ELPRO 415U-1-Cx Condor Series

Battery Powered Wireless IO

Configuration Manual

Version 1.4

General Notices

ELPRO products are designed to be used in industrial environments by experienced industrial engineering personnel with adequate knowledge of safety design considerations.

ELPRO products use communications channels that are subject to noise and interference. The products are designed to operate in the presence of noise and interference, but in an extreme case noise and interference can cause product operation delays or operation failure. Like all industrial electronic products, ELPRO products can fail in a variety of modes due to misuse, age, or malfunction. We recommend that users and designers design systems using design techniques intended to prevent personal injury or damage during product operation and provide failure tolerant systems to prevent personal injury or damage in the event of product failure. Designers must warn users of the equipment or systems if adequate protection against failure has not been included in the system design. Designers must include this Important Notice in operating procedures and system manuals.

These products should not be used in non-industrial applications, or life-support systems, without first consulting ELPRO.

To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the 415U module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. For example: “This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments.”

The 415U modules are not suitable for use in explosive environments without additional protection.

The 415U modules operate proprietary protocols to communicate. Nevertheless, if your system is not adequately secured, third parties may be able to gain access to your data or gain control of your equipment via the radio link. Before deploying a system, make sure that you have carefully considered the security aspects of your installation.

Follow instructions - Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow the instructions can cause personal injury and/or property damage.

Proper use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (1) constitute “misuse” and/or “negligence” within the meaning of the product warranty, thereby excluding warranty coverage for any resulting damage; and (2) invalidate product certifications or listings.

Product disposal

When your product reaches the end of its useful life, it is important to take care in the disposal of the product to minimize the impact on the environment.

General instructions

The product housing is made of die-cast aluminium and may be recycled through regular metal reclamation operators in your area.

The product circuit board should be disposed according to your country’s regulations for disposing electronics equipment.

Europe

In Europe, you can return the product to the place of purchase to have the product disposed in accordance with EU WEEE legislation.

Deployment of ELPRO products in customer environment

There is increasing concern regarding cybersecurity across industries, where companies are steadily integrating field devices into enterprise-wide information systems. This is why ELPRO has incorporated secure development life cycle in their product development to ensure that cybersecurity is addressed at all levels of development and commissioning of our products.

There is no protection method that is completely secure. Industrial Control Systems continue to be the target for attacks. The complexities of these attacks make it very difficult to have a complete secure system. A defence mechanism that is effective today may not be effective tomorrow as the ways and means of cyber-attacks constantly change. Therefore, it’s critical that our customers remain aware of changes in cybersecurity and continue to work to prevent any potential vulnerability of their products and systems in their environment.

At ELPRO we are focusing on helping our customers deploy and maintain our solutions in a secure environment. We continue to evaluate cybersecurity updates that we become aware of and provide the necessary communication on our website as soon as possible.

Product Notices

⚠ ATTENTION

INCORRECT TERMINATION OF SUPPLY WIRES MAY CAUSE INTERNAL DAMAGE AND WILL VOID THE WARRANTY. TO ENSURE THAT YOUR 415U-2-Cx WIRELESS I/O AND GATEWAY ENJOYS A LONG LIFE,

CHECK THIS USER MANUAL TO VERIFY THAT ALL CONNECTIONS ARE TERMINATED CORRECTLY BEFORE TURNING ON POWER FOR THE FIRST TIME.

Safety notices

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

⚠ CAUTION

TO COMPLY WITH FCC RF EXPOSURE REQUIREMENTS IN SECTION 1.1310 OF THE FCC RULES, ANTENNAS USED WITH THIS DEVICE MUST BE INSTALLED TO PROVIDE A SEPARATION DISTANCE OF AT LEAST 20 CM FROM ALL PERSONS TO SATISFY RF EXPOSURE COMPLIANCE.

DO NOT OPERATE THE TRANSMITTER WHEN ANYONE IS WITHIN 20 CM OF THE ANTENNA. ENSURE THAT THE ANTENNA IS CORRECTLY INSTALLED IN ORDER TO SATISFY THIS SAFETY REQUIREMENT.

Avoid

- Operating the transmitter unless all RF connectors are secure and any open connectors are properly terminated
- Operating the equipment near electrical blasting caps or in an explosive atmosphere

⚠ **Note**: All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC notice

Part 15.19—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.

Part 15.21—The grantee is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.

Part 15.105(b)—This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Part 90—This device has been type accepted for operation by the FCC in accordance with Part 90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

⚠ **Note**: This device should only be connected to PCs that are covered by either a FCC DoC or are FCC certified.

Man	Band	Model number	Description	Coax kit	Net Gain
ELPRO	148-174MHz	ANTB000300	VHF Dipole Whip 3dB Antenna c/w 5M Coax N type Connector	N/A	0 dB
ELPRO	148-174MHz	ANTUDP150-C	48-174Mhz Aerial Dipole with N Type Female	CCTAIL-SMA-M	2 dB
ELPRO	148-174MHz	ANTB000100	VHF 3 dBd collinear 5dBi N Type Female connector	CCTAIL-SMA-M	5 dB
ELPRO	148-174MHz	ANTB000100	VHF 3 dBd collinear 5dBi N Type Female connector	CC5-RG213	4.8 dB
ELPRO	340-540MHz	ANTUDP400-C	Dipole Antenna 2dB gain with 100mm RG58 cable and N Female	CCTAIL-SMA-M	1.9dB
ELPRO	340-540MHz	ANTUDP400-C	Dipole Antenna 2dB gain with 100mm RG58 cable and N Type Female connector	CC3-N	1.5dB
ELPRO	340-540MHz	ANTBU3-400	Antenna 3dB Collinear with N Female	CC10-N	2.9 dB
ELPRO	340-540MHz	ANTBU6-400	Antenna 6dB Collinear with N Female	CC10-N	5.9 dB
ELPRO	340-540MHz	ANTYU3-400	400Mhz Aerial 3 element 6dBi YAGI with N Female	CC10-N	3.7 dB
ELPRO	340-540MHz	ANTYU6-400	400Mhz Aerial 6 element 9dBi YAGI with N Female	CC10-N	6.7 dB
ELPRO	340-540MHz	YU16/400	400Mhz Aerial 16 element YAGI 15dBi with N Female connector	CC20-N	10.4 dB

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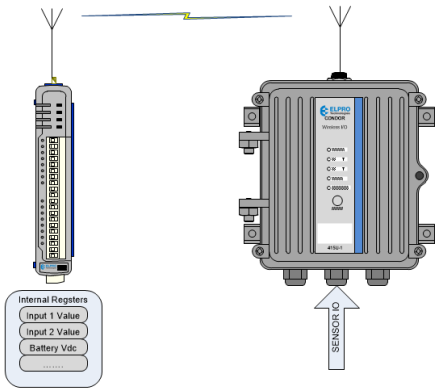
415U-1-Cx Overview

Introduction

The ELPRO 415U-1-Cx battery wireless IO unit provides wireless connectivity to remote sensors for monitoring of critical and non-critical parameters in water/waste water, environmental, factory, plant process, oil and gas or a variety of other applications.
The 415U-1-Cx is self-contained with internal wireless communications, sensor IO processing, battery, solar regulator and sensor IO terminations within a IP66 weatherproof enclosure design for harsh industrial environments.
This unit is designed to operate at ultra-low energy consumption with long life from internal lithium non-rechargeable or where extra sensor power consumption is required from rechargeable lithium battery and solar panel with an internal MPTT regulator.
The 415U-1-Cx provides wireless connectivity to the ELPRO high performance Condor series radio and allows networking into the 415U-2-Cx or 415U-E-Cx unit utilising licenced or unlicenced wireless technologies supported in a majority of world regions.

System Design

The Condor series 415U-1-Cx wireless connectivity to its sensor inputs through either Condor 415U-E-Cx or 415U-2-Cx wireless modem or IO units. These units will collect the IO data from the 415U-1-Cx units in internal registers which can then be distributed to other units in the system or read by SCADA or DCS.
The 415U-E-Cx or 415U-2-Cx units can be configured as either base, repeater or mesh node. The 415U-1-Cx unit is designed to make a point-to-point connection to a network access point (AP), which can be a 415U-E-Cx or 415U-2-Cx setup in base, repeater, and mesh node operating modes.
The Access Point allows the concentration of the IO from one or many 415U-1-Cx units in its internal registers. Then this IO data can either be pulled by Modbus TCP or DNP3 in SCADA applications or for point-to-point IO through normal ELPRO WibMesh mappings in the AP to distribute the IO to other nodes in the network.
Below is a simple example connection of 415U-1-Cx sensor IO with a 415U-2-Cx AP.



Sensor IO data can be discrete input values as ON/OFF or pulsed, analog 4-20mA inputs or internal diagnostic values such as battery voltage, solar or supply input voltage, connectivity status, received signal strength and many more.
The 415U-1-Cx unit is designed to operate from its internal battery for several years depending on the application and senor inputs connected. The very low current consumption of the unit is achieved by using lower power modes (sleeping) for periods between sample the sensor inputs and the ability to be configured to only send data changes infrequently on change of state events (COS) or on timed communications check transmissions or updates.

Sensor inputs sources can be discrete ON/OFF, pulsed, analog, SDI-12 or Modbus and the COS events detected using the sensitivity value of the input. For example, the sensitivity for an ON/OFF input would normally be set to 1, so that any change from 0 to 1 or 1 to 0 would trigger a COS. For all other sensor input types, a sensitivity is set with consideration of significant movement in the value.
The 415U-1-Cx will also send a periodic update event at a configured time interval, as a regular communications check. This periodic update radio transmission includes all configured sensor inputs.
When the application uses discrete output or analog setpoint ON/OFF values remotely set, then each time the 415U-1-Cx makes a connection to the AP it will read the latest values for these sensor IDs and update their values. Sometimes an input change transmitted to SCADA or a PLC in the system needs to set an output in reaction to this event. The 415U-1-Cx allows an output tail time to be configured to allow this change to pass through the 415U wireless network to the 415U-1-Cx immediately.
Normal data transmission process when an event (COS or update time) occurs:

Connection Phase	**Activity**
Link establishment to AP	Send Association Request
	Receive Association Response
	Send Gratuitous ARP
Sensor inputs	Send all sensor input values
Outputs Update (if configured)	Read each output value (discrete output or analog setpoint value)
Tail Time (if configured)	Stay awake for tail time period
	Check for association
Sensor inputs	Send any input values that might have changed since first send
Outputs Update (if configured)	Read each output value (discrete output or analog setpoint value)
Finished – radio goes to sleep	

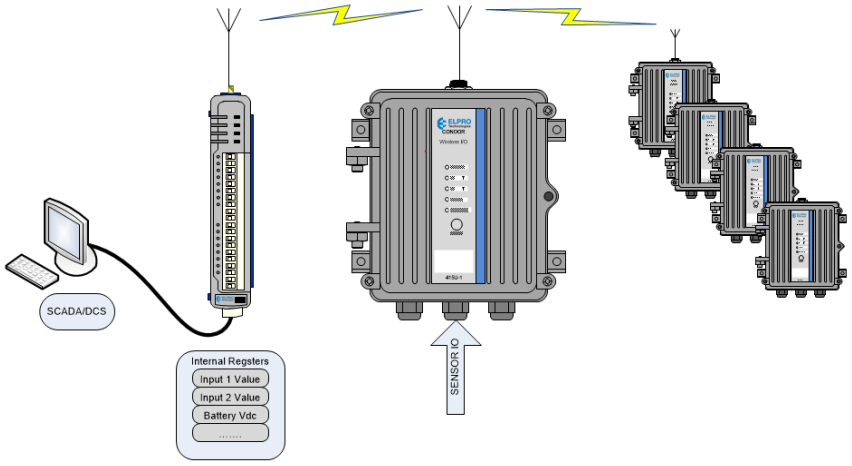
Each message transmitted from the 415U-1-Cx will be sent and acknowledged by the receiving AP. If an acknowledge is not received, then the 415U-1-Cx will retransmit the data message up to 4 times before indicating a failure.
Consideration for either COS, periodic update events and discrete output tail time will impact the rate and duration of a radio transmission in the battery life calculation for the system. The 415U-1-Cx uses the configuration paralysis, which is configured in seconds, to limit the minimum time between radio transmissions and conserve battery life.

Network Design

The Condor 415U-1-Cx offers a lot of functionality for a simple low power consumption device. Due to the drive to lower the overall power consumption of the design there are limitations that need to be consider when designing and deploying a system.
System design considerations to take note of:

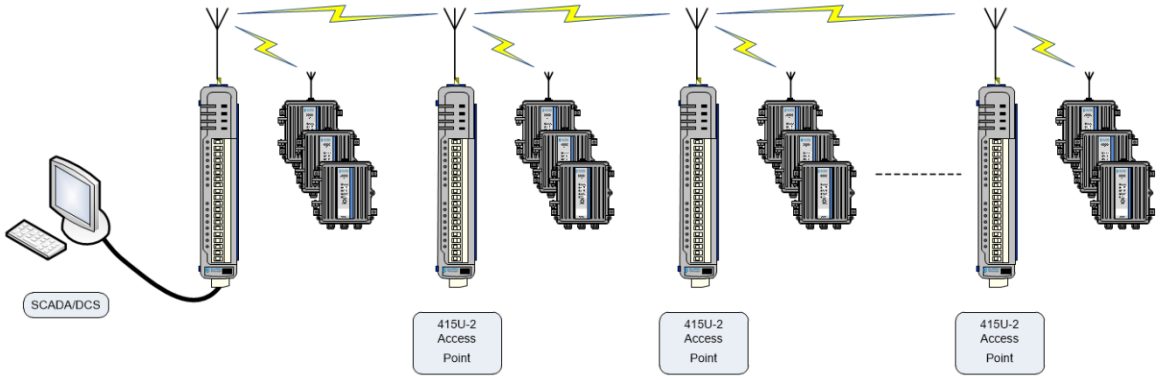
- The 415U-1-Cx does require a Condor wireless access point to connect to the Condor network. This is usually a 415U-2-Cx or 415U-E-Cx unit that is within wireless range of the 415U-1-Cx.
- IP address assignment and ensuring there is no duplication of IP addresses in the system.
- Use of registers inside the AP and transfer of this data to other units or SCADA/DCS/PLC.
- Network topology and distribution of 415U-1-Cx units
- Low power consumption of the 415U-1-Cx means that it will be powered down for much of its operation time, monitoring its local sensor inputs, and not being able to receiver wireless data messages from the Condor system.

