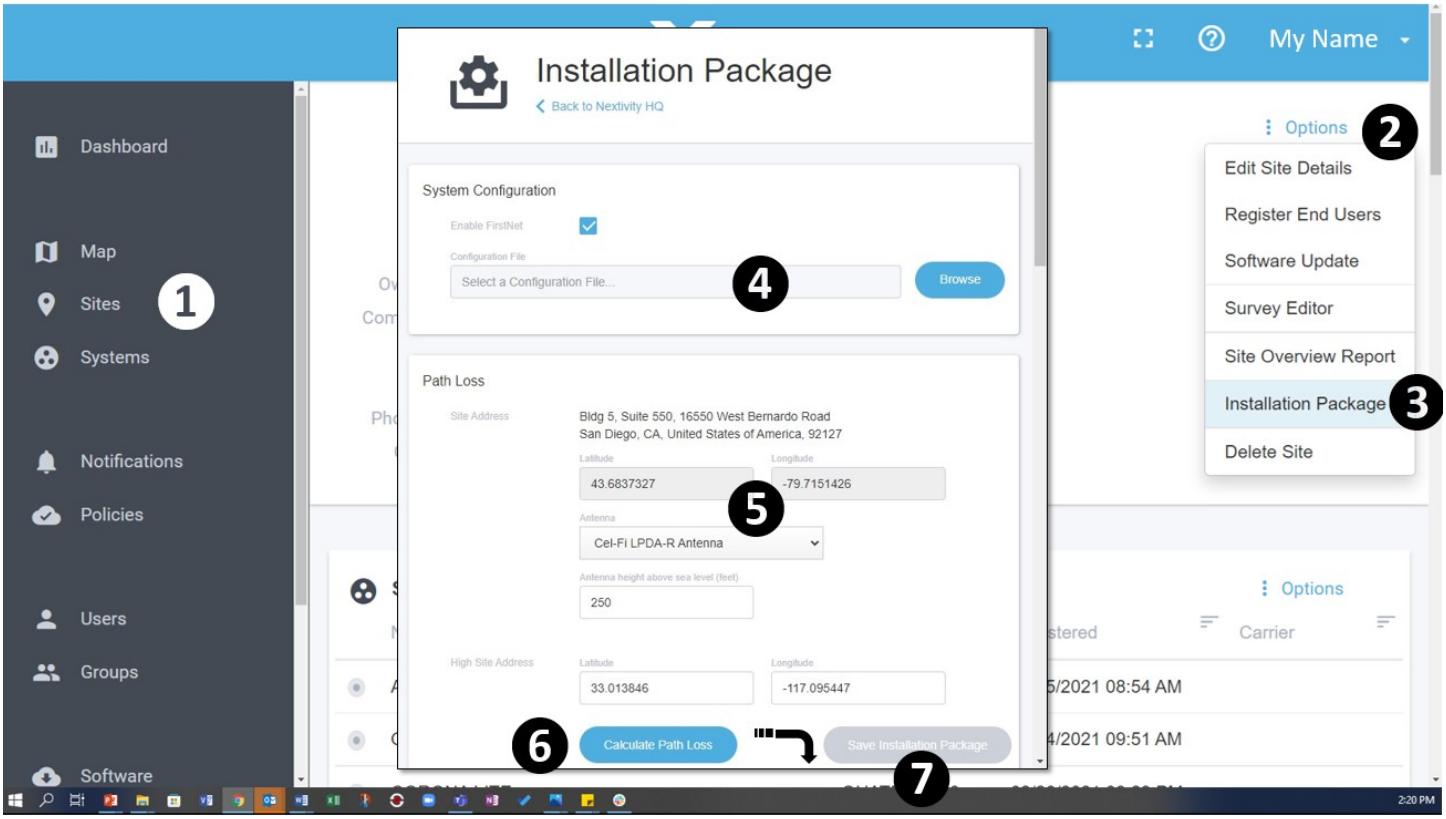
From the newly created Site, select **Installation Package** from the **Options** menu. Select the config file (channel list etc.) you created that belongs with this project Site jurisdiction, and complete the rest of the form. The High Site Latitude and Longitude must be entered in decimal format (easily generated using various apps such as Google Earth).

Select **Calculate Path Loss** to have the portal calculate the path loss from the donor antenna to the High Site.

Then continue entering link budget information further down in the Install Package form, and finally select **Save Installation Package**.

NOTE: Any form data in a box may be edited now, or in the future if changes to the link budget are necessary.

