User Manual **MN032002EN**

Effective May 2016
New information

415U-2 long-range wireless I/O and gateway

Version 2.4

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Powering Business Worldwide

Documentation note

Eaton acquired Cooper Industries in November, 2012. “Cooper Bussmann” may appear in some screen images within this guide.

⚠ ATTENTION

INCORRECT TERMINATION OF SUPPLY WIRES MAY CAUSE INTERNAL DAMAGE AND WILL VOID THE WARRANTY. TO ENSURE THAT YOUR 415U-2 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.

⚠ 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

- Operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated
- Operate 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.

Manufacturer	Model number	Coax kit	Net
ELPRO	UDP400-3	Includes 3 m cellfoil	1 dB gain
ELPRO	UDP400-5	Includes 5 m cellfoil	Unity gain
ELPRO	BU-3/400	CC10/450	2.5 dB gain
ELPRO	BU-6/400	CC10/450	5.5 dB gain
ELPRO	YU3/400	CC10/450	3.5 dB gain
ELPRO	YU6/400	C10/450	6.5 dB gain
ELPRO	YU9/400	CC20/450	5 dB gain
ELPRO	YU16/400	CC20/450	10 dB gain

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.

Hazardous location notices

This equipment complies with the following standards:

- IEC 60079-0:2012/A11:2013
- IEC 60079-15:2010

This equipment complies with 94/9/EC—ATEX Directive Ex nA IIC T4 Gc –30 °C ≤ Ta ≤ +60 °C.

Special conditions

1) This equipment is designed to be installed as a component in an enclosure that meets IP54.

2) This equipment is to be mounted in a vertical orientation to facilitate effective heat dissipation.

⚠ WARNING: EXPLOSION HAZARD

DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

This equipment is suitable for use in Class 1, Division 2, Groups A, B, C and D; Tamb –30° C to +60° C or non-hazardous locations only.

This equipment shall be installed in accordance with the requirements specified in Article 820 of the National Electrical Code (NEC), ANSI/NFPA 70-2011. Section 820.40 of the NEC provides guidelines for proper grounding, and in particular specifies that the antenna ground (shield) shall be connected to the grounding system of the building, as close to the point of cable entry as practical.

This equipment shall be installed in a restricted access location, such as a dedicated equipment room or service closet.

The earth/ground terminal of this equipment shall be connected to earth ground in the equipment installation.

The external power supply installed with this equipment shall be a listed, Class 2 power supply, with a rated output between 15 Vdc and 30 Vdc, and minimum 3500 mA.

GNU free documentation license

Eaton is using a part of Free Software code under the GNU General Public License in operating the 415U-2 product. This General Public License applies to most of the Free Software Foundation's code and to any other program whose authors commit by using it. The Free Software is copyrighted by Free Software Foundation, Inc., and the program is licensed "as is" without warranty of any kind. Users are free to contact Eaton at the following email address: www.eaton.com/wireless for instructions on how to obtain the source code used for the 415U-2.

A copy of the license is included in GNU Free Document License at the end of the manual.

Important notice

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 Eaton.

To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the 415U-2 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-2 module is not suitable for use in explosive environments without additional protection.

The 415U-2 operates 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.

Release notice

This is the December 2015 release of the 415U-2 Wireless I/O and Gateway User Manual version 2.4, which applies to configuration software version 1.10 and firmware version 2.4.

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 aluminum (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 Eaton 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 Eaton 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 defense 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 Eaton we are focusing on analyzing emerging threats and ensuring that we are developing secure products and 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.

Eaton strongly recommends our customers to apply the deployment practices that are outlined on our Cybersecurity whitepaper "Cybersecurity consideration for Industrial Wireless systems".

Table of contents

Introduction

Overview

The ELPRO 415U-2 Ethernet Networking I/O and Gateway is a multiple I/O node that extends communications to sensors and actuators in local, remote, or difficult to reach locations. Designed to work with wired and wireless devices, the ELPRO 415U-2 is capable of providing IP-based I/O across sprawling industrial environments typical of industrial applications.

The 415U-2 can serve as an end node or network gateway and is scalable to thousands of nodes. Gather-scatter and block mapping technology offers the efficient use of network resources, allowing point-to-point transfer of process signal within complex monitoring and control systems. Integrated Modbus® server capability allows further I/O expansion through the use of ELPRO 115S expansion modules.

The module can monitor the following types of signals:

- Digital (on/off) signals, such as a contact closure or switch
- Analog (continuously variable) signals, such as tank level, motor speed, or temperature
- Pulsed signal, frequency signals, such as metering, accumulated total, or rainfall
- Internal signals, such as supply voltage, supply failure, or battery status

The modules monitor the input signals and transmit the values by radio or Ethernet cabling to another module (or modules) that have been configured to receive this information. The 415U-2 radio is available in models to support both unlicensed and licensed operation depending on your country. Refer to section [2.3 Radio] for more detail on radio options.

Input signals that are connected to the module are transmitted and appear as output signals on other modules. A transmission occurs whenever a change of state (COS) occurs on an input signal. A COS of a digital or an internal digital input is a change from “off” to “on,” or a change from “on” to “off.” For an analog input, internal analog input, or pulse input rate, a COS is a configurable value referred to as sensitivity. The default sensitivity is 1000 counts (3%), but you can change this value using the sensitivity block configuration page in the MConfig utility, as described in “MConfig utility” on **page 14**.

In addition to COS messages, update messages are automatically transmitted on a configurable time basis. These updates ensure system integrity. Pulse inputs counts are accumulated and the total count is transmitted regularly according to the configured update time.

The 415U-2 modules transmit the input/output data using radio or Ethernet. The data frame includes the address of the sending module and the receiving module, so that each transmitted message is acted upon only by the correct receiving unit. Each message includes error checking to ensure that no corruption of the data frame has occurred due to noise or interference. The module with the correct receiving address will acknowledge the message with a return transmission (acknowledgment). If the original module does not receive a correct acknowledgment, it will retry multiple times before setting the communications status of that message to “fail.” For critical messages, this status can be reflected on an output on the module for alert purposes. The module will continue to try to establish communications and retry each time an update or COS occurs.

The 415U-2 comes from the factory with ELPRO WIB. Modbus TCP/RTU and DNP3 protocols as standard. WIB protocol provides powerful enhanced features, including IP addressing, and it allows thousands of modules to exist in a system. Modbus TCP and DNP3 protocols provide a standards-based interface to a multitude of commercially available controls systems, including PLCs, DCS, and SCADA.

A system can be a complex network or a simple pair of modules. An easy-to-use configuration procedure allows you to specify any output destination for each input. Each 415U-2 device can have up to 19 expansion I/O modules (ELPRO 115S) connected by RS-485 twisted pair cable. Any input signal at any module may be configured to appear at any output on any module in the entire system.

The units can be configured using the MConfig utility via Ethernet, remotely over the radio, or USB. Advanced users may configure the units by accessing the internal Web pages using a Web browser. The MConfig utility is described in “MConfig utility” on **page 14**. For Web-based configuration, see “Downloading and installing MConfig” on **page 14**.

Module structure

The 415U-2 module is made up of different interface areas with a central input and output storage area (I/O store). The I/O store is an area of memory made available for the status of the physical on-board I/O and internal I/O registers. It also provides services for other processes within the module.

The I/O store is split into eight different block types:

- Two blocks made available for bit data (discrete)
- Two blocks made available for word data (analog)
- Two blocks made available for 32-bit words data (32-bit analogs)
- Two blocks made available for floating point data (floats)

Each of these block types in turn support input and output locations that can interface with the physical I/O on the local machine and also be used for data storage when used as a gateway to external devices. These block type locations are illustrated in **Figure 1** and are described in "Input registers" on **page 75**. There are other registers within the database that can be used for system management.