Simple System Network Diagram Example



Each of the 415U-1-Cx unit will have its sensor inputs and output mapped to the local access point which can be a 415U base unit or repeater. SCADA/DCS can access the 415U-1-Cx by polling through Modbus TCP.

Large system Network Diagram Example



This is a larger network which distributed 415U-1-Cx units located throughout the network which is very typical of a normal system design.

System Design Considerations

Due the 415U-1-Cx unit spending most of its time powered down it needs to connect to an AP (415U-2-Cx) which can then gateway the IO to other units in network or a SCADA/DCS.
Commissioning considerations:

- Check and record radio signal strength and background noise at each 415U-1-Cx unit and the AP to confirm that there is a 10dB margin of signal and allow diagnosis of issues later in the systems life or during regular maintenance visits.
- At the AP unit confirm that the channel utilization is less than 80%. This will allow sufficient margin for busts of traffic during busy periods.
- Configuration of mapping of diagnostic registers is very useful to get back into the SCADA or even just at the AP with logging turned on. It is helpful to keep basic diagnostics such as battery/solar voltage, RSSI, internal status register to a minimum. At the least it is a good idea at the AP to monitor the channel utilization, TX fails, RSSI at a minimum just for diagnostic analysis.

Ordering Guide

Model Overview

The 415U-1-Cx can be delivered as several different models and/or options. To identify the correct model and options that you have, first locate the compliance label, which is located inside the unit on the side opposite to the battery (if fitted).
The compliance label will look like the sample below but may have difference due to sales region/model.

The 415U-1-Cx is available in several options and accessories as detailed below:

Model	
EL-415U-1-Cx	CONDOR SERIES: Battery I/O Radio: I/O = (4)DI + (2)AI + (3)PI, SDI-12 Capable, (1) USB Cable, Select Radio Type from Table Below
EL-415U-1-Cx-EX	CONDOR SERIES: UL Class 1 Division 2 Hazardous Location Battery I/O Radio: I/O = (4)DI + (2)AI + (3)PI, SDI-12 Capable, (1) USB Cable, Select Radio Type from Table Below
BATS-ERTA2-LFP	Lithium iron phosphate (LFP), rechargeable long life 3.0AHr battery for 415U-1-Cx & 905U-K2 with cable and connector
BATS-ERTA2-LiP	Lithium-thionyl Chloride Primary (LiP), non-rechargeable long life 5.8AHr battery for 415U-1-Cx & 905U-K2 with cable and connector
BR-SOLARPOLEMNT	Solar panel mounting kit, angle adjustable, 20/30W, 50mm pole dia max
PS-SOLAR10W	solar panel 12V 10W with 8m (26ft) cable
BR-POLEMERTA2	Pole mounting bracket, hardware kit
SURCSD-N-6000-MF	Coaxial Surge Divertor, Bulkhead N Female to N Male DC-6GHz 30W WITHOUT earth tail - For 415U-1-Cx
SURCSD-GDT-90	Gas Discharge Tube replacement for SURCSD-N-6000 & SURCSD-SMA-2500 series

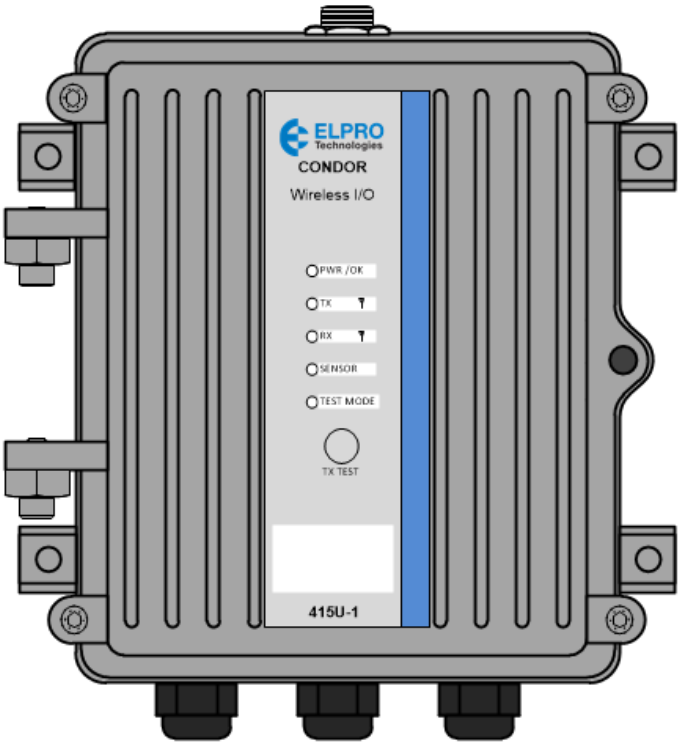
Frequency options -Cx are available as following.

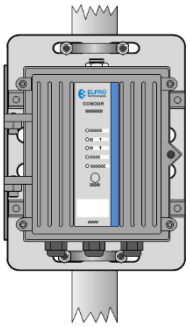
Option	**Description**
-C1	148-174MHz, 5mW-10W, 6.25/12.5/25kHz, 96kbps QAM
-C3	340-400MHz, 5mW-10W, 6.25/12.5/25kHz, 96kbps QAM
-C4	400-480MHz, 5mW-10W, 6.25/12.5/25kHz, 96kbps QAM
-C5	470-520MHz, 5mW-10W, 6.25/12.5/25kHz, 96kbps QAM
-C9	928-960MHz, 5mW-6.3W, 12.5/25kHz, 96kbps QAM

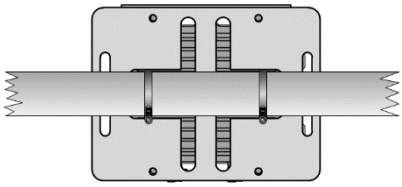
Installation

Enclosure

ELPRO 415U-1-Cx electronics and battery are enclosed in a rugged IP66 rated cast Aluminium 190mm x 197mm enclosure with an opening/removable door.
Sensor and power connections are made through cable entry glands into internal industrial push connect wiring terminals.
It is suitable to be installed in a variety of situations such as outdoor, indoor, and cabinet installations and has the ability to be secured with padlock if required.



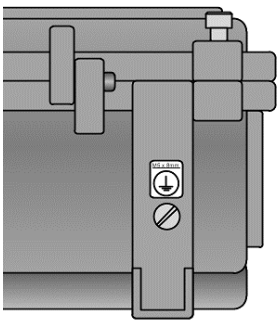




Mounting options are

- Standard panel mounting via M6 mounting Holes 176mm x 119mm square provide by integrated mounting feet on the enclosure
- Pole or Rail (horizontal or vertical) mounted using an aluminium mounting plate and either Standard U clamps or s/s cable ties.

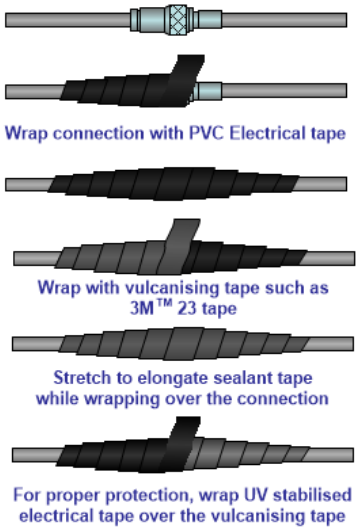
Grounding

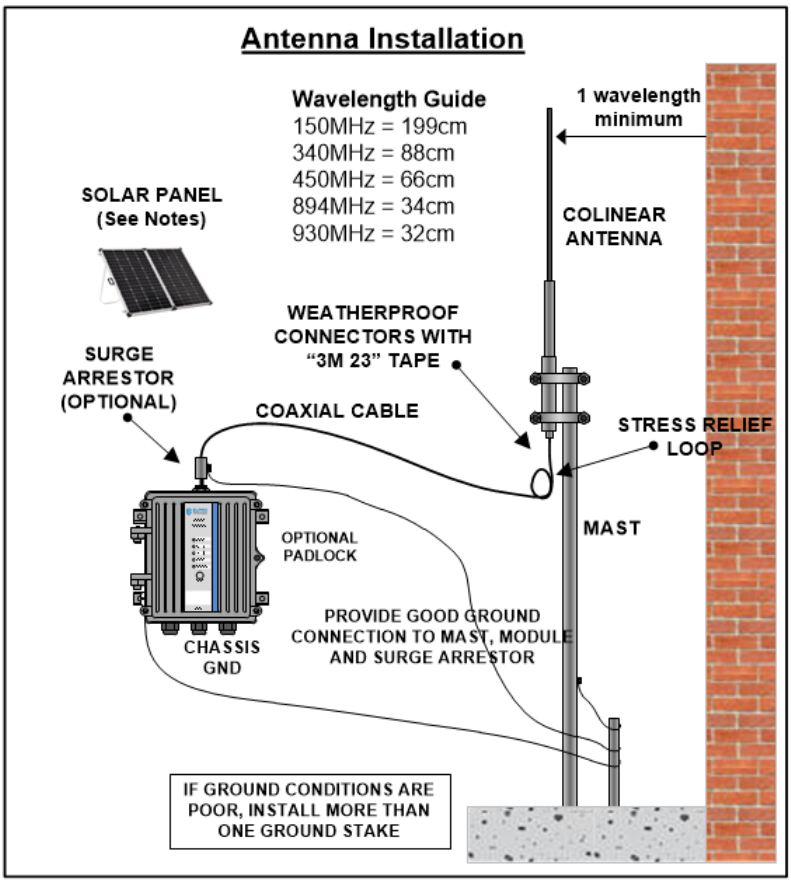


To provide maximum surge and lightning protection for antenna connection and sensor inputs, each module should be effectively earthed/grounded via a GND terminal on the module. This is to ensure that the surge protection circuits inside the module are effective.
If the 415U-1-Cx is to be mounted in an enclosure you need to ensure the enclosure ground and the antenna mast/pole ground are connected to the same common ground point to avoid lightning surges.
The 415U-1-Cx has a dedicated earth/ground connection M5 x 0.8 screw on the side of the enclosure for this Earth connection. All earth/ground wiring should be minimum 18 AWG (2 mm2),. Earth screw maximum length is 10mm.
Recommended installation earthing for outdoor installation is outline in diagram.

Antenna Connections

Antenna Connection is via the N50 Female Bulkhead coax connection on the top of the enclosure.
Coax connection must be taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems because it greatly increases the radio losses. We recommend that the connection be taped—first with a layer of PVC tape, next with vulcanizing tape (such as 3M™ 23 tape), and finally with another layer of PVC UV-stabilized insulating tape. The first layer of tape allows the joint to be easily inspected when troubleshooting because the vulcanizing seal can be easily removed.
To obtain the maximum range, collinear and dipole antennas should be mounted vertically, preferably at least one wavelength away (see figure below for distances) from a wall or mast and at least 3 ft (1 m) from the radio module.





I/O Overview

The 415U-1-Cx unit can take data from several different types of external sensor inputs such as discrete (Digital) on/off, pulsed, 4-20mA analog and SDI-12, allowing for a variety of different sensors to be monitored.
There are also a number of internal diagnostic inputs that can be transmitted or logged e.g. battery health, power supply or solar, communications status and internal temperature.

I/O Type	Number	Configurations
Digital	4	DI1 to DI4 - ON/OFF configurable
Pulsed	3	DI1, DI2 & DI3 – Pulsed (10Hz Maximum)

Analog	2	0-20mA, 4-20mA 16 Bit resolution
SDI-12	1 Channel	Up to 46 variables can be configured
Modbus	1 Channel	Up to 46 variables can be configured
Internal	5	Battery Voltage, Supply/Solar Voltage, Radio Received Signal Strength (RSSI) , Internal Temperature, Internal Status

Digital or Pulsed inputs

Digital Input channel 1 & 2 on the module can be used for a digital ON/OFF switch, a pulsed signal from something like a Flow Meter or Rain Gauge, or even a Shaft Encoder for measuring level.
Digital Input 3 is a Pulsed input signal only, Maximum Pulsed input rate is 10Hz. For example, a pulsed signal from a Tipping Bucket Rain Gauge (TBRG), which is a dry contact closure through a small magnetic switch triggered from a measure of rain fall.
Digital Input 4 can only be used as a Digital ON/OFF input, which could be used for a limit switch or intruder alarm.
The digital inputs whether a Pulse, Switched or Encoder are activated by connecting the input terminal to GND or common, either by voltage free contact, TTL level, or transistor switch.