All SOLO RED setup information has now been generated, and is ready to be uploaded into SOLO RED using the WAVE PRO app to complete the installation and put the system into service



OPTIONAL – Survey Editor

If performing DL or UL Grid Tests with the COMPASS tool, select the **Survey Editor** from the **Options** menu. This editor lets you quickly input floorplans, critical areas, equipment locations, and grids that the WAVE PRO app accesses when performing measurement Surveys. See COMPASS documents for more information.

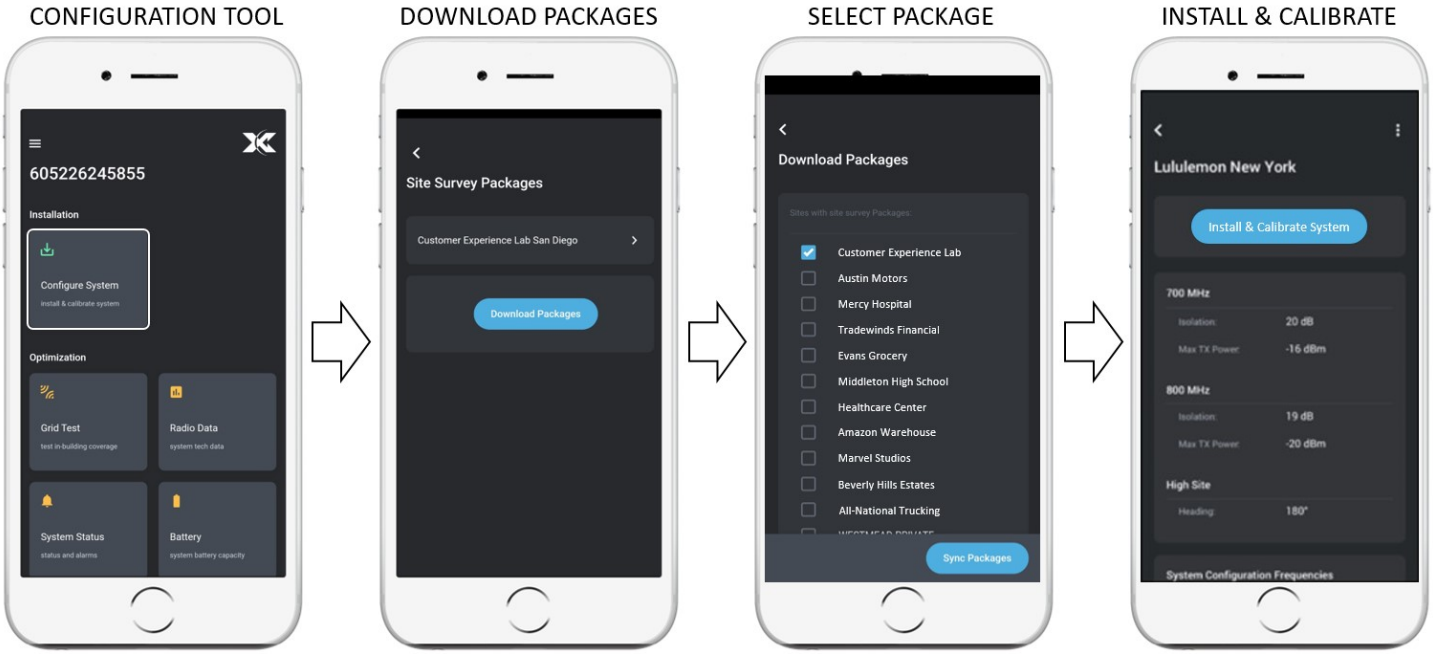
STEP 4 - Use the WAVE PRO app to load the Installation Package into the BDA

In this final step, you will use the WAVE PRO app to upload the Installation Package into the BDA and calibrate the system.

The Cel-Fi WAVE App is designed for end-users, installers, and channel partners to activate and manage the Cel-Fi product line. The app connects to the system via Bluetooth and is available for smartphones and tablets.

Follow these steps to configure your SOLO RED System:

1. Open the WAVE PRO app in the presence of the BDA.
2. The app will auto-connect if only one system is found, or you may select it from a list.
3. Select **Configure System** to run the configuration tool.
4. Select **Download Packages** (you may be asked to log into the portal).
5. Select the desired Installation Package from the list and click **Sync Packages** to load them into the app.
6. Select **Install & Calibrate System**. Your system is now ready to provide Public Safety service.
7. You can make changes to the configuration in the portal at any time, and upload the new configuration to your SOLO RED system using the app.



Set Isolation using the app

SOLO RED automatically calculates and sets isolation according to any value given. The default isolation value is 20 dB. To enter a new value for isolation:

1. Click on the current isolation value
2. Type-in the new value
3. Click on calculate and set

A message will appear on the screen once the system has been adjusted to the new value.