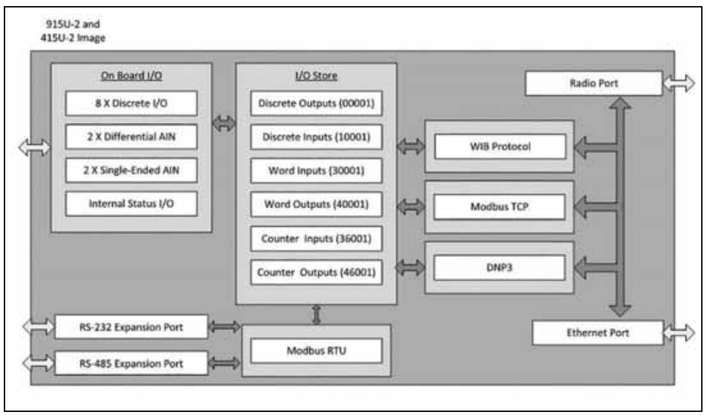


Figure 1. Module structure

The radio and Ethernet interfaces (see **Figure 1**) allow the 415U-2 to communicate with other modules within the system using a proprietary protocol called WIB. I/O Messages from other 415U-2 modules are received on the communication ports and then passed to the I/O store which will in turn update the register locations accordingly. The WIB protocol is designed to provide reliable communications suitable for an Ethernet channel or for an open license-free radio channel. It is an extremely efficient protocol for radio communications because the messages are sent using exception reporting (only transmitting when there is a change of an input signal) rather than transmitting all of the time. Update messages can also be configured at a predetermined time for integrity checks.

Each message can be comprised of multiple I/O values, referred to as a "block of I/O." The messages use error checking and return acknowledgment for greater reliability. Up to four attempts are made when transmitting the message over each hop of the radio path, and if no acknowledgment is received a Comms indication can be flagged.

The on-board I/O includes eight discrete I/O, two single-ended analog inputs, two differential analog inputs, and two current sourcing analog outputs. Each discrete I/O can function as either a discrete input (voltage-free contact input) or discrete output (transistor output). Each I/O point is linked to separate I/O registers within the I/O data store.

The following internal I/O can be accessed from the I/O store. The inputs can be used to interpret the status of a single module or an entire system:

- **Battery voltage**—The battery terminal voltage, displayed as an analog value.
- **Loop supply**—The +24 Vdc analog loop supply (ALS) used to power analog current loops, displayed as an analog value.
- **Expansion module volts**—The supply voltage of the connected expansion modules, displayed as an analog value.
- **RSSI—**The radio signal level for the selectable address, reported as a dB level.
- **Comms Fail**—A selectable register can indicate a Communications Fail error for a particular message transmission.

The expansion port, allows 115S expansion I/O modules to be added to the module. Expansion I/O is dynamically added to the internal I/O of the 415U-2 module by adding an offset to the address.

Getting started

Most applications for the 415U-2 module require little configuration. The 415U-2 has many sophisticated features, but if you do not require these features you can use this section to configure the units quickly.

To get started quickly:

1. Read "Installation" on **page 3**, which describes the power supply, antenna/coax connections, and I/O connections.
2. Power on the 415U-2 module and set up an Ethernet connection to your PC. For detailed steps, see "Connecting to the module" on **page 14**.
3. Install and run the MConfig utility. For MConfig installation instructions, see "Downloading and installing MConfig" on **page 14.**

Installation

General

The 415U-2 Series modules are housed in a aluminum enclosure with DIN rail mounting, providing options for up to 14 I/O points, and separate power and communications connectors. The enclosure measures 6.7" x 5.9" x 1.6" (170 mm x 150 mm x 40 mm), including the connectors. The antenna protrudes from the top.

Thermal

The 415U-2 contains a high-power radio that can generate a significant amount of heat.

For effective heat dissipation, the device must be mounted in the vertical orientation, with the antenna connection at the top, and with clearance of at least 25 mm on the right side to allow thermal convection.

When powering the radio from the "SUP" inputs and using the radio at high duty-cycle (for example in a Repeater or Base station role), you must check the derating chart below to ensure the radio will operate at your expected ambient temperature.