Analog inputs

The module provides two floating differential analog inputs that are capable of measuring 0-20mA from something like a pressure transducers or sensors.
It should also be noted that the analog inputs can except single ended current sinking or sourcing devices and can be connected in the top or the bottom of analog loop.
The module also can provide a 24V Analog Loop Supply (ALS) with a maximum of 50mA for any single ended current loops. To get the best battery life performance the ALS should be configured in the 415U-1-Cx unit to only turn on during the sample period and can also provide a sensor warmup time before sampling analog value.
The 4-20mA signal is normally used for process variables such as level, pressure, temperature and flow.
For example, measuring a level using a pressure transducer which detects a pressure at the bottom of the vessel and produces a 4-20mA output which represents meters of level. As the level rises, the pressure at the bottom of the vessel increases.

SDI-12 Smart Sensor Input

Smart sensors can be connected using the SDI-12 input. SDI-12 interface is often used with sensors used for monitoring in environmental, water quality or agricultural applications. The sensor types include a wide range of parameters such as wind speed, rain fall, air temperature, humidity, water dissolved oxygen, turbidity, pH, soil moisture, ice on roads and many more.
The 415U-1-Cx SDI-12 smart sensor input can support up to 46 variables and/or sensors on a single serial channel.
SDI-12 connectivity is shared with the RS-485 communications channel and is not available if the unit is configured as a Modbus Smart Sensor.

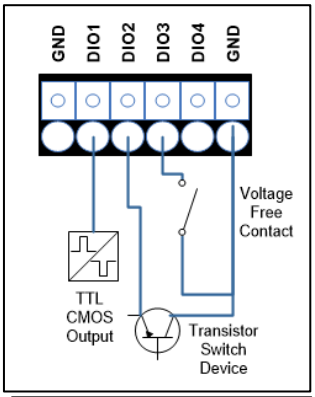
Modbus Sensor Inputs

Smart sensors communication using Modbus RTU RS-485 can be connected to the 415U-1-Cx unit and their data transmitted to other units or to DCS or SCADA via the Condor wireless network.
Modbus smart sensors can monitor a wide range of process variables, such as pressure, flow and level.
Support for up to 32 Modbus slave devices with up to 46 variables able to be configured.
SDI-12 connectivity is shared with the RS-485 communications channel and is not available if the unit is configured as a Modbus Smart Sensor.

Connections (Terminals)

Digital Inputs

The module has 4 physical digital inputs and 3 of these (DIO1, DIO2 & DIO4) can be used for digital signals either switched from a voltage free contact closure or an NPN transistor output.



Pulsed Inputs

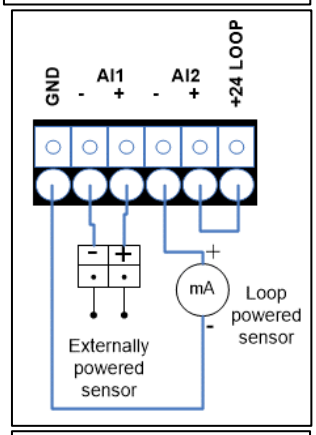
DIO1, DIO2 & DIO3 can also be used for Pulsed inputs and have a maximum input rate of 10 Hertz.

Analog Input

Analog Inputs (AI1 & AI2) Differential Current

The modules also have two 4-20mA analog input for the purpose of measuring analog signals for a transducer or sensor.

The analog inputs can be wired to support differential or single ended loop powered 4-20mA sensors as shown.



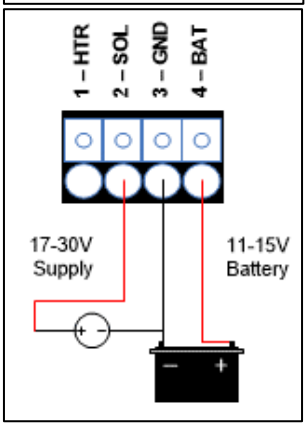
Supply / Solar

The Supply/Solar terminals allows for the connection of an external 24V power supply or a 5-30W solar panel (12V Panel only) to power or charge the internal or external Lithium battery as well as connections for the battery and Heater control.

External supply or Solar Connection should be connected to the “SOL” & “GND” Terminals.

If using an external battery, then this needs to be connected to the terminals “BAT” & “GND”.

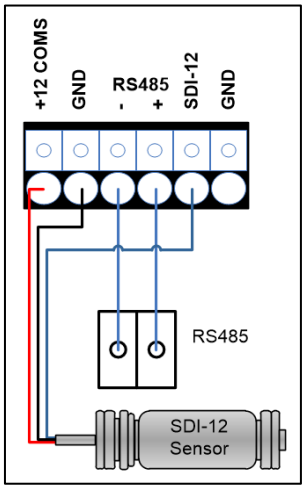
Warning: Solar input is suitable for solar panels rated as 12V nominal only. 24V solar panel can produce open circuit voltages of 44Vdc which will exceed the rated input of the solar regulator and cause damage.



Sensor (Serial / SDI-12 / Modbus)

The Sensor/RS485 terminal strip has the connections for Modbus RS485 and SDI-12 communications

- SDI-12: Is a communication bus for SDI-12 sensors or devices. SDI-12 devices require a “+12 Coms”, “GND” and an “SDI-12” Communication connection. Note: RS485 and SDI-12 cannot be used at the same time.
- RS485: Modbus Smart sensor connection which will allow the module to poll an External Modbus RTU Slave device, Read I/O and map to internal registers.



Connections (Other)

RS232 Port

The 9 pin DB connector is the RS232 Port and used for connection to the module for diagnostics and configurations.

USB A

This port is a USB host (master port) that can interface with USB storage devices for upgrading the module firmware and for removing logged data files.

USB B

The module also provides a USB device (USB-B) connector. This connector provides configuration and diagnostic of the device.

Configuration

Connecting to Menu

The 415U-1-Cx unit configuration can be performed through several different ports such as USB, Bluetooth (future) and RS232 serial. It's recommended that for initial provisioning of the unit to use the USB port.

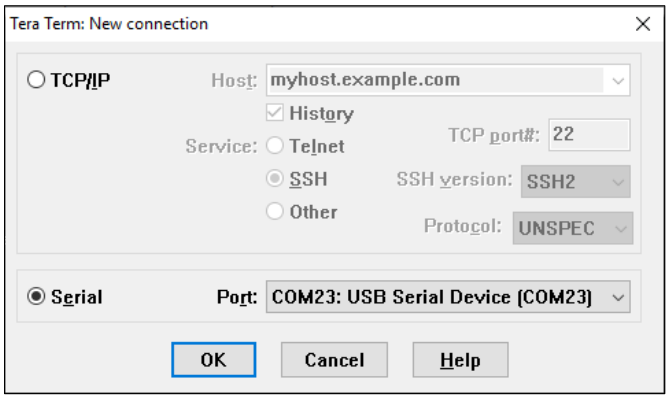
You will need a USB type A to type B cable to connect your laptop/computer to the 415U-1-Cx unit. This is commonly used for peripheral devices such as printers/scanners and is available from ELPRO, part number CBLUSB-ATOB.

To access the text-based configuration menu through USB or RS-232 you will need a serial terminal emulator. You can use programs such as Putty, Tera Term or Realterm. Tera Term is quite a simple application to install and setup.

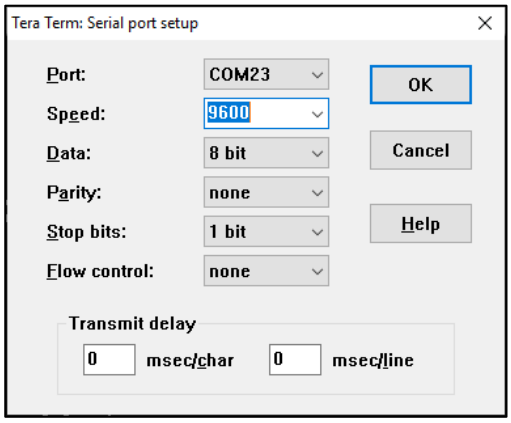
To setup a connection to the 415U-1-Cx using Tera Term, follow the basic steps below:

Google Tera Term, download and install.

With the 415U-1-Cx connected and powered, connect the USB type A power to the PC and wait a minute or two for the driver to install (will happen only the first time). Then run Tera Term and you will see the dialog box below. Select Serial connection.

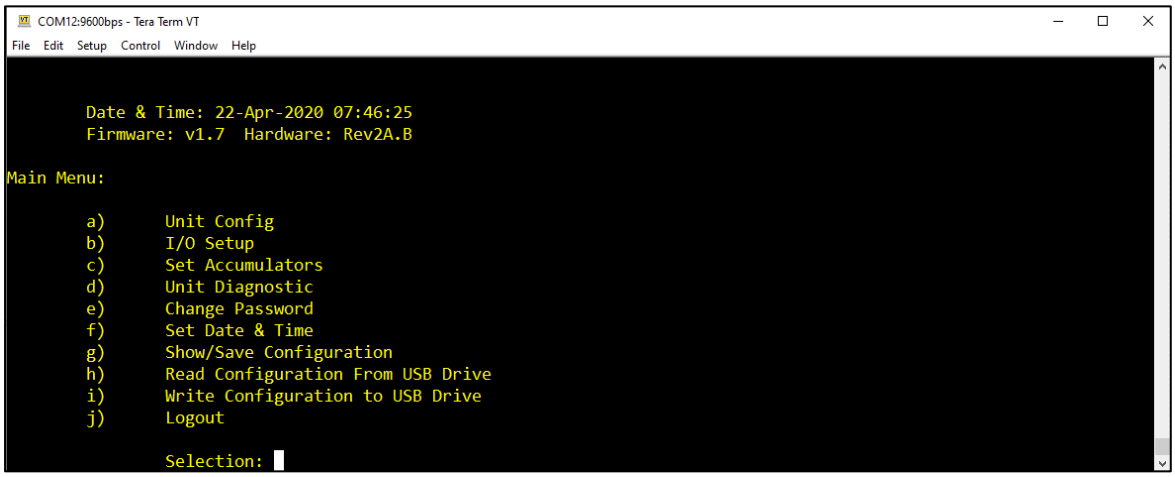


If you do not see a Port detected, check your USB connections. When the USB is connected to the PC the 415U-1-Cx should power PWR/OK should light continuously indicating the unit is awake and ready. Tera Term will default its serial settings to 9600, n, 8, 1 as below, which is the default requirement for connecting to the 415U-1-Cx. But if you need to change then do so through the Setup-Serial Port menu.



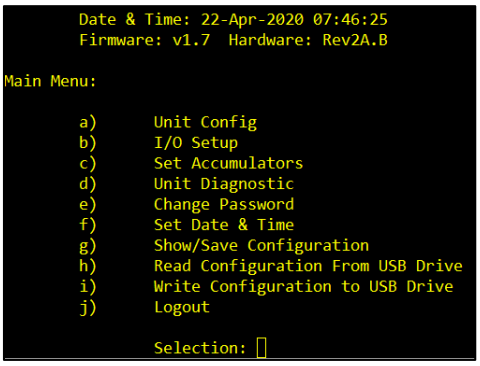
Click OK and hit enter on the keyboard and you should see 415U-1-Cx login menu as below.

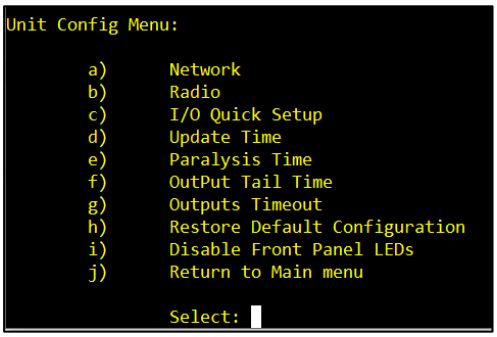
Select option a) Engineer to login with Engineer access and enter default password “Elproeng”. You should see the main menu displayed as below however there may be some slight menu differences due to model and firmware variations.



Quick Start Guide

Below is a QuickStart guide for connecting a 415U-1-Cx Lower Power I/O radio to a 415U-2-Cx-C Condor Radio.