If you can't achieve enough isolation, you can try one of the options below:

1. Increase the spatial separation between the donor and the closer server antenna.
2. Try a larger value for the coupler feeding the antenna causing the issue
3. Look for a donor antenna location with some physical obstructions such as walls or columns.
4. If you're using a wide-angle donor antenna, consider replacing it by a high-isolation antenna.

Set Uplink power using the app

In this section, you will learn how to set a value for the output transmit power to reach the high-site without blocking the receiver. Two pieces of information are required to determinate the most optimal value. Decimal coordinates from both the high-site and SOLO RED and the desired signal level reaching the remote site (the default value is -95dBm).

1. Open the WAVE PRO app and select **Uplink output power configuration**.
2. Enter the coordinates of the remote site.
3. Enter the coordinates of the building.
4. Enter the desired value in dBm to reach the high-site.
5. Press the **Calibrate** button and wait until you see the message "System has been calibrated."

Appendix A - Required Tools

The following are the recommended list of tools for new installation and routine maintenance.

- Slotted Screwdrivers (2.5mm, 3.5mm, 7mm)
- Philips Screwdriver
- Wrench set (Assorted metric and standard sizes)
- Masonry drill bit (¾” or 19mm)
- Electrically operated drill and masonry drill bits (Assorted size: 5~10mm)
- Anti-static Wrist Strap
- Side Cutter
- Voltmeter (e.g., Fluke)

Appendix B - Diagnostics and Testing

General System Alarms

Alarm	Description	Troubleshooting
NU1	NA	NA
Modem	NA	NA
Normal AC Power	Normal operation. Not an alarm	NA
Loss of Normal AC Power	AC power interruption, battery backup is engaged	Check AC power source and wiring. A fully depleted battery will recharge once AC power has been restored, but the BBU will remain in alarm until battery capacity has been restored.
Battery Charger Fail	Battery charging fault	Make sure the battery cables are clean and properly connected, and that the DC breaker is ON. A battery that has failed or are not sufficiently charged may cause this alarm. Allow the battery to charge, and test the battery if the alarm does not clear.
Low Battery Capacity	The BBU has detected less than optimum battery capacity	See the Preventative Maintenance section for more information.
Donor Antenna Disconnection	There is a coaxial disconnect to the donor antenna	Check donor antenna, coax, and connectors. The DC resistance at the donor antenna port should measure 10k ohms. Note that a lightning arrestor must be DC pass-through. The donor antenna must be a Cel-Fi Public Safety donor antenna with 10k resistor, or a suitable antenna with a 10k ohm QAUTRA RED Donor Antenna Sensor.
Active RF Emitting Device Malfunction	The BDA is malfunctioning	Go to the WAVE Portal for alarm information and guidance.
System Component Malfunction	One of the SOLO RED components is reporting an alarm	Observe the LEDs states for all components, and log onto the portal for diagnostic information. If a RA or monitored antenna is added or removed, restart the system so all hardware reregisters with the system.
Donor Antenna Malfunction	The donor antennas is reading improper impedance	Check donor antenna, coax, and connectors. The DC resistance at the donor antenna port should measure 10k ohms. Note that a lightning arrestor must be DC pass-through. The donor antenna must be a Cel-Fi Public Safety donor antenna with 10k resistor, or a suitable antenna with a 10k ohm QAUTRA RED Donor Antenna Sensor.

Alarm Testing

FACP Alarms	Meaning	How to Test the Alarms
Loss of Normal AC Power	The MBBU/MU/BDA is no longer being supplied with AC power and is running on battery backup.	Turn off the AC breaker in the MBBU/BBU or from the mains circuit feeding the unit.
Battery Charger Fail	Turn off the DC breaker on the	Turn off the DC breaker in the MBBU/BBU or unplug a battery cable (be careful not to short the battery cable to the housing or another battery terminal).
Low Battery Capacity	Battery capacity has been depleted to 30% or a battery is failing to hold a charge properly.	Method 1) Run the Battery Capacity Test on the WAVE PRO phone app and follow the directions. 2) Turn off AC power and let the system run on battery power until the alarm triggers.
Donor Antenna Disconnection	There is a coaxial disconnect to one or more donor antennas	Disconnect a donor antenna feed.
Active RF Emitting Device Malfunction	An active RF device such as an NU, CU or BDA has malfunctioned	Disconnect a CU cable for QUATRA RED, or disconnect the SOLO RED internal BDA DC power plug.
System Component Malfunction	A component of the system has malfunctioned	Unplug the RA or Active Service Antenna if used. Or disconnect the SOLO RED internal BDA DC power plug.
Donor Antenna Malfunction	The donor antenna is connected but is having an impedance problem	Connect an Attenuator in-line with the donor antenna cable.