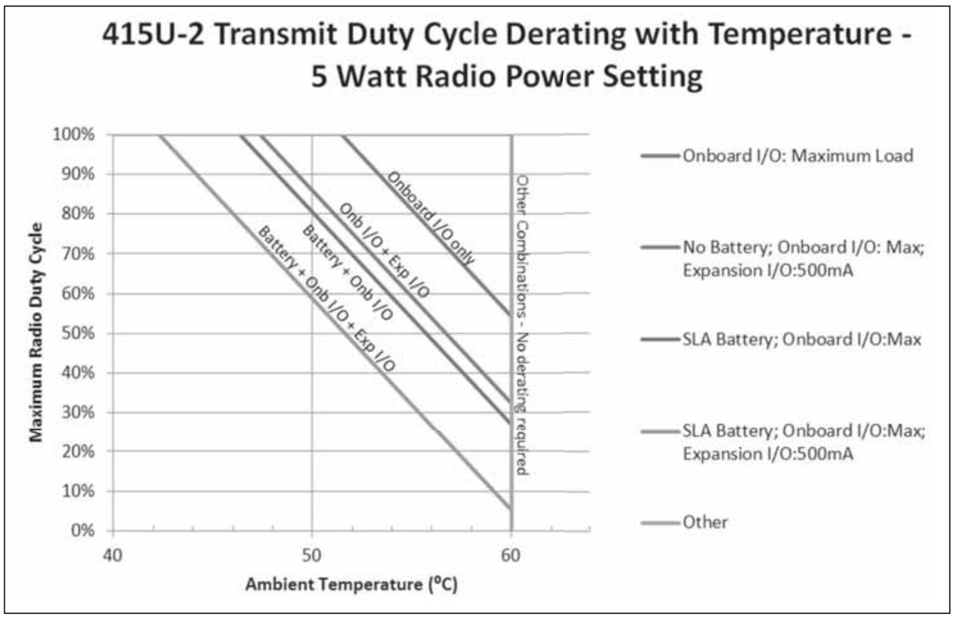


Figure 2. Temperature derating—5 W

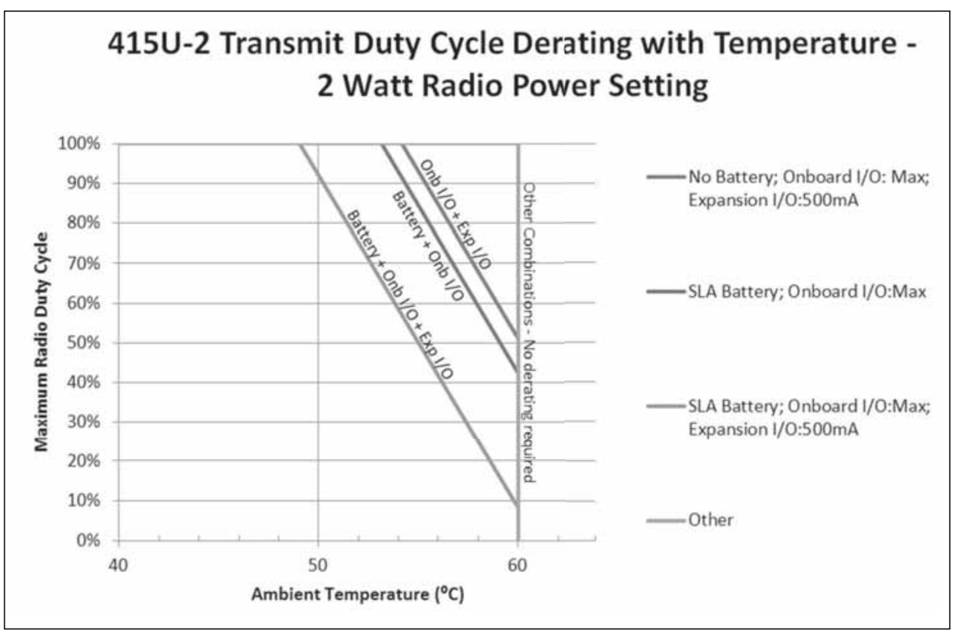


Figure 3. Temperature derating—2 W

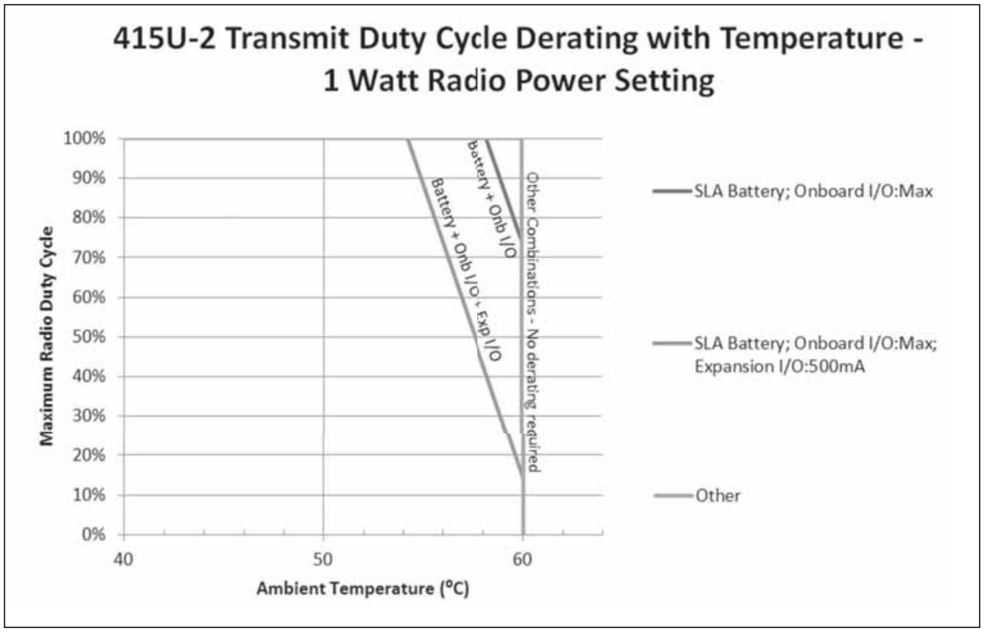


Figure 4. Temperature derating—1 W

Power supply

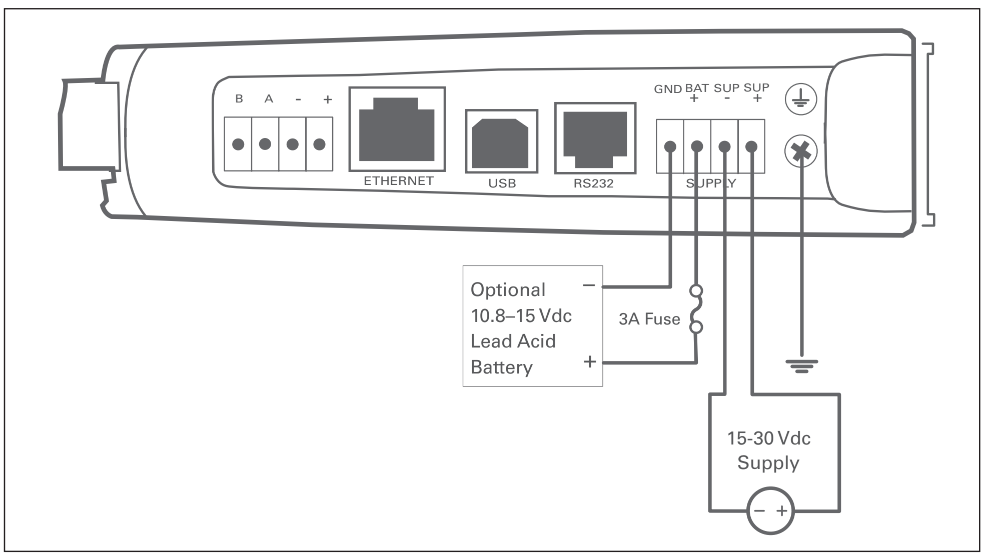


Figure 5. Supply connections

Powering from the SUP+ and SUP– terminals

The 415U-2 will operate from a 15–30 Vdc supply (nominal 24 Vdc) connected to the SUP+ and SUP– terminals. The power supply must be able to supply enough current to operate the device, to power all of the I/O circuits 415, and to power the device's radio transmitter when it is sending data. A 24 Vdc 2.5 A power supply such as ELPRO PSG60E or PS-DINAC-24DC-OK is suitable for all configurations, including configurations requiring battery charging and expansion I/O.

If you need to use a supply with a lower power rating; or if you need to power additional equipment in your installation; use these guidelines to determine your required power supply current. Add the relevant elements from **Table 1** to determine your power supply current requirement. Remember you also need to add current for any other equipment being powered from the same power supply, including relays, loop isolators, indicators, etc.

Table 1. Power supply current requirements

	Supply voltage		
	17 Vdc	**24 Vdc**	**30 Vdc**
Base operating current	250 mA	180 mA	140 mA
Radio transmit current—5 W radio	1500 mA	1100 mA	900 mA
Radio transmit current—0.5 W radio	1000 mA	700 mA	550 mA
Discrete I/O (per active input or output)	11 mA	7 mA	5 mA
Analog inputs and outputs (per 20 mA loop)	55 mA	38 mA	30 mA

Connecting a back-up battery to the BAT+ and GND terminals

The 415U-2 provides an internal battery charger for Sealed Lead Acid (SLA) batteries. You can connect a 13.8 V SLA battery to the BAT+ and GND terminals to provide a backup power source if the main supply fails. While the main supply is present, the battery will charge at up to 0.9 A rate until the battery voltage reaches 14.3 V. The battery charger will then maintain a float charge on the battery at this voltage. To fully charge the SLA battery, the main supply must be at least 17 Vdc.

When you connect a backup battery, you need to provide sufficient power to support the additional charge current required when the battery is discharged (when it is recovering from an extended power interruption). **Table 2** shows the *additional* current from your power supply to support battery charging.

Table 2. Additional current to support battery charging

Supply voltage (V_{sup})	Current required (I_{sup})
17 Vdc	1000 mA
24 Vdc	700 mA
30 Vdc	550 mA
Formula	$I_{sup} = \frac{16.5}{V_{sup}}$

Powering expansion I/O modules

The 415U-2 allows connection of 115S Series modules to the RS-485 port to provide expanded I/O capacity. You can use the "+" and "–" connections on the 415U-2 to provide up to 500 mA supply for expansion I/O modules. If you have a back-up SLA battery connected to the 415U-2, then this connection will also be powered from the back-up supply, so that the expansion I/O modules receive the backup power as well as the main module.

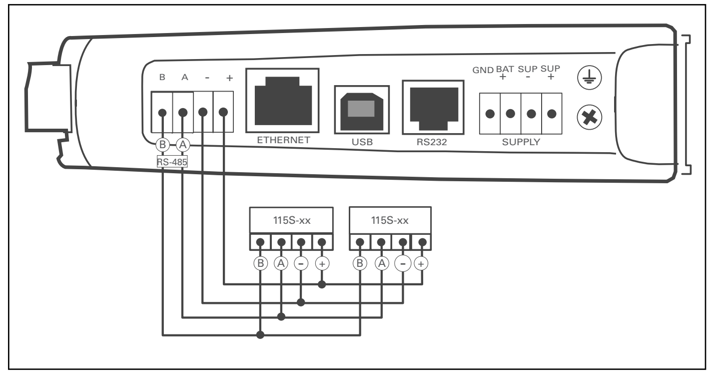


Figure 6. Expansion I/O power and RS-485

When the module is being powered from the main supply (SUP+ and SUP– terminals), you need to provide sufficient power to support the additional current required by the expansion I/O modules. **Table 3** shows the *additional* current from your power supply to support expansion I/O connection.

Table 3. Additional supply current to support expansion I/O

	Expansion I/O current (I_{exp})	Current required (I_{sup})		
		Supply voltage		
		17 Vdc	**24 Vdc**	**30 Vdc**
Base operating current 115S	120 mA	130 mA	90 mA	75 mA
Discrete inputs (per active input)	13 mA	14 mA	10 mA	8 mA
Discrete outputs (per active output)	25 mA	27 mA	20 mA	16 mA
Analog inputs and outputs (per 20 mA loop)	50 mA	55 mA	38 mA	30 mA
Formula	$I_{sup} = \frac{I_{exp} \times 18.4}{V_{sup}}$			

Powering the module directly from the BAT+ and GND terminals

In some situations it may be desirable to power the module directly from a 13.8 Vdc supply. This may be because this voltage supply is already available at an installation; because the power requirements for 115S modules are more than can be supplied by the "+" and "–" expansion I/O connections; or because the installation cannot meet thermal requirements when being powered from the SUP inputs (refer to "Thermal" on **page 3**).

Use **Table 4** to determine the device's current requirements at 13.8 Vdc. Remember you also need to add current for any other equipment being powered from the same power supply, including relays, indicators, and any additional 115S modules.

Table 4. Current requirements

	Supply current at 13.8 Vdc
Base operating current	230 mA
Radio transmit current—5 W Radio	1350 mA
Radio transmit current—0.5 W Radio	920 mA
Discrete I/O (per active input or output)	10 mA
Analog inputs and outputs (per 20 mA loop)	50 mA

Internal I/O

The internal supply voltage register locations shown in the following table can be monitored using the Diagnostics Web page within the module's Web-based configuration utility (see "Product Reconfiguration" on **page 65** for details). The values can also be mapped to a register or an analog output on another module within the network.