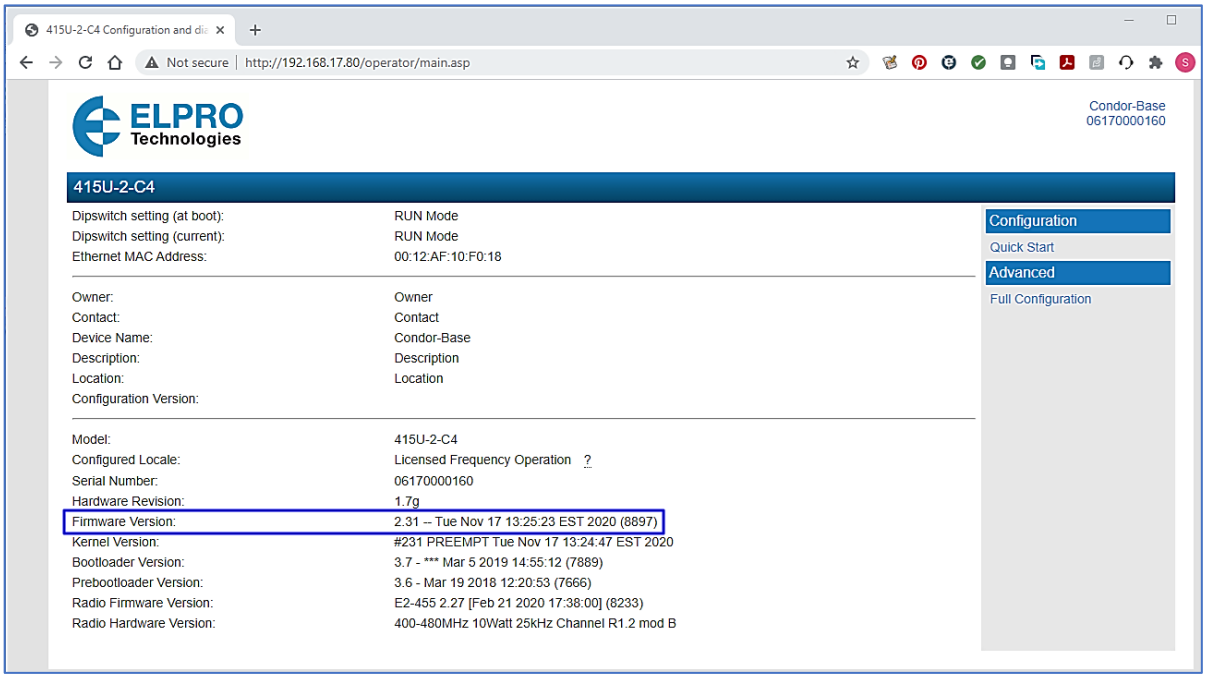


Connect to the 415U-1-Cx Terminal menu and navigating to the Unit config (a) and from here you will need to configure the Network and Radio parameters to match the configuration of the 415U-2-Cx Access Point. Go through the Network and Radio config selections, and match the parameters shown below from the 415U-2-Cx AP.

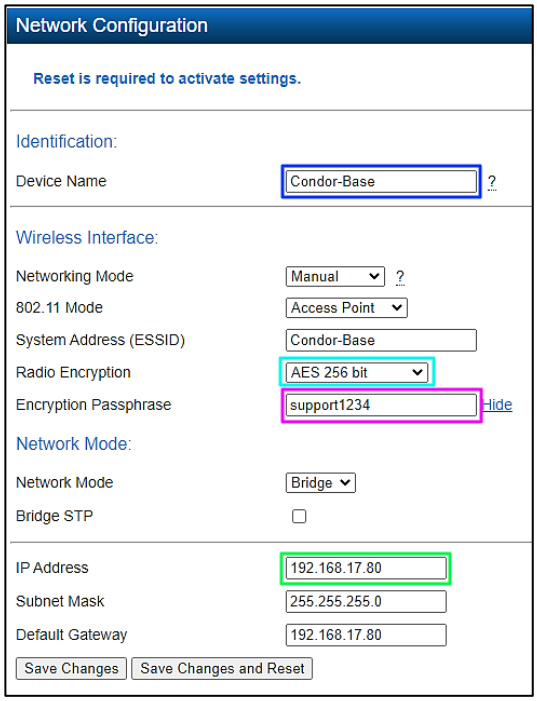
Below is guide that shows the correlation between parameters.

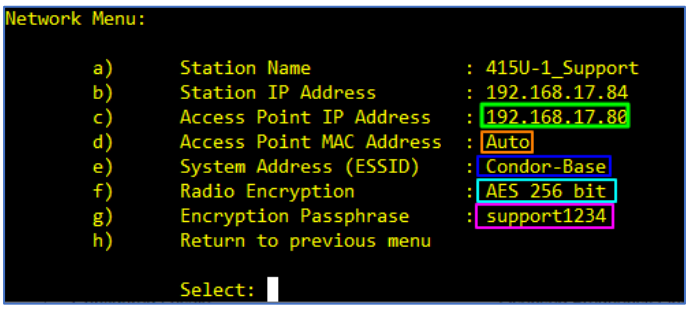
First ensure the 415U-2-Cx firmware version is a least V2.31 or higher.

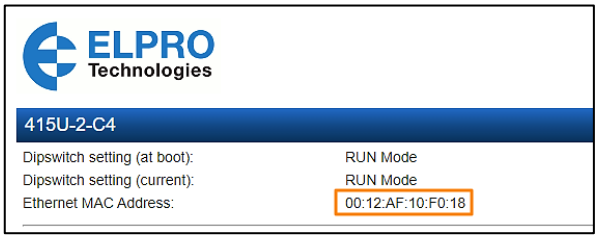
Check version by connecting to the Main webpage IP address using a browser.



Go through the Network and Radio config selections, and match the parameters shown below between the 415U-2-Cx AP and the 415U-1-Cx Low Power I/O.
Below shows the relevant Network parameters that need to be configured.

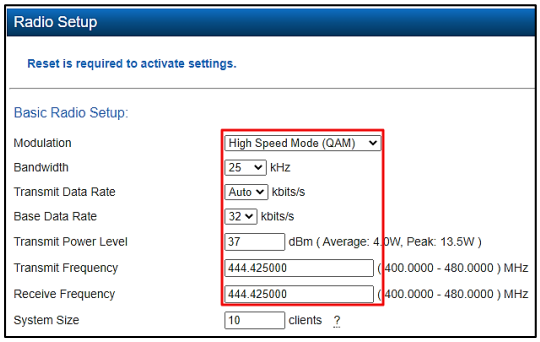


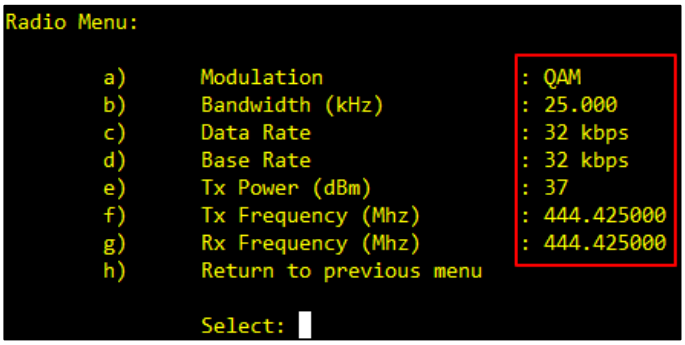




Configure AP MAC Address for “Auto” however if you have difficulty connecting try configure to the AP’s MAC which you can find on the Main

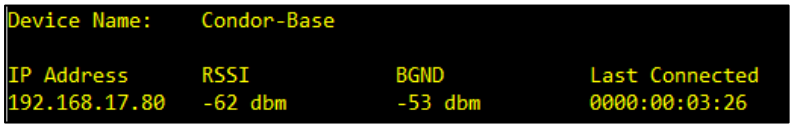
Then configure the Radio parameters as per the below screenshots.



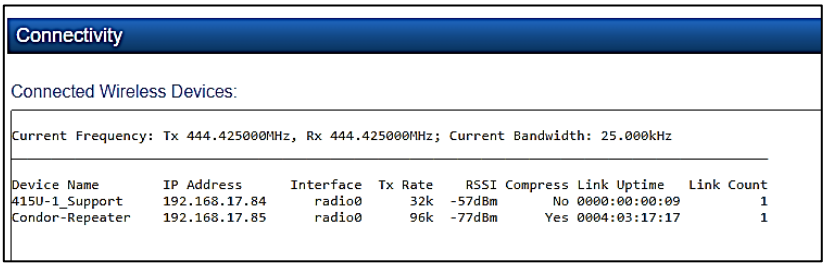


When all parameters are configured, save the 415U-1-Cx configuration by going back to the main menu and selecting option “g) Show/save configuration”.
Then go to the “d) Unit diagnostics” menu and select “c) Test Mode Send Message” This will force the 415U-1-Cx to send a transmission to the AP.

To check Communication Status, select “b) Show last connection/status” to show 415U-1-Cx connection status.



Or on the 415U-2-Cx AP check the “Connectivity” page to check what remote units are connecting. You should be able to see the 415U-1-Cx in the connectivity list.



Sensor Inputs Configuration

For each digital, analog or SDI-12 (future) sensor value connected to the 415U-1-Cx unit configured to report in the data frame, the user will need to configure the follow parameters.
Mode: Type of input, i.e. Pulsed input, Digital Input (On/Off) or analog Input (4-20mA)
REG: Register address value to reference the data sent. The REG value is the register address to store the value in at the AP. A value of 0 will disable the sensor so that it does not generate update or change of state events to trigger messages to be sent over the communications network. It is recommended to use the Quickstart (See **I/O Quick Setup** below for explanation) configuration for REG values be used so that they align with the Modbus convention and type. Full table of registers can be found in the appendix of this user manual.
Format: Analog input sensor Report Format is used to set the value type that is sent. If the application is using ELPRO WIBMesh point to point protocol, then choose ELPRO default for standard scaling of discrete and analog values. Or you can choose custom type length values. Custom Type/length allows the configuration of value type as unsigned, signed, floating point or ELPRO. Length can then be set up for signed and unsigned values as 1, 2, 3 or 4 byte values. Floating point values are fixed as 4 byte length only.
Span/Range, Zero/Offset: These two menu items work together to allow the setting of a custom span and zero for the sensor to allow scaling of sensor value before it is sent over the communications network. For a pulsed input there is only zero/offset available which will apply a manual offset to the accumulator value.

Display Units: Sensor value units that are displayed within the configuration menu internally.
Display Scaling: Allows scale multiplier to be applied to the sensor value that is displayed within the unit. This can be used to scale to engineering units. This value is a float so will allow fractional scaling.
Report Sensitivity: Sensor value change before a change of state event is generated. This value is a float, so fractional values are allowed. Typical Input configuration below.

External Inputs:

	DI3	DI4	AI1	AI2
Mode	ON/OFF	ON/OFF	4-20mA	4-20mA
REG	2	7	40001	40501
Format	ELPRO	ELPRO	ELPRO	ELPRO
Range	1	1	32768	32768
Offset	0	0	16384	16384
sens	1	1	100	100
Raw	Off	On	4.67 mA	14.54 mA
Value	0	65535	17756	37972

Internal Status:

	Battery	sup/sol	RSSI	Status
REG	39031	39033	39035	35012
Format	ELPRO	F-4	F-4	ELPRO
sens	1000	5	127	1
Value	21406	0.01	-102dBm	LS

I/O Quick Setup

Using the I/O Quick Setup option in the Unit Configuration menu is the easiest way to quickly setup the I/O and can be done for multiple units using multipliers. This can be used a basis for most applications and then the sensor inputs and discrete output can be tailored to fit with the application. Selecting I/O Quick Setup option in the Unit Config Menu will step through the Setup options (shown below):

```
Select: c
Warning! IOs state and register address reset to default. OK? (y/n):y

Enter Destination Register Multiplier ( 1 - 99): 1
Configured DI1 as Pulse
Configured DI2 as Pulse
Configured DI3 as On-Off
Configured DI4 as On-Off
Configuring  Analog1
        Analog Range:32768 (0xC000)
        Analog Offset:16384 (0x4000)
        Analog Sensitivity:1000
Configuring  Analog2
        Analog Range:32768 (0xC000)
        Analog Offset:16384 (0x4000)
        Analog Sensitivity:1000
        Analog Sample Time: (min) 15
        Analog Warmup Time: (sec) 10
Configured Internal Battery Voltage.......
Configured Internal Solar Voltage.....
```

First a Multiplier will need to be configured which is an offset value that will be applied to the I/O so as to offset the Destination Address in the AP where the I/O value will be stored.
It will automatically setup Digital Inputs 1 & 2 as Pulsed inputs, and Digital inputs 3 & 4 as ON/OFF.
The analog inputs will be setup as standard ELPRO 4-20mA and will prompt for a Sensitivity value for each, which is the number of bits the analog needs to change before triggering a COS message to be sent, default is 1000.
Then it will prompt for a Sample time (default 15 mins) and an analog warmup time (default 10 Sec).

See below for an example of the I/O and the use of multipliers.
I/O Quick Setup Mapping example for configuration of 3 stations:

Configuration Values				Example Units		
Input Name	**Input Type**	**Register Values**	**Register Type**	**Remote 1 Multiplier**	**Remote 3 Multiplier**	**Remote 10 Multiplier**
Discrete input 1	Pulsed	37011	Unsigned 32 Bit	37011	37031	37101
Discrete input 2	Pulsed	37013	Unsigned 32 Bit	37013	37033	37103
Discrete input 3	ON/OFF	15010	Unsigned 16 Bit	15010	15030	15100
Discrete input 4	ON/OFF	15011	Unsigned 16 Bit	15011	15031	15101
Analog Input 1	4-20mA	35010	Unsigned 16 Bit	35010	35030	35100
Analog Input 2	4-20mA	35011	Unsigned 16 Bit	35011	35031	35101
Battery	Vdc	39011	Float	39011	39031	39101
Sup/Sol	Vdc	39013	Float	39013	39033	39103
RSSI	dBm	39015	Float	39015	39035	39105
Status	Bit Field	35012	Unsigned 16 Bit	35012	35032	35102

Access Point Register (REG) Address Values

If manually configuring the AP register it is recommended for application to use the standard Modbus convention for REG address values used in the application. REG values can be set to a value up to a maximum of 65535 and a value of 0 (zero) is used to disable a sensor REG where it is not used so that no data is transmitted.
Below is a listing of REG address ranges that are recommended for use in a 415U-E-Cx or 415U-2-Cx units when used as the AP for the 415U-1-Cx unit.