Additional (non-FACP) Alarm Testing

Additional MU/BDA/RA LEDs	Meaning	How to Test the Alarms
NU/Status	The NU is reporting an error (normally off, red if in alarm)	While the system is operating normally, unplug the Ethernet cable connecting the NU and MBBU/MU.
MBBU/MU/RA LINK	If an RA is used, the RA monitors its link to the MBBU/MU, and the MBBU/MU monitors its link to the RA. A green LED indicates normal operation.	While the system is operating normally, unplug the Ethernet cable connecting the MBBU/MU and RA.

WAN/MODEM	Your system may connect to the cloud NMS Portal with a modem or LAN. Green is operating normally.	While the system is operating normally, unplug the LAN/WAN cable if a LAN is used. If a modem is used, remove the modem antenna connection.

WAVE Portal Alarms

The WAVE portal has additional system alarm capabilities that go beyond what the Remote Annunciator and Fire Alarm panel can provide. These alarms and troubleshooting guidance are shown in the table below.

Bit	Variable Name	Category	Definition	UI Message
0	PS_STATUS_SYSTEM_OSCILLATION	Oscillation	The system detected Oscillation potential and reduced its gain.	Check the isolation parameters in the configuration file try to commissioning the system again. You may need to increase the isolation value or the spatial separation between donor and server antennas.
5	PS_STATUS_FINAL_OKTORELAY_FAIL	LINK	Final OkToRelay results fail	Check the channel configuration on the install package. If the issue persists, please contact technical support.
6	PS_STATUS_LMR_PS_ANTENNA_MALFUNCTION	DONOR ANTENNA	LMR PS antenna malfunction	The antenna may be damaged or is the wrong type. Use Cel-Fi antennas A62-V44-200 or A32-V32-201 only.
7	PS_STATUS_LMR_PS_ANTENNA_DISCONNECTED	DONOR ANTENNA	LMR PS antenna disconnected	The cable from the donor antenna is disconnected or damaged. Reconnect or replace the cable to clear the alarm.
8	PS_STATUS_ETHUNKER_FREQ_CLEAR_FAIL	BBU LAN	FREQ HAMMS msg fail (Ethunker)	The BBU is experiencing an abnormal operation; please contact support for assistance
9	PS_STATUS_FLASH_FREQ_TABLE_CRC_ERROR	FLASH Memory	FREQ TABLE CRC Error	The unit found an error, please try again or contact support for assistance

10	PS_STATUS_CALIBRATION_UL_FAIL	CALIBRATION	Calibration UL Fail	The calibration process couldn't be completed. Check the parameters in the configuration file and clear all the alarms in the system.
11	PS_STATUS_CALIBRATION_DL_FAIL	CALIBRATION	Calibration DL Fail	The calibration process couldn't be completed. Check for errors or alarms and try again.
23	PS_STATUS_HAMMS_TCPIP_CONN_FAIL	BBU Management	TCP/IP connection fail	Check the WAN configuration and cable connections. If the problem persists, please contact technical support.
25	PS_STATUS_FLASH_SYSGAIN_TABLE_ERROR	CALIBRATION	SYSTEM Gain table Error	The system gain cannot be calculated. Check the parameters in the configuration file and try again. Contact technical support if the issue persists.

Appendix C - Unit LED Status Tables

BDA LED User Interface

The table below shows the NU LED display panel (front) to indicate system status.

	Normal OK Status	Alarm
Normal AC Power	Green	Off
Loss of normal AC power	Off	Red
Battery Charger Fail	Off	Red
Low Battery Capacity	Off	Red
Donor Antenna Disconnection	Off	Red
Active RF Emitting Device Malfunction	Off	Red
System Component Malfunction	Off	Red
Donor Antenna Malfunction	Off	Red

RA LED User Interface

The table below shows the color coding for any alarm condition in the Remote Annunciator. Alarm LEDs will be OFF if there is no alarm. If an alarm is present LEDs will be RED.

In the event that power from the BBU is lost, the RA will continue to display the last known alarm state using its internal battery. To silence the alarms, press the EPO Switch. This will also trip the AC/DC breakers in the BBU. To restart the system, reset the EPO Switch and turn on the DC breaker within the BBU.