Table 5. Internal supply voltage registers

Register	Description
30005	Local supply voltage (0–40 V scaling).
30006	Local 24 V loop voltage (0–40 V scaling). Internally generated +24 V supply used for analog loop supply. Maximum current limit is 100 mA.
30007	Local battery voltage (0–40 V scaling).
30008	115S supply voltage (0–40 V scaling).
38005–38008	Floating point registers that display the actual supply voltage, battery voltage, +24 V supply, and 115S supply. Note that these are actual voltage values, whereas registers 30005–30008 display a number between 8192 and 49152 that represents the voltage scale 0–40 V.

To calculate the supply voltages from the register value use the following calculation:

$$\text{Volts} = \frac{(\text{Register Value}) - 8192}{1024}$$

High and low voltage alarm indication may be configured for each of these supply voltages. See "Analog inputs" on **page 11** for details on how to configure these alarms.

Grounding

To provide maximum surge and lightning protection 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. The module should be connected to the same common ground point as the enclosure ground and the antenna mast ground.

The 415U-2 has a dedicated earth/ground connection screw on the bottom end plate next to the supply terminals. All earth/ground wiring should be minimum 0.8 in^2 (2 mm^2), 14 AWG. If using the 415U-2 with serial expansion I/O modules, all expansion modules must have a separate earth/ground connection from the front terminal back to the common earth or ground point. See **Figure 7**.

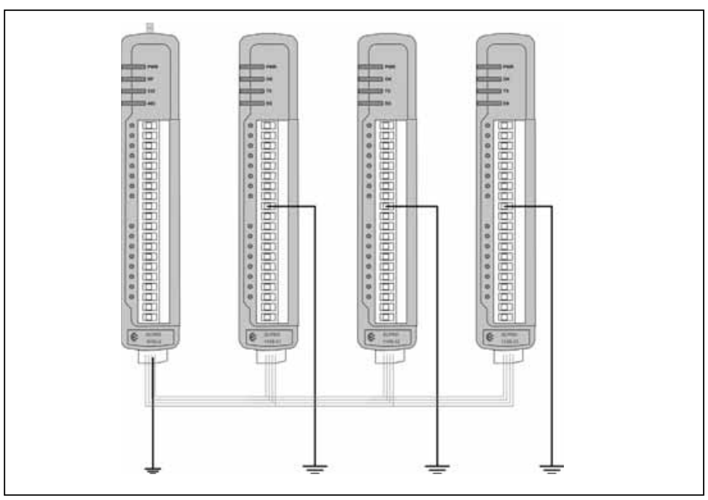


Figure 7. Grounding

Radio

The 415U-2 radio uses narrowband radio transmission to transfer data over licensed radio channels. There are models to support frequencies in the range 360 MHz to 512 MHz, and to support narrow (12.5 kHz) and wide (25 kHz) channels.

The 415U-2 is available in high powered (5 W radio) and low powered (500 mW) configurations. The high powered configuration supports applications using licensed radio frequencies. The low powered configuration supports operation on unlicensed bands, with transmit power adjustable down to 10 mW.

Data is transmitted using direct frequency shift keying with either one or two bits per symbol (2FSK, 4FSK). This supports data rates of 9600 baud (2FSK) and 19,200 baud (4FSK) on a wide (25 kHz) channel, and 4800 baud (2FSK) and 9600 baud (4FSK) on a narrow (12.5 kHz) channel.

The radio protocol is based on the 802.11 protocol commonly used in 2.4 GHz and 5 GHz WiFi applications. If you are familiar with 802.11, many of the radio networking concepts used in the 415 will also be familiar to you.

The data rates achievable with the 415U-2 are significantly lower than those for WiFi applications, so care must be taken to make the best use of the available channel bandwidth.

The 415U-2 module is shipped from the factory without any radio configuration. The radio will not send any transmission until initial device provisioning has been completed. At power-up, the device will set its OK LED to RED to indicate that this initial provisioning has not been completed.

To configure the device's radio for the first time, you must configure the radio Locale and radio Quick Start to set the radio to meet regulations at its target location. Refer to "Radio configuration" on **page 23** for instructions on configuring the radio using the Configuration utility, and to "Configuring the locale" on **page 53** and "Quick start—basic device configuration" on **page 54** for instructions on how to configure the radio using the Web interface.

Antennas

Antennas can be either connected directly to the module's RF connector or connected via 50-ohm coaxial cable (such as RG58 Cellfoil or RG213) terminated with a male SMA coaxial connector. The higher the antenna is mounted, the greater the transmission range, but as the length of coaxial cable increases so do cable losses.

The net gain of an antenna and cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB). Maximum net gain for the 415U-2 will depend on the licensing regulation for the country of operation and the operating frequency.

Typical antennas gains and losses are:

Table 6. Typical antennas gains and losses

Antenna	Gain (dBi)
Dipole	2 dBi
Collinear	5 or 8 dBi
Directional (Yagi)	6–15 dBi
Cable type	Loss (dB per 30 m/100 ft)
RG58 cellfoil cable kits (3 m,10 m, 20 m)	–1 dB, –2.5 dB, –4.8 dB
RG213 per 10 m (33 ft)	–1.8 dB
LDF4-50 per 10 m (33 ft)	–0.5 dB

The net gain of the antenna and cable configuration is determined by adding the antenna gain and the cable loss. For example, an 8 dBi antenna with 10 meters of Cellfoil (–2.5 dB) has a net gain of 5.5 dB (8 dB – 2.5 dB).

Dipole and Collinear antennas

Dipole and collinear antennas transmit the same amount of radio power in all directions, and are easy to install and use because they do not need to be aligned to the destination. The dipole antenna does not require any additional coaxial cable. However, a cable must be added if using any of the other collinear or directional antennas. In order to obtain the maximum range, collinear and dipole antennas should be mounted vertically, preferably at least one wavelength away (see **Figure 8** for distances) from a wall or mast and at least 3 ft (1 m) from the radio module.

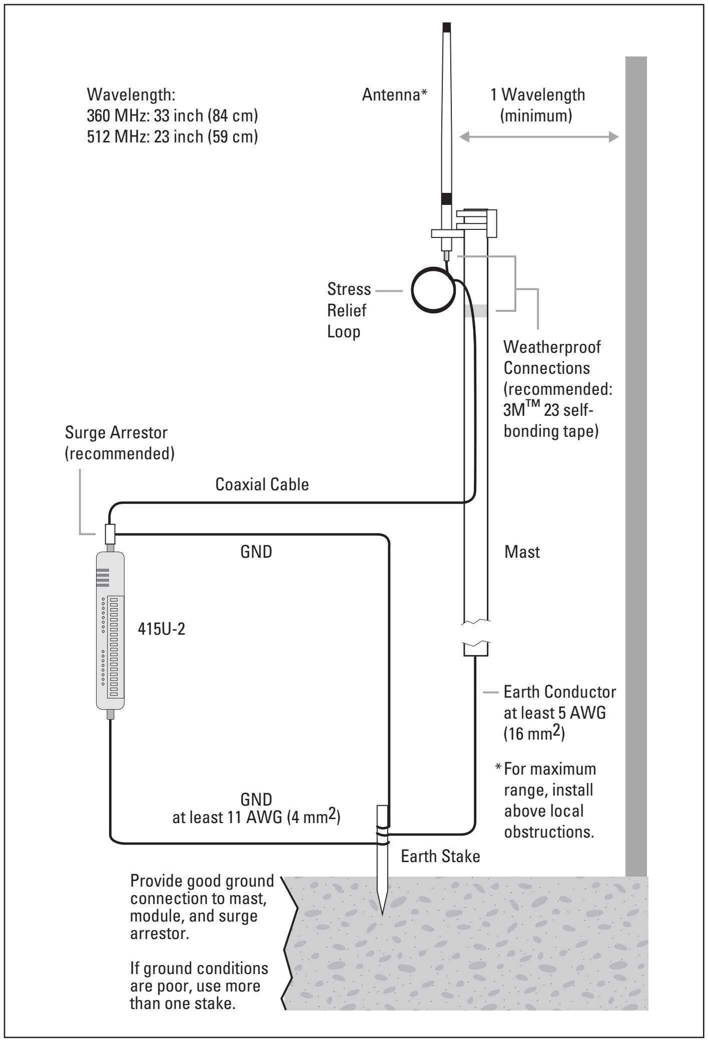


Figure 8. Antennas installation—Collinear/Dipole

Directional antennas

A directional antenna provides high gain in the forward direction, but lower gain in other directions. This type of antenna may be used to compensate for coaxial cable loss for installations with marginal radio path. Directional antennas can be any of the following:

- Yagi antenna with a main beam and orthogonal elements
- Directional radome, which is cylindrical in shape
- Parabolic antenna

Yagi antennas should be installed with the main beam horizontal, pointing in the forward direction. If the Yagi antenna is transmitting to a vertically mounted omni-directional antenna, the Yagi elements should be vertical. If the Yagi is transmitting to another Yagi, the elements at each end of the wireless link need to be in the same plane (horizontal or vertical).