Input Type	REG Address Range	REG Area	Value Type
Discrete inputs	10406-20000	General Purpose Bit Storage	Single bit
Word Inputs	32256-36000	General Purpose Word Storage	Unsigned 16 bit
Long Inputs	36001-38000	General Purpose 32-bit Storage	Unsigned 32 bit
Float Inputs	38001-40000	General Purpose Floating Storage	Float 32 bit

Sensor input configuration is best completed after you have configured the Unit Config and Communications as selected from main menu. It is recommended to use the I/O Quick Setup in the Unit Config menu as well as it is a very fast way to setup basic IO configuration.
Once you have this basic setup completed then access the input setup through I/O Setup option from main menu. This menu is displayed as shown below.
The current status of inputs will be displayed in the header of this menu. Sensor ID of 255 is used to disabled/unused sensor and will have values that are bracketed with # and ID indicated with – as shown below.

External Inputs

	DI1	DI2	DI3	DI4	AI1	AI2
REG	37031	37013	15010	15011	35010	35011
Format	U-4	U-4	ELPRO	ELPRO	ELPRO	ELPRO
Raw	0	0	On	Off	0 mA	0 mA
Value	0	0	65535	0	8192	8192

External Outputs

	DO1	DO2
Mode	ON/OFF	ON/OFF
REG	10001	10008
Sens	100	100
Value	0	0

I/O Setup Menu:

a) Digital 1
b) Digital 2
c) Digital 3
d) Digital 4
e) Analog 1
f) Analog 2
g) Battery Voltage
h) Solar/Supply Voltage
i) RSSI
j) Internal Temp
k) Status Sensor
l) Analog Sampling
m) Return to Main Menu

The 415U-1-Cx allows for each input to be configured with the sensor REG value, transmitted data format, Scale/offset and displayed units.
As values are changed and finalised, to save changes return to the main menu and select "Show/save Configuration". A reminder is shown in menu header when there are unsaved changes.
Digital inputs can be configured as simple on/off, or pulsed (count).
Table below outlines the configuration options for each of the inputs:

Digital Input	ON/OFF	Pulsed
1	Y	Y
2	Y	Y
3	Y	Y
4	Y	N

Discrete input configuration Menu

For each discrete/digital the menu below is displayed to allow the configuration of where this input is sent to in the connected AP unit.
Discrete input configuration menu

DI3 Mode ON/OFF REG 2 Format ELPRO Range 1 Offset 0 Sens 1 Display Value 1 Digital 3 Menu:	
a) DIO mode	Configure mode as ON/OFF, pulsed input or ON/OFF, Latched output.
b) Sensor REG	Access Point register address to send to or read from if output.
c) Report Format	Custom Type (Unsigned, signed integer or Floating point) or ELPRO standard format.
d) Scaling (per count)	Scaling applied to the raw input value. Floating point value.
e) Zero / Offset	Offset value applied to the raw input value. Floating point value.
f) Display Units	Engineering units used for display of values inside configuration menus.

g) Display Scaling	Additional scaling for displayed engineering units.
h) Report sensitivity	Number of counts that the scaled value needs to change by to trigger an event. For ON/OFF mode this is set to 1.
i) Save Config	Save Configuration changes
j) Return to previous menu	Return to previous Menu

Analog Input Configuration

Analog input sensors can be connected to the 415U-1-Cx unit that support 4-20mA current loop interface which corresponds to a 0 to 100% measure range of the sensors span.
Analog Sensor Input Menu below allows to be setup for the application.

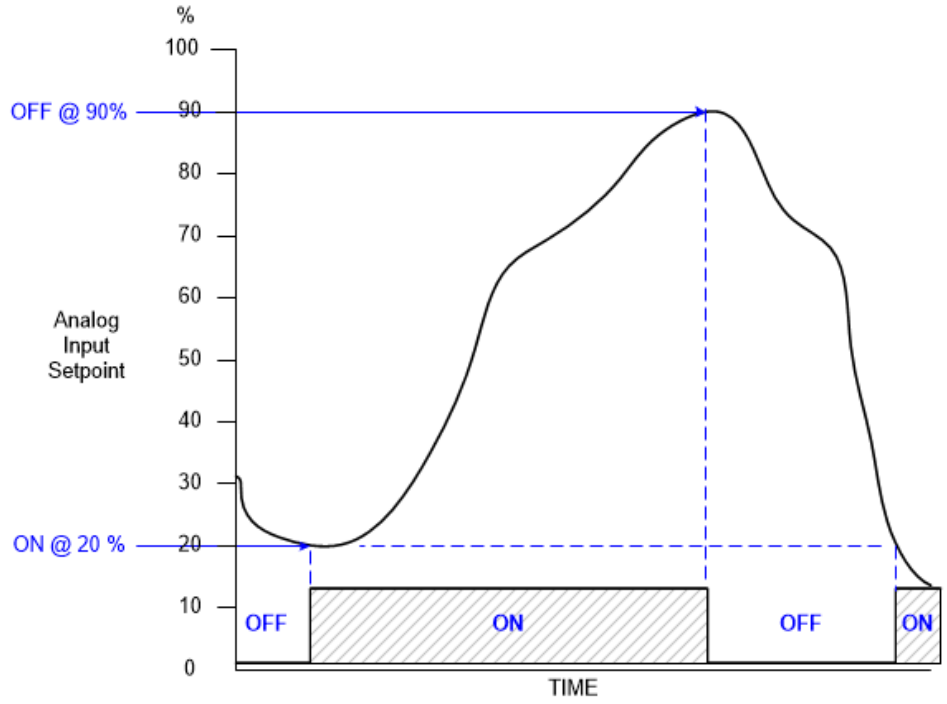
AI1	
Mode 4-20mA	
REG 40001	
Format ELPRO	
Range 32768	
Offset 16384	
Sens 100	
Display mm	
Value 39003	
Analog 1 Menu:	
a) Sensor REG	Access Point register address to send analog value to. Please ensure this register is in the correct range for the value type.
b) Report Format	Custom Type (Unsigned, signed integer or Floating point) or ELPRO standard format.
c) Span / Range	Span applied to the raw input value. Floating point value based on 0% at 4mA and 100% at 20mA.
d) Zero / Offset	Zero reference value applied to the raw input value. Floating point value.
e) Display Units	Engineering units used for display of values inside configuration menus.
f) Display Scaling	Additional scaling for displayed engineering units.
g) Report Sensitivity	Number of counts that the scaled value needs to change by to trigger an event.
h) Save Config	Save Configuration changes
i) Return to previous menu	Return to previous Menu

Analog Sensor Input sample and warmup time can be configured when choosing the Analog Sampling menu option. This setting is common for both analog input 1 and input 2.
Analog sample time is configured in minutes with a range of 1 to 1440 minutes. Sensor warmup time is the time that the 415U-1-Cx will wait to allow sensor reading to stabilize before taking the value reading. It is configured in seconds and has a range of between 1 and 600 seconds.
In applications which are powered by internal battery only, it is important to choose the analog sensor input values carefully to get the longer battery option life. For the given application, select a long sample time as practical and consult with sensor data to select the shortest warmup time.

Analog Setpoints

Note: supported in R1.6 or later firmware
For each of the two analog inputs there is an internal discrete input that can be configured to be set ON or OFF based on the analog value exceeding the high or low analog values. This allows for a

discrete input alarm or control signal to be created that for example could be used to control a high or low level alarm.



The high and low set point values that used for the internal set point discrete input are either from configurable default values or from a register that can be written to remotely. The default is used when the unit is reset and until a value is written into the high or low register if configured.
Analog set point menu can be accessed from the I/O Setup menu and will display as below.

	SP1	ASP1OFF	ASP1ON
REG	15501	35501	35502
Actual	On	90	10
Value	On	90%	10%

Analog Set Point Menu:

a)	AN1 Set Point	Configure analog input 1 setpoint registers, high/low default and register values.
b)	AN2 Set Point	Configure analog input 1 setpoint registers, high/low default and register values.
c)	Return to Main menu	

For each analog set points there is the flowing configurable parameters:

- Internal setpoint discrete register.
- Setpoint High Level default value at which the internal input is set to OFF if analog value is greater than.
- Setpoint High Level register that if set with a value will override the configured default value.
- Setpoint Low Level default value at which the internal input is set to ON if analog value is less than.
- Setpoint Low Level register that if set with a value will override the configured default value.

Selecting the configuration for AN1 Set Point will display the following menu:

Analog Set Points:	

SP1 SP REG 15501 ON Def On OFF Def On ON REG 35502 OFF REG 35501 AN1 Set Point Menu:	
a) Set Point Value REG	Sets the discrete input register
b) ON Level Default	Sets the default value for ON level as a percentage of full scale
c) OFF Level Default	Sets the default value for OFF level as a percentage of full scale
d) ON Level Control REG	Sets the register that holds the ON value as a percentage of full scale. The value written to the register is stored with two fixed decimal places, eg: 10.5% use value of 1050
e) OFF Level Control REG	Sets the register that holds the OFF value as a percentage of full scale. The value written to the register is stored with two fixed decimal places, eg: 85.23% use value of 8523
f) Return to Main menu	

Modbus Slave Smart Sensor

Note: supported in R1.7 or later firmware

Smart sensors using either SDI-12 or Modbus can be connected, and values can be transmitted through the Condor wireless network. This section describes the configuration of the Modbus master gateway to be able to poll slave devices, such as pressure or level transducers and read field values.

A Modbus mapping in required to be configured for each sensor input value. This mapping defines the Modbus ID, register address, value format and the AP register address that the value will be sent to.

Each mapping when configured will be added to the config menu to allow later editing if required.

Each of these mappings once setup will be polled based on the configured sample time and there is a configurable sensor warmup time to allow the Modbus sensor values to stabilize after power on before sampling.

Modbus slave poll timeout is fixed to 5 seconds and the number of retries is fixed to 3 for all slave devices.

There is no limitation of the number of connected slave devices, but there is a limitation on the number of sensor inputs. The maximum number that can be configured is 46, not including the fixed discrete, analog and internal inputs.

To configure the Modbus gateway from the main menu, select the I/O Setup and then select Smart Sensor menu item.

Smart sensor menu will be displayed as below:

Modbus IOs				
REG	15513	35001	40001	AP registers that sensor inputs are transmitted to.
Format	U-2	U-4	F-4	Data type: Unsigned int or float in 1-, 2- and 4-byte formats. 4 Byte formats can also be adjusted for word order, most significant or least significant word first.
Range				Scaling value range or span
Offset				Scaling value offset or zero

Sens	Sensitivity value (float) which is configured to the value of change that will trigger a transmitted event.
Raw	Raw sensor data value as read
Value	Scaled using Range/Offset, sensor data value that is transmitted.
Modbus IO Points Menu:	
a) Select SDI-12 or Modbus: Modbus	Enable Modbus or SDI-12 smart sensor configuration. Default is Modbus. **Note: If there is a configuration for SDI-12 or Modbus, then user must delete all configuration before switching or removing.**
b) Add IO Point	Configure new Modbus input mapping.
c) Sampling / Warmup Time	Configure the Modbus sensor sample and warmup time. Warmup is used to allow the sensor to stabilize before a poll is performed.
d) Modbus Serial Config	Setup of the Modbus serial setting for baud rate, stop bits, parity and number of data bits. Default is 9600, 8, N, 1
e) Force Modbus Poll	Force a poll of all configured mappings as in menu below.
f) Slave ID# 2: REG 10001 (FC 2:00000), AP REG 15513 g) Slave ID# 2: REG 30010 (FC 4:00009), AP REG 35001 h) Slave ID# 2: REG 10004 (FC 2:00003), AP REG 40001	Example mapping reading from slave ID 2, Modbus register 10001 (discrete input 1) which is sent to AP register 15513. Selecting this menu item will open a new menu to edit mapping. See below.
l) Return to Main menu	Return to main menu.

Modbus mapping menu item can be selected from menu above to allow changes to be made to individual parameters after initial configuration.

Modbus IOs	
REG 15513	
Format U-2	
Range 0	
Offset 0	
Sens 1	
Display -	
Raw	
Value ON	
Slave ID# 2: REG 10001 (FC 2:00000), AP REG 15513 Menu:	
a) AP REG	Change AP destination Register
b) Report Format	Change the Reporting format
c) Span / Range	Change Span / Range
d) Zero / Offset	Change Zero / Offset
e) Display Units	Change Display Units
f) Display Scaling	Change Scaling
g) Report Sensitivity	Change Sensitivity
h) Slave ID	Change Slave ID
i) Slave Register/Function Code:Address	Change Function Code or Address
j) Remove IO	Remove the Poll mapping
k) Save Config	Save configuration
l) Return to previous menu	Return to previous menu

SDI-12 Smart Sensor Configuration

Smart sensors using either SDI-12 or Modbus can be connected, and values can be transmitted through the Condor wireless network.

SDI-12 smart sensors are often used with environmental or agricultural sensors such as weather stations (wind speed, direction, rain fall, temperature, humidity), water quality and ground moisture measurements. The 415U-1-Cx allows these SDI-12 sensors to be connected and their internal variables to be transmitted via the Condor wireless network.

By accessing the Smart Sensor menu from I/O setup, the configuration allows SDI-12 sensors to be added and variables configured to be sent over the 415U-1-Cx communications port.