	Normal OK Status	Alarm
Normal AC Power	Green	Red
BBU Link	Green	Red
Loss of normal AC power	Off	Red
Battery Charger Fail	Off	Red
Low Battery Capacity	Off	Red
Donor Antenna Disconnection	Off	Red
Active RF Emitting Device Malfunction	Off	Red
System Component Malfunction	Off	Red
Donor Antenna Malfunction	Off	Red

Appendix D - Preventative Maintenance

BBU Main Battery and Charging

Nextivity recommends a Deep-Cycle battery (inspect and maintain BBU battery according to battery manufacturer instructions).

Normal Battery Voltage	12VDC
Charge Voltage	12-14VDC
Current (Max)	12A

Once a year, inspect the BBU battery for cracks or corrosion, and make sure wires and battery connections are not loose or corroded. Clean and tighten battery terminals if needed.

If the BBU Low Battery Capacity LED alarm is triggered, perform the following tests:

Step 1: Open the BBU door panel and power down the BBU by switching OFF both DC and AC circuit breakers.

Step 2: Remove all battery wire terminals, being careful not to short any wires to the BBU housing. Inspect and clean battery terminals and wire connections. Measure the Open Circuit voltage of each battery. The volt meter negative tester lead must connect to the battery's negative post and the positive tester lead to the positive post.

Step 3: If your battery displays a charge within the 12.85 to 12.95 range, it is 100 percent charged. The battery should measure within this range if freshly charged. A voltage of 12.65 means it is only 75 percent charged, while a 12.35 reading correlates to a 50 percent charge. A voltage reading of 10.5 volts or lower usually indicates a dead or damaged cell battery which must be replaced.

Step 4: If any battery fails to fully charge after the wire terminators and battery terminals have been cleaned and properly attached, replace the battery.

Remote Annunciator Internal Lithium Battery

The RA internal battery requires no maintenance and it not user replaceable.

Other System Components

The EPO does not require maintenance.

Appendix E - General System Specifications and Dimensions

System RF Specifications (50 ohm)

	LMR	
	700	**800**
Frequency Range, Downlink (MHz)	768-775	851-861
Frequency Range, Uplink (MHz)	798-805	806-816
Technology	P25/Analog	P25/Analog
Downlink Output Power (dBm)	27	
Uplink Output Power (dBm)	26	
Minimum Input Level (dBm) (DL/UL)	-100 / -91	
Maximum Input Level (dBm) (DL/UL)	-35 / -20	
System Maximum Gain (dB)	100	
Noise Figure at Max Gain (dB)	5	
Return Loss (dB)	-8	
System Group Delay max @ 12.5 kHz (usec)	35	
Operating Temperature	0°C - 50°C	
Operating Humidity	95%	

BDA

Width	**Height**	**Depth**	**Weight**
460 mm	290 mm	118 mm	9.1 kg

BBU

Width	**Height**	**Depth**	**Weight**
436 mm	391 mm	304 mm	7.3 kg (without battery)

Remote Annunciator Panel

Width	Height	Depth	Weight
115 mm	230 mm	230 mm	2.5 kg

Power	PoE
Output Connector Type	RJ45

EPO Switch

Width	Height	Depth	Weight
100 mm	94 mm	140 mm	0.25kg

Switch Type	NC
Output Connector Type	RJ45

Appendix F – NMS (Portal) Firewall Settings

Cel-Fi SOLO RED uses the Nextivity's WAVE platform to perform management and reporting functions. To facilitate this, the Cel-Fi QUATRA Network Unit is connected to the internet through the install site LAN. Typical data payload is around 2kBytes once per hour, or 17 MB per year (system health data) or can increase temporarily during software updates or for remote troubleshooting. Commissioning requires this internet connection, even if temporary. Ping (ICMP) is not supported.

The WAVE system requires the following networking access:

1) DHCP (standard UDP port 67)
2) DNS (standard UDP port 53)
3) ntp.cel-fi.com (standard UDP port 123, used for internal certificate validation only.)
4) iot.cel-fi.com (TCP port 443 (HTTPS))
5) NextivityIoTHubQA.azure-devices.net (TCP port 443 (HTTPS))
6) nextivitystorageqa.blob.core.windows.net (TCP port 443 (HTTPS))

Connections are always initiated from the device side. There is no need to configure any inbound ports on the firewall, thereby reducing exposure to external threats. To achieve both these attributes and still remain responsive to external commands, QUATRA uses Websockets. Websockets is a lightweight IETF protocol that is built on top of HTTP and establishes persistent TCP connections between a client and server. Since the connection is initiated on client side and uses regular HTTPS, typically no special inbound firewall configuration is needed, yet commands can be delivered to the device in real-time.

- SOLO RED Installation Videos
- SOLO 4000 Installation and User Guide
- SOLO 1000/2000 Installation and User Guide
- Frequently Asked Questions - WAVE for Mobile
- COMPASS Software Update Process

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