Directional radomes should be installed with the central beam horizontal, and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna.

Parabolic antennas should be mounted according to the manufacturer's instructions, with the parabolic grid at the back and the radiating element pointing in the direction of the transmission.

Ensure that the antenna mounting bracket is well connected to ground.

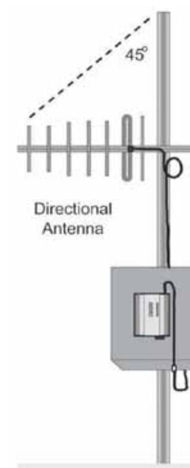


Figure 9. Directional antenna

Installation tips

Connections between the antenna and the coaxial cable should be carefully 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 (see **Figure 10**).

Where antennas are mounted on elevated masts, the masts should be effectively grounded to avoid lightning surges. For high lightning risk areas, approved ELPRO surge suppression devices, such as the CSD-SMA-2500 or CSD-N-6000, should be fitted between the module and the antenna. If using non-ELPRO surge suppression devices, the devices must have a "turn on" voltage of less than 90 V. If the antenna is not already shielded from lightning strike by an adjacent grounded structure, a lightning rod may be installed above the antenna to provide shielding.

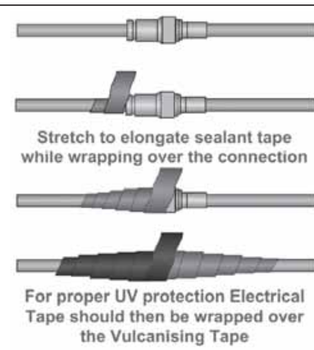


Figure 10. Vulcanizing tape

Connections

Bottom panel connections

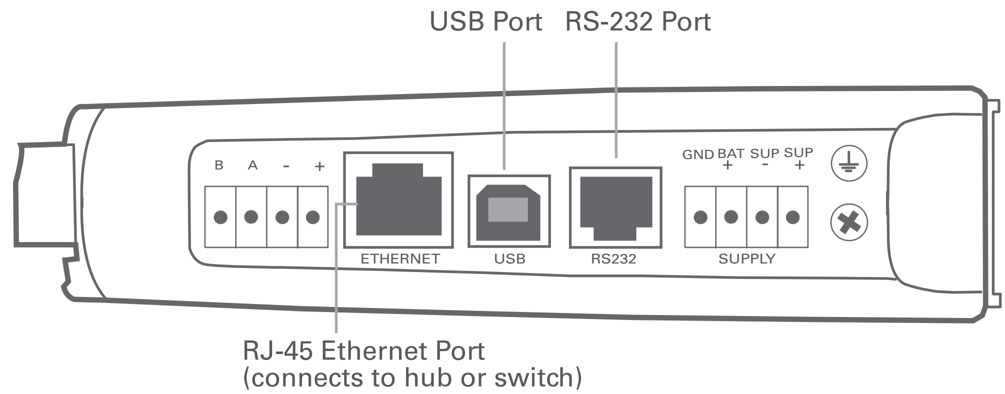


Figure 11. Bottom panel connections

Ethernet port

The 415U-2 modules provides a standard RJ-45 Ethernet port compliant to IEEE 802.3 10/100Base-T. This port provides full access to the module, including configuration, diagnostics, log file download, and firmware upload of both the local and remote units. Additionally, the Ethernet port can provide network connectivity for locally connected third-party devices with Ethernet functionality.

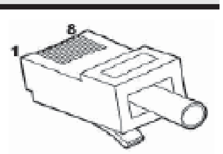
USB device port for configuration

The 415U-2 module also provides a USB device (USB-B) connector. This connector provides configuration of the device and remote configuration access to other devices in the radio network.

RS-232 port

The 415U-2 module provides an RS-232 serial port that supports operation at data rates up to 230,400 baud. This port supports Modbus protocol. The RS-232 port is accessed using an RJ-45 connector wired as a DCE according to the EIA-562 Electrical Standard.

Table 7. RJ-45 connector

RJ-45	Signal	Required	Signal name	Connector
1	RI	—	Ring Indicator	
2	DCD	—	Data Carrier Detect	
3	DTR	Y	Data Terminal Ready	
4	GND	Y	Signal Common	
5	RXD	Y	Receive Data (from module)	
6	TXD	Y	Transmit Data (to module)	
7	CTS	—	Clear to Send	
8	RTS	—	Request to Send	

RS-485 port with Modbus support

The 415U-2 module provides an RS-485 serial port that supports operations at data rates up to 230,400 baud. The default baud rate is 9600 baud, no parity, 8 data bits and 1 stop bit, which matches the 115S serial expansion module default settings. This port supports the Modbus protocol.

The RS-485 port terminal is hosted on the four-way expansion connector on the bottom edge of the module. An on-board RS-485 termination resistor provides line termination for long runs. As a general rule, termination resistors should be enabled at each end of the RS-485 cable. When using 115S expansion I/O modules, remember to enable the RS-485 termination resistor switch that is located on the end module.

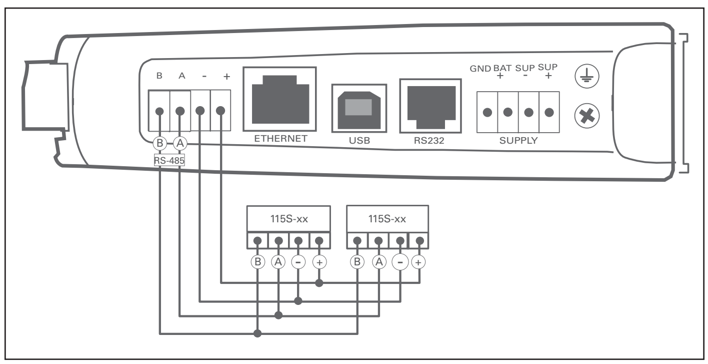


Figure 12. RS-485 connections

Side access configuration panel

A small access panel on the side of the module hides a factory boot switch, USB host port, and a small bank of DIP switches that are used for analog input voltage and current selection, external boot, and default configuration settings. Use a screw-driver to unscrew the retained screw to open the access panel.

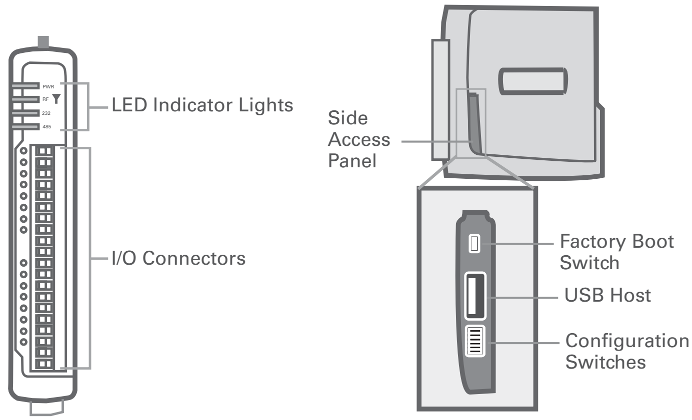


Figure 13. Access panel

Factory boot switch

The factory boot switch is used for factory setup and diagnostics. This switch should only be used if advised by ELPRO technical support.

USB host port

This port is a USB host (master port) that can interface with USB storage devices for upgrading the module firmware and for uploading logged data files. For details, see "To perform a full firmware upgrade using USB flash drive" on **page 86**. Also see "Data logging" on **page 67**.