TIP: If you are adding multiple sensors to the SDI-12 port it is best to connect one sensor at a time and use scan to add sensor measurement variables, change address to unique value. Then connect the next sensor, use add sensor option, change address, and so forth until all sensors are added.

The SDI-12 configuration menu has the following options:

SDI-12 config Menu:	Description
a) Select Smart Sensor SDI-12 or Modbus: SDI-12	Switch between SDI-12 and Modbus Smart Sensor options. Note that only one type can be used at a time and all mappings need to be deleted to switch types.
b) Scan for Device	Send out address query to identify any connected sensor and then automatically add sensor found.
c) Manually add Device	Send manual commands to sensor diagnostic
d) Send manual command	Send manual command to add sensor. Use this option if more than one sensor connected to bus.
e) SDI Sampling Time	Configure the SDI sensor system sample time in minutes and warmup time in seconds. This is common for any connected sensors and warmup time should be configured to allow for slowest sensor.
f) SDI Measurement CMD	Change the measurement command from default (M!) to R! or to use CRC with MC! or MR! commands. Leave at default if unsure.
g)….o) Setup Sensor AA ID	As sensors are added with address AA and ID using Scan or Manual Add menu options the menu to grow more options for the setup of each sensor. Eg. f) Setup Sensor 5 5ELPROTECH##0000011.0001

When selecting automatic scan for a connected sensor the 415U-1-Cx will power the sensor and then send an address query command using the default warmup time. For very slow sensors you may need to adjust this longer to get a response. The Scan for Device option will take quite some time as it powers sensor, waits for the warmup time (default is 20 seconds), then request address, number of measurement variables and waits the measurement time to get current measure variable values. Once the scan for device process is complete the sensor configuration menu is opened. See below for an example of the process of automatic scanning for an SDI-12 sensor.

```
Scan for Device:
        Warming up the Sensor...
        Getting SDI Params structure (address, time, variables,)....
        Sending C! Command...
Response return (atttnn): 500509
```

The response above from the SDI-12 indicates the sensor address, number of variables available to use.

The available SDI-12 variables are loaded then the sensor configuration menu will be show as below:

```
Config NOT Saved
```

```
Addr: 5
Model: 5ELPROTECH##0000011.0001


                    MV0     MV1     MV2     MV3     MV4     MV5     MV6     MV7
ID                  -       -       -       -       -       -       -       -
Format              F-4     F-4     F-4     F-4     F-4     F-4     F-4     F-4
Offset
Sens
Value               #1.11#  #22.78# #3.33#  #4.44#  #5.56#  #6.67#  #7.78#  #8.89#

SDI SENSOR 5ELPROTECH##0000011.0001 Menu:
    a)  MV0
    b)  MV1
    c)  MV2
    d)  MV3
    e)  MV4
    f)  MV5
    g)  MV6
    h)  MV7
   Selection:
```

In the above example sensor, you can see that there are 8 variables reported by the SDI-12 sensor and can be mapped as an input to transmit in the 415U-1-Cx unit. By default, each of these variables is disabled indicated by – in the ID row.
You can now configure the 415U-1-Cx sensor ID to a value other than 255 to enable transmitting of data and then configure the sensitivity, zero/offset, display units as required for the application.
Note that all SDI-12 measurement variables are sent as floating-point values.
Select the letter corresponding to the measurement variable that you need to configure, and the menu below will be displayed to allow the setup of each individual sent DATA sensor IDs.

```
MV1                                 Current configuration values
ID      30
Value   #22.7778#
Format  F-4
Offset  0
Sens    0.1

MV2 Menu:
a)  DATA Sensor ID (255 to disable)  Configure the transmitted sensor ID.
b)  Report Format                    For SDI-12 this is fixed as F-4 which is a float single
                                     precision value.
c)  Zero / Offset                    Zero or offset adjustment value if required.
d)  Display Units                    Engineering units to display, eg mm, ft, PSI, degC
e)  Report Sensitivity               Value of change before a event will be triggered and
                                     value is sent.
```

Discrete Outputs

Outputs Operation

Note: supported in R1.6 or later firmware

The 415U-1-Cx has discrete outputs which can be configured to allow external devices, plant or equipment to be controlled. There is a maximum of four outputs available for use depending on the mode of operation used.
The outputs can be configured as two modes, simple on/off or pulsed operation.
ON/OFF mode is normally used for applications like starting a pump or flashing warning lights for example.
Pulsed outputs ais a mode that is often used with devices designed to be used in low power consumption applications like latching solenoids or relays. When outputs are used in pulsed mode then each output uses two pins on the connector, so there is a maximum of two available for use.
Due the low power consumptions nature of the 415U-1-Cx, the unit spends much of its time in a partially powered down mode to conserve battery energy. Because of this operation the access point cannot directly send the value of an output directly to the 415U-1-Cx and must wait until its awake when sending a digital analog input event or periodic update communication. This should be considered in the system design and allowances for control system timing.
To allow the 415U-1-Cx to remain "awake" longer to wait for control from remote PLC or SCADA the Output Tail Time can be configured from the Unit menu.
If there is a communications failure the Outputs Timeout value can be configured from the Unit menu, to reset outputs to default state to allow plant or equipment to return to a default or off condition.

Outputs Configuration

From the main menu select the option, I/O Setup to access the outputs configuration. Each digital I/O can be configured separately and accessed by selecting the menu item a) through to d). see menu below.
For pulsed mode outputs each output will use two physical outputs on the unit. For example, if Discrete 1 is set to a pulsed more output, then it will use discrete 1 and discrete 2 pair together and driven from a single register. Pulse mode inputs include configuration of pulse duration to allow the control of latch or push-pull type solenoids or valves.

External Inputs

	DI3	DI4	AI1	AI2
Mode	Pulse	ON/OFF	4-20mA	4-20mA
REG	37513	15011	35010	35011
Format	U-4	ELPRO	U-2	ELPRO
Raw	0	Off	8 mA	-0.06 mA
Value	0	0	8004	8067

External Outputs

	DO1	DO2
Mode	Latch1	Latch1
REG	1	1
LPD	10	10
Value	1	0

I/O Setup Menu:

a) Digital 1	Discrete input or output configuration. For pulsed (latch) output combined with discrete output 2.
b) Digital 2	Discrete input or output configuration. For pulsed (latch) output combined with discrete output 1.
c) Digital 3	Discrete input or output configuration. For pulsed (latch) output combined with discrete output 4.
d) Digital 4	Discrete input or output configuration. For pulsed (latch) output combined with discrete output 3.
e) Analog 1	

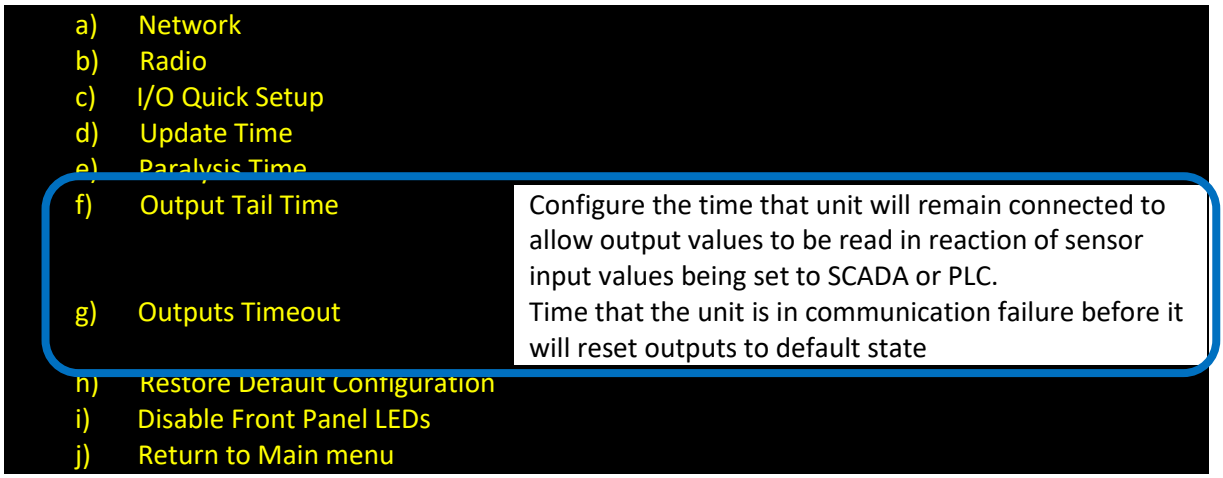
f) Analog 2 g) Battery Voltage h) Solar/Supply Voltage i) RSSI j) Internal Temp j) Internal Temp k) Status Sensor l) Analog Set Points m) SDI-12 Device config n) Analog Sampling o) Return to Main menu	

When configuring simple ON/OFF discrete outputs, then simple select the digital output menu option to configure settings.
For Pulsed (latched) outputs the discrete outputs are paired. To configure select discrete 1 or discrete 3. For example if discrete output 1 is configured as pulsed, when this output is set ON the physical DIO1 will pulse ON for the configured duration. When set to OFF, then DIO2 will pulse ON for the configured duration. This configuration allows the use of low power latching solenoids or relays to be used.
To configure a digital as an output, select DIO mode see menu options below:

DO1 Mode Latch1 REG 37011 LPD Value Digital 1 Menu: a) DIO mode b) Sensor REG c) Latching pulse duration d) Save Config e) Return to previous menu	Select Discrete as Input or Output. If Output is selected, then can be configured as ON/OFF or Latch for pulsed output. Register used for input or output For Latched or pulsed outputs configuration of time that output is ON or active.

For discrete and pulsed (latched) outputs there are two other configuration items available. Output Tail Time is configured with a time in seconds which will keep the 415U-1-Cx powered and able to receive messages from the access point. This configuration can be used in applications where a 415U-1-Cx sensor input might be known to possible trigger the activation of a discrete output. So, it will allow this output to be received while and minimize latency.
If the application is not time critical then it is best to keep the Output Tail Time to a minimum value or zero to maximize battery life.
Output Timeout can be used to reset outputs to a failsafe state if the 415U-1-Cx has lost communication with the access point. This setting is a timeout value and should be set to a value longer than the update time. A recommendation is to use 2.5 times the update time.
Configuration of the Output Tail Time and the Output Timeout can be found in the Unit config menu, accessed from the Main menu.

Unit Config Menu:



Saving and loading of Unit Configuration

Note: supported in R1.6 or later firmware

The Condor 415U-1-Cx internal configuration is stored in non-volatile memory in the unit. It is recommended that the configuration is backed up to allow quick replacement of units if there is a unit failure by surge for example. The configuration can be written to a USB memory stick and then later reloaded into the unit if required.

The file is secured and encrypted using the units Engineer password and to later load the configuration this password will be needed to de-encrypt the file.

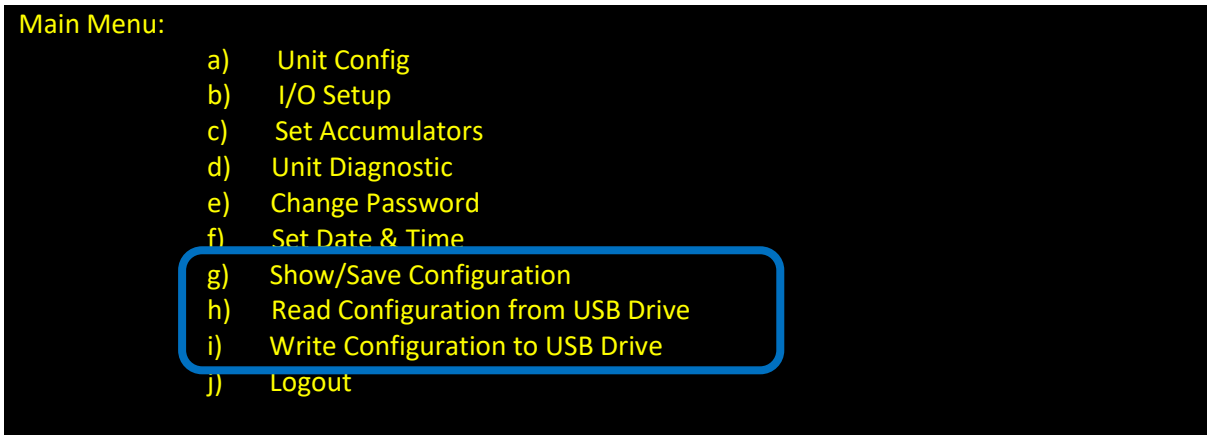
The file name used when saved includes the units serial number and Station name which allows multiple files to be saved onto USB and then recovered very quickly to load into the correct 415U-1-Cx unit.

It is recommended that the configuration files be backed up securely and not rely on USB media for long term storage.

Note that during the configuration writing and read process the terminal USB connection will be temporarily suspected which with some terminal programs will require to be reconnected. Others such as Teraterm can do this reconnection automatically.

Not also that during the writing and reading process DO NOT remove the USB memory stick from the unit as file corruption can occur.

The Show/Save configuration, read from USB and Write to USB configuration options are accessed from the main menu as below as indicated:



Show/Save Configuration will display the complete configuration and if there are pending configuration changed then will prompt user to save these to internal memory.