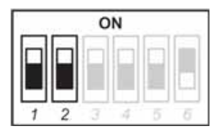
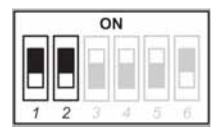
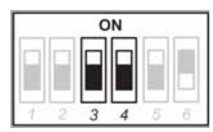
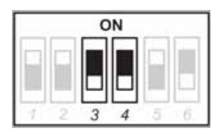
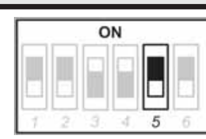
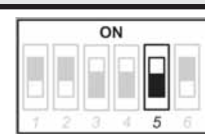
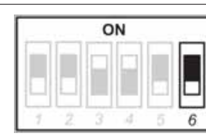
DIP switches

The DIP switches are used to select a number of functions within the module, as shown in the following table.

- **DIP switches 1 to 2**—Used for measuring current or voltage on analog input 3. Set DIP switches to "on" to measure current (0–20 mA) and "off" for voltage (0–5 Vdc).
- **DIP switches 3 to 4**—Used for measuring current or voltage on analog input 4. Set DIP switches to "on" to measure current (0–20 mA) and "off" for voltage (0–5 Vdc).
- **DIP switch 5**—Not used.
- **DIP switch 6**—When set to "on" (enabled) and the module is restarted, the module boots up with a known factory default configuration, including a default IP address for the Ethernet connection. See "Connecting to the module" on **page 14**.

⚠ **Note**: When DIP switch 6 is "on," radio and I/O functionality is disabled.

Table 8. Switch functions

Switch	Function	Current	Voltage
DIP 1 and 2	Analog input 3		
DIP 3 and 4	Analog input 4		
Switch	**Function**	**Disabled**	**Enabled**
DIP 5	Not used		
DIP 6	Setup mode		

Front panel connections

The front panel on the 415U-2 module provides connections for the following:

- Eight digital input/output (DIO 1–8)
- Two 12-bit, 0.1% accuracy differential analog inputs
- Two single-ended 12-bit, 0.1% accuracy analog inputs
- Two 13-bit, 0.1% accuracy current sourcing analog outputs
- Connection terminals for common and +24 V analog loop supply (ALS); maximum ALS current limit is 100 mA

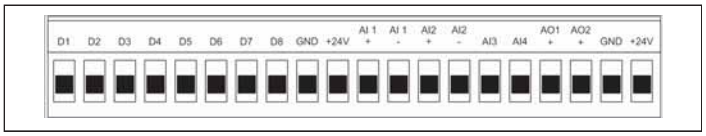


Figure 14. Front panel connections

Digital or pulsed inputs

Each digital I/O channel on the 415U-2 module can act as either an input or an output. The input/output direction is automatically determined by the connections and configuration of the I/O. If you have an I/O channel wired as an input but operate the channel as an output, no electrical damage will occur but the I/O system will not operate correctly. If you are operating the channel as an output and you read the corresponding input value, it will indicate the status of the output.

Marked D1–8, the digital inputs share the same terminals as the digital outputs on the 415U-2 module. A digital input is activated by connecting the input terminal to GND or common, either by voltage-free contact, TTL level, or transistor switch. Each digital input has an orange indication LED that will turn on when the input has been connected to a GND.

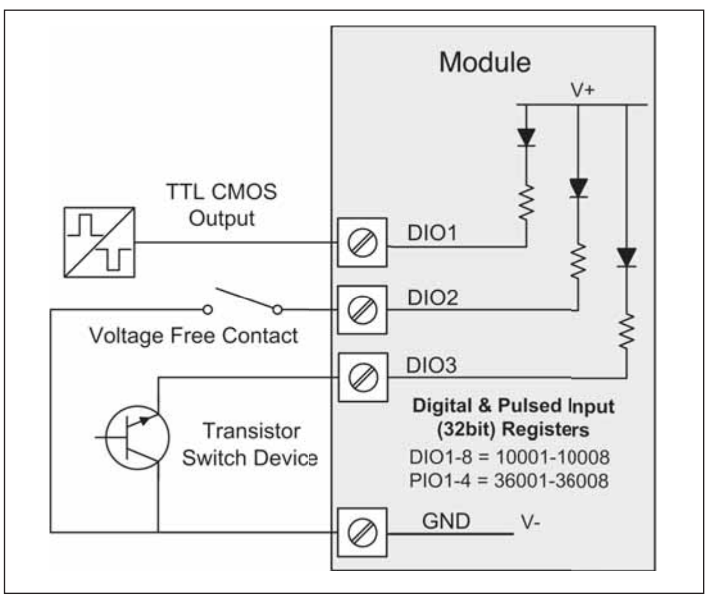


Figure 15. Digital/pulsed input wiring

Digital inputs 1–4 can be used as pulsed inputs. The maximum pulse frequency is 50 kHz for input 1 and 2, and 1 kHz for input 3 and 4. Digital/pulsed inputs are suitable for TTL signal level, NPN-transistor switch devices, or voltage-free contacts (a relay or switch with debounce capacitor).

Frequencies greater than 1 kHz need to use a TTL logic drive or an external pull-up resistor (1 KΩ to V+). Pulsed inputs are converted to two different values internally. The first value is the pulse count, which is an indication of how many times the input has changed state over a configured time period. The second value is a pulse rate, which is an analog input derived from the pulse frequency. For example, 0 Hz = 4 mA and 1 kHz = 20 mA.

All pulsed input counts are stored in non-volatile memory, so that the values are saved in the event of a power failure or a module reset.

Digital outputs (pulsed outputs)

Digital outputs are open-collector transistors, and are able to switch loads up to 30 Vdc, 200 mA. The eight digital outputs share the same terminals as the digital input. These terminals are marked D1–8.

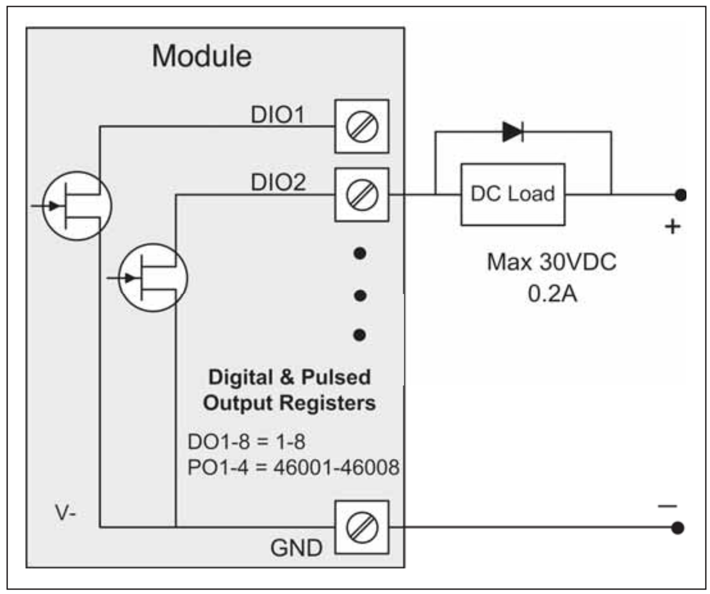


Figure 16. Digital pulsed output wiring

When active, the digital outputs provide a transistor switch to EARTH (Common). To connect a digital output, see **Figure 16**. A bypass diode (IN4004) is recommended to protect against switching surges for inductive loads such as relay coils. The digital channels D1–4 on the 415U-2 module can be used as pulse outputs with a maximum output frequency of 10 kHz.

Digital output fail-safe status

In addition to indicating the digital output status (on or off), the LEDs can also indicate a communications failure by flashing the output LED. This feature can be used by configuring a fail-safe time and status via the I/O Digital Output screen in the MConfig utility.

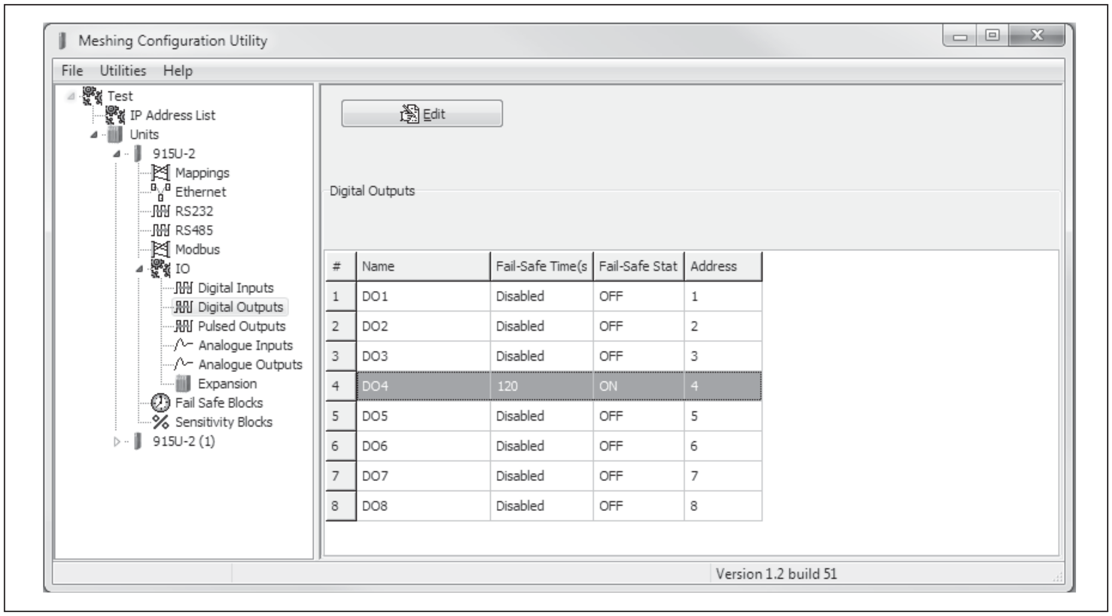


Figure 17. Digital output fail-safe times

The fail-safe time is the time the output counts down before activating a fail-safe state. Normally this would be configured for a little more than twice the update time of the mapping that is sending data to it. This is because the fail-safe timer is restarted whenever it receives an update. If you send two successive updates and fail to receive both of these messages, the timer counts down to zero and activates the fail-safe state.

If the fail-safe state is enabled (on), the LED flashes briefly off and the digital output turns on. If the fail-safe state is disabled (off), the LED flashes briefly on and the digital output turns off.

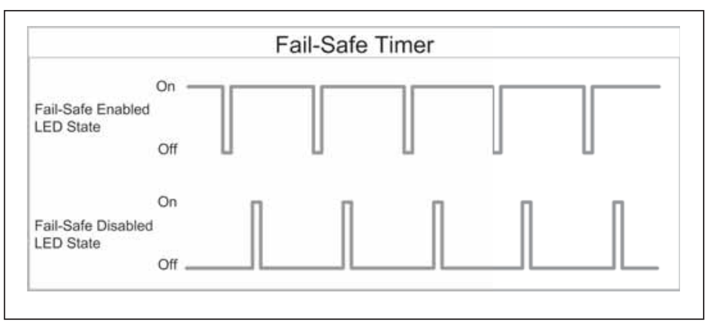


Figure 18. Fail-safe state

Analog inputs

The 415U-2 module provides two floating differential analog inputs and two grounded single-ended analog inputs. Analog inputs 1 and 2 will automatically measure current (0–20 mA) or voltage (0–25 V), depending on what is connected to the input. Analog inputs 3 and 4 must be configured to measure current (0–20 mA) or voltage (0–5 V) via the DIP switches on the configuration panel (see “Side access configuration panel” on **page 9**).

An internal 24 V analog loop supply (ALS) provides power for any current loops with a maximum current limit of 100 mA. The LEDs have an analog diagnostic function and will indicate the status of the input. The LED comes ON when any analog signal is detected, and will go OFF when the analog signal drops to zero.

⚠ **Note**: By default, there is a one-second delay on the input because of the filter. Filter times can be changed using the Analog Input screen within the MConfig utility. For more information, see “Analog inputs” on **page 11**.

The LEDs next to AI1+, AI2+ indicate the current on these inputs. The LEDs next to AI1– and AI2– indicate the voltage on the analog inputs.

Differential current inputs

Only analog input 1 and 2 can be wired as differential Inputs. Differential mode current inputs should be used when measuring a current loop, which cannot be connected to ground. This allows the input to be connected anywhere in the current loop. Common mode voltage can be up to 27 Vdc.

Figure 19 indicates how to connect loop-powered or externally powered devices to the 415U-2 differential analog inputs. It should also be noted that the differential inputs can also be used to connect single-ended current sinking or current sourcing devices. **Figure 21** shows how to connect to these types of devices.

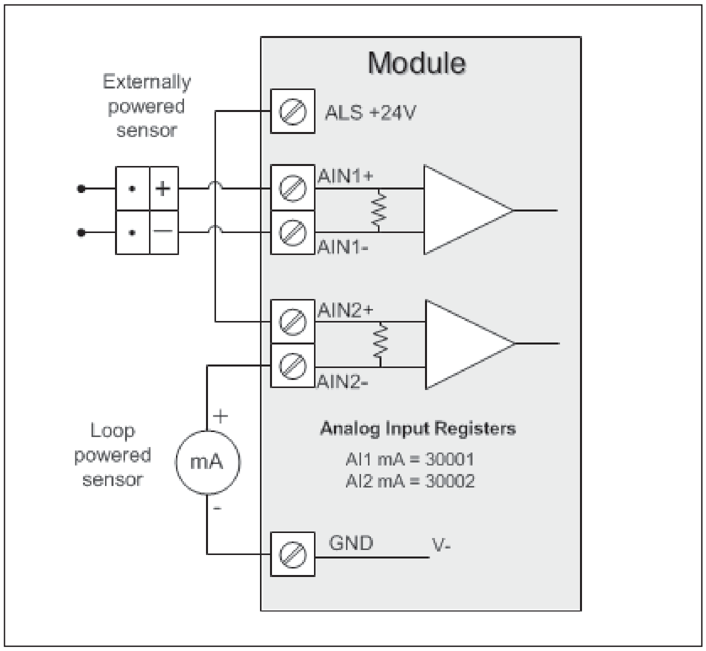


Figure 19. Differential current inputs (AI1 and AI2)

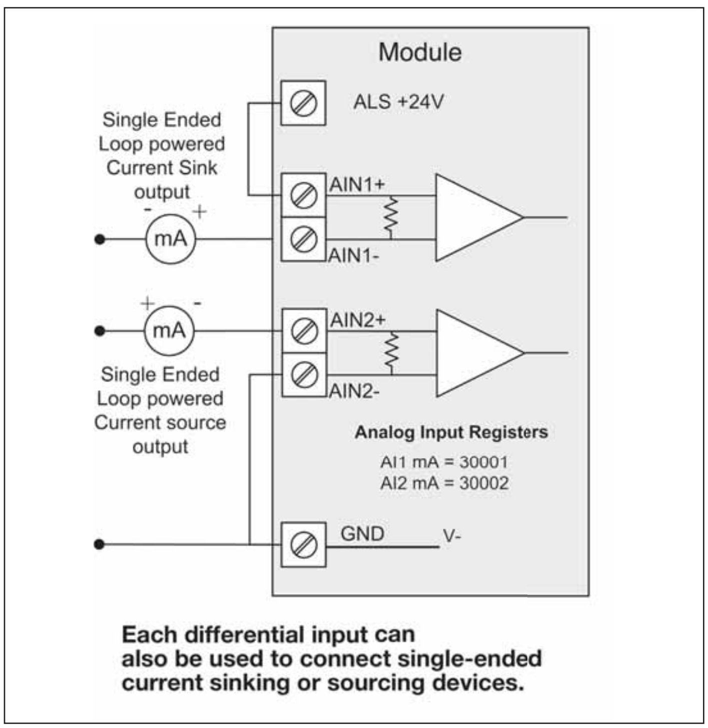


Figure 20. AI1 and AI2 single-ended current inputs

Single-ended current input mode is useful if the sensor loop is grounded to the 415U-2 module. Devices can be powered from the 24 V analog loop supply (ALS) generated internally from the module.

The DIP switches (located in the side access panel) are used to determine if the inputs will be current or voltage. DIP switches 1 and 2 are used for analog 3, and DIP switches 3 and 4 are used for analog 4. For current, set both DIP switches to the “on” position. For voltage, set both to “off.”