Save to filename: 0123456789_415U-1-Cx_TANK.cfg? (y/n):y Configuration will be encrypted using login password. Connection to menu will be temporarily closed during file save. Now insert the USB Drive. Press any key to continue...	Filename used to save file on the USB memory device. Can be customised if N is selected. Menu USB connection will be shut down during the writing to USB memory device. Press key to start
Saving configuration. Connection will be lost in 2 seconds... Reconnect required when ALL LEDs (D0 - D3) ON or Stopped Turning ON.	DIO LEDs should progress lighting each LED from DIO1 to DIO4
LEDs Detail: D0 : USB Initialized D1 : File found D2 : Start loading to Flash D3 : Load Completed	Writing process is complete when DIO1-4 is ON. If process stops at any other LED then error is as is indicated by the LEDs
Press any key to continue…	Press a key once terminal connection is restored. With some terminal programs this needs to be done manually.
Successfully saved config file to USB Drive. Press any key to continue...	Write to USB memory device has been completed

When menu option to read configuration file:

Save to filename: 0123456789_415U-1-Cx_TANK.cfg? (y/n):y Decrypt configuration using login password? (y/n):y Connection to menu will be temporarily closed during file save. Now insert the USB Drive. Press any key to continue...	Filename used to save file on the USB memory device. Can be customised if N is selected. If you need to use a different password, then select N and enter the password required. Menu USB connection will be shutdown during the writing to USB memory device. Press key to start
Reading configuration. Connection will be lost in 2 seconds. Reconnect required when ALL LEDs (D0 - D3) ON or Stopped Turning ON.	DIO LEDs should progress lighting each LED from DIO1 to DIO4
LEDs Detail: D0 : USB Initialized D1 : File found D2 : Start loading to Flash D3 : Load Completed	Reading process is complete normally when DIO4 is ON. If process stops at any other LED then error as indicated in
Press any key to continue…	Press a key once terminal connection is restored. With some terminal programs this needs to be done manually.

Successfully loaded config from USB Drive. Press any key to continue...	Read from USB memory device has been completed and configuration stored in 415U-1-Cx

Diagnostics

The 415U-1-Cx has a range of diagnostics available from the configuration menu to allow the commissioning or to fault find of a system.
There is also a range of internal sensor diagnostic inputs available to allow mapping of critical diagnostics back through the access point to SCADA or DCS systems. See sensor inputs section of this user manual.

Diagnostic menu options

The diagnostic menu is access from the main menu and is summarized below:

Unit Diagnostic Menu:	
a) Show I/O Values	Display internal inputs, Battery Voltage, Solar/Supply Voltage, RSSI, Internal Temperature, Internal Status and also current external input values for discrete, pulsed and analog inputs. Will force analog loop supply to turn on to sample fresh values.
b) Show Outputs	Allows you to manually turn on/off the outputs, Output number turns it on and zero turns it all off.
c) SDI-12 value & Test	Test functions for SDI-12 sensor to allow reading/changing of sensor address, info commands, etc. to allow fault diagnosis.
d) Modbus Testing	Test the Modbus functionality, you will need to have a Modbus device and I/O point configured to get access to this menu.
e) Show Last connection/status	Displays the Status and last connection details
f) Test Mode Send Message	Force sending of Multi-sensor report message.
g) Show Firmware Version	Display Firmware versions of host, bootloader and radio.
h) Show Hardware Version	Display hardware revision of host electronics printed circuit board assembly.
i) Activate BLE DFU	Turn on Bluetooth (BLE) configuration port – FUTURE
j) Update Host Bootloader	Upload new firmware into the host bootloader.
k) Calibrate Analog Input 1	Calibrate analog input 1 – requires precision 4-20mA source.
l) Calibrate Analog Input 2	Calibrate analog input 2 – requires precision 4-20mA source.
m) Set Analog Default Calibration	Reset analog inputs 1 and 2 to factory defaults.
n) Erase Flash Memory	Erase all flash memory – logged data, factory calibration and configuration.
o) Enable Debug Console Output	Turn on diagnostic messages
p) Enable Monitor Radio Comms	Enable radio communication monitor
q) Return to Main Menu	Return to Main Menu

Show I/O values.

Internal Inputs/Status:

	Battery	sup/sol	RSSI	Int Tmp	Status
Raw	14.13 V	23.92 V	-42 dBm	32 degC	0

External Inputs:

	DI1	DI2	DI3	DI4	AI1	AI2
Raw	Off	Off	Off	On	-0.07 mA	-0.07 mA

Show Outputs.

Turn ON (Outputs = 1,2,3,4; 0 = ALL Outputs OFF): 0

Enter the output number (1,2,3,4,) to turn ON and enter 0 will turn all OFF.

SDI-12 value & Test

Test the SDI-12 Sensor I/O, will need to have a sensor configured before this menu can be accessed.

Modbus Testing

Test Modbus Device I/O, will need to have Modbus configured before this menu can be accessed.

Will scan the Modbus and then display the I/O menu below.

a) Read Coil
b) Read Discrete
c) Read Registers
d) Read Inputs
e) Write Coils
f) Write Registers
g) Write Coil
h) Write Register
i) Poll Slave 1
j) Return to Main menu

Select the menu option and Enter the Address, count, and start location, i.e. for Read discrete.

Discrete 1: ON
Discrete 2: OFF
Discrete 3: OFF
Discrete 4: OFF
Discrete 5: OFF
Discrete 6: OFF
Discrete 7: OFF
Discrete 8: OFF

Show Last Connection/status

Will display the Status and last connection details.

Int Status: ALL OK.

Device Name: Condor-Base

IP Address	RSSI	BGND	Last Connected
192.168.17.80	-43 dbm	-39 dbm	0000:00:10:34

Module Uptime : 0000:19:53:41
Link Failed Count : 2
Read Failed Count : 0
Smart Sensor Read Failed Count : 2

Test Mode Send Message
Forces the Radio to send all its configured I/O and you will see a Wibmesh report showing Destination Addresses and their values.

Show Firmware Version
Show the current Firmware for the Host, radio, and bootloader.

```
Host Firmware       : v1.7 Apr 14 2021 10:28:01 : 9109
Radio Firmware      : E2-455 2.27 [Feb 21 2020 17:38:00] (8233)
Host Bootloader     : v1.1 - 8832M-0:4-1:17-2:0-3:0
```

Show Hardware Version
Shows Hardware Revision and serial number.
Hardware: Rev2A.B Serial Number: 00015872
Update Host Bootloader
Updates the Host bootloader firmware.

Calibrate Analog Input 1 or 2
Allows the calibration of the analogs. Shows a warning before continuing.
Steps through a two-part scan and calibrate process

```
Set Channel 1 to 4mA
Enter exact Current (mA) value when Ready: 4.00
Set Channel 1 to 20mA
Enter exact Current (mA) value when Ready: 19.94
Calibration Saved!
```

Set Analog Default Calibration.
Allow you to Set analog calibration back to Factory default. Shows a warning before continuing.

Enable Debug Console Output
Enable / disable Console option. Function stays enabled/disabled until menu is reselected.

Enable monitoring radio communication.
Enable / disable Monitor Radio Comms logging. This feature gives you a detailed view of the radio messages. You can view the low-level radio transmissions, the radio signal strength, and indication of corrupted radio messages. Each message is time stamped in the radio (time from power up) and will begin with the type of message transmitted (Tx) or received (Rx), then frequency, Tx Sequence Number/Rx Signal Strength, Mac Length/Total Length (bytes), frame control (802.11), MAC Destination address and MAC Source address.
For more detail on these messages see the 415U-2-Cx user manual.
Example log below.

```
0:23:02.516 Rx :   444.425  -84dBm ( 111/ 105) 8000 FFFFFFFFFFFF 0012AF1113A3
0:23:02.945 Rx :   444.425  -50dBm (  72/  66) 0843 0012AF117D9B 0012AF10F01B
0:23:02.955 Rx :   444.425  -36dBm (  10/  11) D400 0012AF10F01B
0:23:05.265 Rx :   444.425  -49dBm ( 109/ 103) 8000 FFFFFFFFFFFF 0012AF10F01B
0:23:10.063 Tx : 1 444.425 [   26] (  95/  94) 0000 0612AF10F01B 0012AFA58CBC
0:23:10.076 Rx : * 444.425  -46dBm (  10/  11) D400 0012AFA58CBC
0:23:10.106 Rx : - 444.425  -46dBm (  78/  77) 1000 0012AFA58CBC 0612AF10F01B
0:23:10.118 Tx : = 444.425 [65535] (  10/  11) D400 0612AF10F01B
0:23:10.275 Rx :   444.425  -87dBm ( 113/ 109) 8000 FFFFFFFFFFFF 0A12AF1113A3
```

Note: Function stays enabled/disabled until menu is reselected.

Postn	Name	Description
1-13	Time Stamp	Message timestamp according to the radio's time. Format is hh:mm:ss.sss, providing millisecond. This should be close to the host time
15-18	Dir'n	Tx indicates Transmitted Message. Rx indicates Received Message
20	Flag	More information about the message: 1-9: Transmission Counter (re-tries) * : Received Acknowledgement to transmitted message (from this station) - : Received message (to this station) =: Transmitted Acknowledgement to received message (to this station) B: Bit-Error test frame
22-29	Freq	Radio Frequency (in MHz)
30-36	Seq (Tx) RSSI (Rx)	For transmitted messages, the sequence number of the message. [65535] indicates internally generated message ACK or CTS. For received messages, the RSSI (signal strength) of the message in dBm
38-48	Length	The message length in bytes. first number is the MAC message length. Second number is the on-air length.
50-53	Frame Control	The frame Control field according to 802.11 protocol. Some common values are shown here. 8000 - Beacon frame from AP D400 - ACK (message acknowledge) 0000 - Association Request 1000 - Association Response 4000 - Probe Request 5000 - Probe Response 0803 - Data Frame (Unencrypted) B400 - RTS (Channel Request) C400 - CTS (Channel Grant) A000 - Disassociation B000 - Authentication (WPA only) C000 – De-authentication
CRC Error		ERROR! is displayed in positions 50-55 for a corrupted received frame. If the message Header is received, the Length will indicate the message length. Otherwise, it shows zero.
55-66	Dest	Address1 field from 802.11 protocol This is the destination MAC address for the message. FFFFFFFFFFFF for broadcast messages
68-79	Source	Address2 field from 802.11 protocol This is the source MAC address for the message (blank for acknowledgements)

LED Functionality

Discrete input status is shown on LED only when USB is plugged/menu active to conserve battery energy. See table below for front panel LED functions:

PWR/OK	Normal operation: Short Green Flash every 10sec Fault or No link to AP: Short Red Flash every 10sec Unit Active/USB Plugged In: ON Green no faults or ON Red Fault or no link
TX	Radio Transmitting Data
RX	Radio Receiving Data
SENSOR	Analog 4-20mA 24V Loop Active or Modbus/SDI-12 Smart Sensor Active

TEST MODE	TX Test Button Pressed and current data is being transmitted to AP

OK LED Red Status Internal register bits decoder

The status register is an internal register available the in the 415U-1-Cx that gives a view of any internal errors that occurred and indicated by a red OK LED. If there is a RED OK then go the Diagnostics menu, then select the Show I/O Values menu item. The status register value will be displayed in decimal notation and as a character notation in some menus. Fault indicated can be decoded using the table below.

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
65535	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
			i	L	P	r	V	t	A	R	S	L	m	n	c	B
Not Used	Not Used	Not Used	Radio Initialization	Radio Supply Too Low	Radio Supply Low	Radio Rx PLL lock	Antenna VSWR	Radio Tx PLL lock	Set Point ON/OFF Read	Outputs Read Fail	Smart Sensor Read Rail	Communication Link	Host Modem	Host Network	Host Communications	Battery Low

Note: Low battery indication threshold is triggered at 12.0Vdc to give early indication and allow service technician time to take action if required.

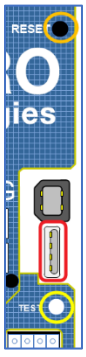
Restore factory default configuration

Factory defaults can be reset either through “Unit Config / Restore Default configuration” menu option or through button push process as described below.

1. Connect terminal to USB.
2. Reset unit.
3. Press test button for 3 seconds.
4. Message on terminal will be displayed to indicate factory defaults are restored.

```
Configuration Saved!!
Factory Reset Completed!
```

Firmware upgrade



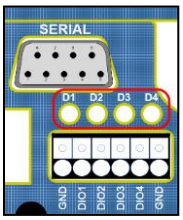
Note: Firmware updates and log files must use USB2.0 only not USB3.0)

1. Plug in USB stick (formatted as standard FAT32 file system) that contains “CONDOR-415U1Vx.x.bin” firmware file into the USB “A” socket (red indication in diagram).
2. Press and release the “Reset” push button (Orange indication in diagram) and then within 1 second press and hold “Test button” (Yellow indication in diagram) for more than 1 second.
3. Input LED’s D3 & 4 will illuminate briefly then LED 1(D1-Left most) will light to indicated USB has been detected and the firmware update process will begin.

NOTE: DO NOT REMOVE USB stick during writing process as doing so may render the unit inoperable.

4. As the firmware update progresses it will light Input LED 2 (D2), (D3) and finally (D4). Process should only take a few minutes.
5. When all four input LEDs (D1 – D4) are lit then you can safely remove the USB stick and the unit will restart.

If there is a problem with firmware update it will abort the process. To gain further information on the updating process, connect to the RS232 port at 9600, n, 8, 1, and you will see descriptive text on the progress and any error conditions that may be reported.
Below is a guide to progress as observed from the Digital Input LEDs.



Digital Input	Debug Digital Input LEDs
D1	Start Header Verification, Product ID Matched, Offset Matched, Entry/Destination Address Matched, Firmware Length Matched, Polynomial Matched, CRC Matched, Signature Length Matched
D2	OK (the signature is valid)
D3	Firmware updating.....100.00%
D4	Firmware update has been successful

Specifications

Operation

- Modes / Topology: Remote Unit type.

Input and Output

- Discrete Inputs/Outputs:
    - Input:
        - 4 x digital I/O configurable as on/off or DI1 -3 pulse inputs
        - On-state voltage: <2 Vdc
        - Off-state voltage: >3 Vdc
        - Wetting current: 30µA
        - Minimum input pulse width 1ms (active input).
        - Max Pulse Rate 10Hz
    - Outputs
        - ON/OFF or Latch (Drive H Bridge pulsed)
        - ON current < 200mA
        - OFF open circuit voltage < 30Vdc
        - NPN Transistor close to ground when active
        - Latch pulse time configurable in ms
- Analog input:
    - 2 differential analog inputs configurable mA
    - 0-20mA current loop (under/over range)
    - 16 bits resolution
    - Impedance < 250Ω
    - Input/common mode voltage max 30Vdc
- Sensor Loop Power:
    - Analog: 24Vdc, max 50mA
    - SDI-12 or Modbus: 12Vdc, max 500mA
- Modbus RTU Smart Sensor
    - Serial RS-485 communications with cable length less than 1km
    - Maximum of 46 sensor variables in total for all slave devices
    - Configurable serial baud rate (300-115,200), data bits, parity and stop bits
- SDI-12 (V1.4):
    - Maximum of 5 variables total:

  - M or R command / CRC configurable
  - Data Rate: 1200 bps, 7 data, 1 parity
- Heater Option: Open Collector output (active close to ground) available to allow internal heating in very cold environments. ON @ -0°C, OFF @ 2°C, 30Vdc/2A max

Configuration

- User configuration & diagnostics: USB Type-B or Bluetooth (FUTURE release)
- Configurable Parameters: Communication, Unit details, I/O mappings, I/O parameters, Analog sample time, SDI-12/Modbus sensor sample time, SDI-12 polled sensor variables and Modbus polled registers.

LED Indications & Diagnostics

- LED Indications:
  - Front Panel: Power/OK, Radio TX/RX, Sensor, Test Mode.
  - Internal: I/O Status, Link Status, Modbus connection status, Battery Charger status.
- Push Buttons:
  - Front Panel: Test transmission.
  - Internal: Factory defaults, Test, Reset, Firmware update (Button Sequence).

Reported Diagnostics

- Radio Diagnostics: Monitoring communications, RSSI measurements, Antenna fail, Background noise, low battery voltage, Modbus communications fail.
- External/internal inputs: digital/pulsed/analog, solar panel/external supply voltage, battery voltage, SDI-12 data

Connections

- Serial: 1 x RS232 (Future features)
- Serial: 1 x RS-485 Modbus RTU master gateway
- USB 1: Type-B - Firmware upgrades
- USB 2: Type-A - Local unit configuration/diagnostics
- Push-in Terminals: Internal wiring terminals (push connect), 0.20 - 1.5 mm² (24 - 16 AWG), Wire Strip Length 8mm (0.3”)
- Antenna connector: N-type Female

Transmitter and Receiver

- Frequency bands
  - C1: 148 - 174MHz
  - C3: 340 - 400MHz
  - C4: 400 - 480MHz
  - C5: 470 - 520Mhz
  - C9: 928 - 960MHz
  - Transmit Power: 10mW - 10 W configurable.
    - QPSK = C1,3,4,5, - 4W (+36dBm), C9 - 2.5W (+34dBm)
    - 16-QAM & 64 QAM = C1.3.4.5 - 2.5W (+34dBm), C9 – 1.6W (+32dBm)
- Modulation: QPSK, 16-QAM, 64-QAM
- Receiver Sensitivity: 6.25/12.5/25kHz (PER 5%)
  - QPSK-FEC: C1,3,4,5 = -116 dBm, C9 = -112dBm
  - QPSK: C1,3,4,5 = -113 dBm, C9 = -109dBm
  - 16-QAM: C1,3,4,5 = -104 dBm, C9 = -100dBm
  - 64-QAM: C1,3,4,5 = -97 dBm, C9 = -93dBm

- Channel Spacing: 6.25, 12.5, 25kHz (software configurable, 6.25 not available in C9)
- Data Rate Raw @ 6.25, 12.5, 25kHz (6.25 not available in C9)

	6.25Khz	12Khz	25Khz
▪ QPSK-FEC:	4 kbps	8 kbps	16 kbps
▪ QPSK:	8 kbps	16 kbps	32 kbps
▪ 16-QAM:	16 kbps	32 kbps	64 kbps
▪ 64-QAM:	24kbps	48 kbps	96 kbps

- Typical Range (LoS) - 50km+ (62 miles)

Compliance

- Regulatory
    - Australia: RCM
    - Europe: CE/RED
    - USA: FCC
    - Canada: IC
- EMC: FCC CFR47 Part 15; EN 301 489-3; EN 301 489-5
- RF (radio): FCC CFR47 Part 90; IC RSS 119; EN 300 113; EN 300 220; AS/NZS4295; AS/NZS4268
- Safety: EN/IEC/UL 62368
- Hazardous Area: UL Class I Div 2 (RF Power 2W EIRP)

Power Supply

- Supply/Solar - 17-30 Vdc, under/rev voltage protection, Ext Battery - 11-15Vdc into battery connection terminal.
- Battery Options
    - Internal (LFP rechargeable) Lithium Iron Phosphate LiFePO.
    - Internal (LiP non-rechargeable) Lithium Thionyl Chloride LiSOCI2.
    - External 12Vdc, Lead acid or Lithium Iron Phosphate LiFePO, charge current max 2A
- Solar Regulator or Battery Charger
    - External power supply/solar panel charges internal lithium iron phosphate or external lead acid battery
    - Smart charger up to 2A charge current MPPT optimised for 5-30W solar panel
- Idle Current draw: 120µA @ 13V
- Transmit current Draw (max): 2.5A @ 13.8V (10W RF), 1.2A @ 24V (10W RF)

General

- Size: 190mm x 197mm x 98mm (7.5” x 7.8” x 3.8”)
- Housing: Aluminum cast enclosure with removable door IP66 rated
- Mounting: Panel mount standard (DIN rail, pole, or solar mount options)
- Operating Temperature
    - external supply -40 to 70°C (-40 to 158°F)
    - LFP rechargeable battery -20 to 60°C (-4 to 140°F)
    - LiP non-rechargeable battery -40 to 70°C (-40 to 158°F)
- Humidity Rating: - 0-99% RH noncondensing
- Cable Entry: Standard M20 cable gland 5-13mm cable diameter UL/VDE, Accessory option M20 to ½”NPT Conduit Adaptor
- Weight: 1.8 kg (4.0lb) – not including internal battery
- Altitude: 0-2000m (0-8000ft)
- Pollution Degree: 4

415U-2-Cx/-E Register Map Reference

Digital output registers (coils)	
Address range	Description
0001 – 0008	Local DIO1–DIO8 as digital outputs
0009 – 0020	Spare
0021 – 0400	Space reserved for locally attached 115s expansion I/O modules. Twenty register per module address, maximum number of modules is 19.
0401 – 10000	General purpose bit storage used for: Staging area for data concentrator; Fieldbus mappings storage; Force mapping registers
Digital input registers (bits)	
10001 – 10008	Local DIO1–DIO8 as digital inputs
10009 – 10020	Set point status from analog inputs 1 through 12
10021 – 10400	Space for locally attached 115s expansion I/O modules. Twenty register per module address, Maximum number of modules is 19.
10401	Reserved - Used for repeater status indication
10402-10405	Radio hard fault status flags
10402	Radio power amplifier over temperature
10403	Radio general hardware fault
10404	Radio frequency lock error
10405	Antenna VSWR fault
10406 – 20000	General purpose bit storage used for: Staging area for data concentrator; Fieldbus mappings storage;
Input registers (words)	
30001 – 30004	Local AI1–AI4 (analog inputs, current mode)
	AI1 and AI2: 4–20 mA differential
	AI3 and AI4: 4–20 mA sink
30005	Local supply voltage 0–40 V scales to 0-20mA
30006	Local 24 V loop voltage 0–40 V scales to 0-20mA
30007	Local battery voltage 0–40 V scales to 0-20mA
30008	115S supply voltage 0–40 V scales to 0-20mA
30009 – 30010	Local AI1, AI2, Voltage Mode. 0-24V Scales to 0-24mA.
30011 – 30012	Local AI3, AI4, Voltage Mode. 0-5V Scales to 0-20mA
30013 – 30016	Local pulse input rates: PI1–PI4
30018 – 30020	Spare
30021 - 30400	Space for locally attached 115s expansion I/O modules. Twenty registers per module address, maximum number of modules is 19.
30401	RSSI: When configured as a Remote, MeshNode, Repeater, or Manual Client, the RSSI of the connected upstream device in (negative)dBm
30402	Connected Time: When configured as a Remote, MeshNode, Repeater, or Manual Client, the time (in hours) that the connection to the upstream
	device has been made.
30403	Generation Count: When configured as a Remote, MeshNode, Repeater, or Manual Client, the generation count of the connection to the upstream
	device.
	This is the number of times the connection has been lost and re-established
30404 – 30405	Upstream IP Address: When configured as a Remote, MeshNode, Repeater, or Manual Client, the IP Address of the upstream device.

	Most Significant Byte High byte of Register 30404
	Second Byte Low byte of Register 30404
	Third Byte High byte of register 30405
	Least Significant Byte Low byte of register 30405
30406	Current Radio Channel for frequency agility
30407 – 30408	Radio Transmit Frequency (in Hz). 32-bit. Most significant word at lower (odd) address.
30409 – 30410	Radio Receive Frequency (in Hz). 32-bit. Most significant word at lower (odd) address. (As for Transmit Frequency)
30411	Module uptime: The time (in hours) that this module has been up and running
30412	Channel Utilization % (average of last 60 seconds)
30413	Background Noise (average of last 60 seconds)
30414	Tx retry % (average of last 60 seconds): The percentage of total transmissions that required at least one retry
30415	Tx failed % (average of last 60 seconds): The percentage of total transmissions that failed to get an acknowledgement after all retries exhausted.
30416 – 30419	Channel Utilization, Background noise, Tx Retry % and Tx Failed % (average of the last 60 minutes)
30420 – 30423	Channel Utilization, Background noise, Tx Retry % and Tx Failed % (average of the last 60 hours)
30424	Radio Power Amplifier Temperature. Actual temperature is reading - 100 °C. (-40 °C reads as 60, 25 °C reads as 125, 70 °C reads as 170 etc).
30425	Radio primary connection data rate (Upstream data rate).
30426 – 30490	Spare - General purpose word storage used for: Staging area for data concentrator; Fieldbus mappings storage;
30491	Logic Engine Execution State: 0 -> Stopped. 256 -> Running; 32768 -> Overrun
30494 – 30500	Internal information registers: serial number, firmware version and patch level
30494	First four digits of serial number (Encodes Manufacture Month & Year
30495	Next three digits of serial number (Encodes Manufactured Firmware version)
30496	Remaining four digits of the serial number
30497	First part of Current Firmware version
30498	Second part of Current Firmware version
30499	Third part of Current firmware version
30500	Patch Level of current firmware version
30501 – 32000	General purpose word storage used for: Staging area for data concentrator; Fieldbus mappings storage;
32001 - 32255	RSSI List: When configured as an Base, Repeater, or Manual AP. The RSSI of each connected downstream is added to an I/O register according to the last byte of that device's IP Address. For example, a downstream device with IP Address 192.168.0.199 will have its RSSI stored in I/O register 32000 + 199 = 32199. If no device is connected with that IP address, the corresponding register has the value Zero.
32256 – 36000	General purpose word storage used for: Staging area for data concentrator; Fieldbus mappings storage;
36001 - 36008	Local pulsed inputs 1–4, big endian format Most significant word at lower/odd address
36009 – 36040	Spare space for 32-bit register values
36041 – 38000	Not Available

38001 - 38032	Local analog inputs as floating-point values. ModScan format (sign + exponent + most significant 7 bits of significant at even/higher addressed location; lower 16 bits of significant at lower/odd, addressed location) (example: Analog input 1 at 12.3 mA gives registers 38001=CCCD, 38002=4144)
38033 – 40000	Spare space for floating point values
Output registers (holding registers)	
40001 – 40002	Local AO1 and AO2 analog outputs
40003 – 40020	Spare
40021 – 40400	Space for locally attached 115s expansion I/O modules. Twenty registers per module address, maximum number of modules is 19.
40401 – 46000	General purpose word storage area used for: Staging area for data concentrator; Fieldbus mappings storage
46001 – 46008	Local pulsed outputs 1–4. Big endian format. Most significant word at lower/odd address
46009 – 46040	Spare 32-bit registers
46041 – 48000	Not Available
48001 – 48004	Local analog outputs as floating-point values. ModScan format (sign + exponent + most significant 7 bits of significant at even/higher addressed location) Lower 16 bits of significant at lower/odd, addressed location (example: Analog output 1 at 12.3 mA gives registers 48001=CCCD, 48002=4144)
48005 – 50000	Spare space for floating point values
50001	Onwards Not available