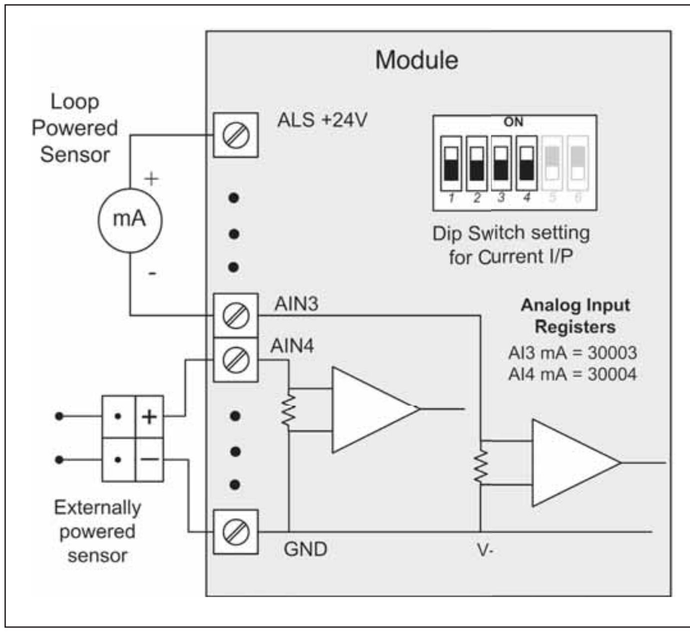


Figure 21. AI3 and AI4 Single-ended current inputs

Voltage inputs

All analog inputs can be set up to read voltage. If using analog input 1 and 2, connect the voltage source across the positive terminal of the input and ground. If using analog input 3 and 4, connect across the input terminal and GND.

⚠ **Note**: Default scaling gives 0–20 V for 0–20 mA output on analog 1 and 2. Default scaling for analog 3 and 4 gives 0–5 V for 0–20 mA output. For voltage input on analog 3 and 4, set both DIP switches to the OFF position.

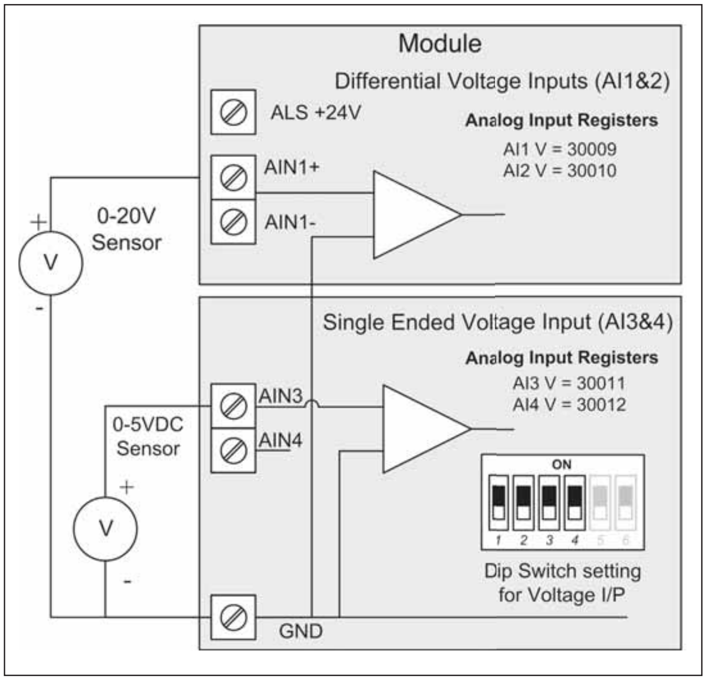


Figure 22. Single-ended voltage inputs

Analog outputs

The 415U-2 module provides two 0–24 mA DC analog outputs for connecting to analog inputs on equipment (such as PLCs, DCS, and loggers) or connecting to instrument indicators for displaying remote analog measurements. The 415U-2 analog outputs are a sourcing output and should be connected from the analog output terminal through the device or indicator to ground (GND). See **Figure 23** for connections. The LEDs provide level indication depending on current. The LEDs appear dimmed for 4 mA and bright for 20 mA.

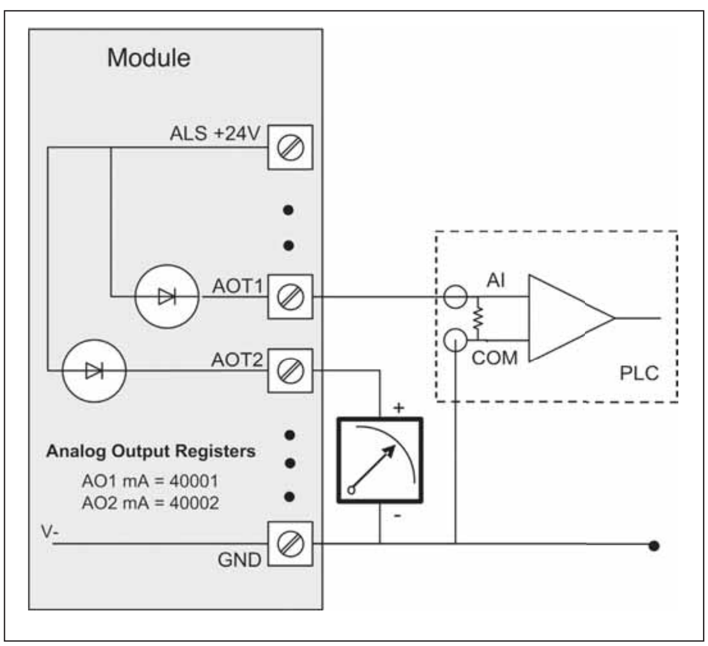


Figure 23. Analog outputs

System design

Design for failures

All well-designed systems consider system failure. I/O systems operating on a wire link will fail eventually. Failures can be short-term, such as interference on the radio channel or power supply failure, or long-term, such as equipment failure.

The modules provide the following features for system failure:

- Outputs can reset if they do not receive a message within a configured time. If an output should receive an update or change message every 10 minutes and it has not received a message within this time, some form of failure is likely. If the output is controlling machinery, it is good design to switch off the equipment until communications are re-established.
- The modules provide a fail-safe feature for outputs. This is a configurable time value for each output. If a message has not been received for this output within the configured time, the output will assume a configured value. We suggest that this reset time be a little more than twice the update time of the input. It is possible to miss one update message because of short-term interference. However, if two successive update messages are missed, long term failure is likely and the output should be reset. For example, if the input update time is three minutes, set the output reset time to seven minutes.
- A module can provide an output that activates on communication failure to another module. This can be used to provide an external alarm indicating that there is a system fault.

Testing and commissioning

We recommend that the system is fully bench tested before installation. It is much easier to find configuration problems on the bench when the modules are next to each other as opposed to being miles apart. When the system is configured and you are confident that it works, back up the configurations of all modules.

Configuration

The 415U-2 modules can be configured using the Windows®-based Mesh and I/O Gateway Configuration Utility (MConfig), or via the embedded Web-based management utility.

Connecting to the module

Use the following procedure to directly connect a PC to the 415U-2 in order to configure modules using the MConfig utility or the Web-based configuration utility. Before connecting, make sure that the MConfig utility is installed on the PC. For instructions, see "Downloading and installing MConfig."

You need an Ethernet cable for connecting to the module's Ethernet port. The module's default IP address, subnet mask, and gateway IP address are as follows:

- **IP Address:** 192.168.0.1XX (shown on the printed label on the side of the module)
- **Subnet Mask:** 255.255.255.0
- **Default Gateway:** 192.168.0.1

If the module is not new out-of-the-box and does not have the default settings, you need to restore these settings. For instructions, see "I/O configuration" on **page 47**.

1. Connect an Ethernet cable between the module's Ethernet port and the PC.
2. Open Internet Explorer (version 8.0 or later) on the PC.
3. Type "http://" followed by the IP address of the module and press **Enter**.
   The module responds with a username and password box.
   If the module does not respond, the PC networking setting may be incorrect. For more information, see "Networking" on **page 22**.
4. Type the username and password.
   The default username is "user" and the default password is "user".

   This connects you to the home page of the Web-based configuration utility (see **Figure 78**). This utility allows you to manage wireless connection links between all modules in the system through a standard browser, such as Microsoft® Internet Explorer®. We recommend using MConfig as your primary configuration utility because it is easier to use than the Web-based configuration utility and simplifies the configuration process. The Web-based utility is required only for modifying wireless connection settings for all 415U-2 modules in the system.

   For information on using MConfig, see "MConfig utility" on this page.

   For information on using the Web-based utility, see "Web-based configuration utility" on **page 52**.

MConfig utility

The MConfig configuration utility is a Windows-based software program that allows system-wide configuration and diagnostics for WIBMesh products. The utility can be downloaded from the Eaton website (www.eaton.com/wireless) and is compatible with all current Windows versions. MConfig uses a simple point-and-click interface that allows you to create projects, adjust parameters to suit the application specifics, program, and diagnose—all from a single point. You can also configure advanced settings, including:

- Over-the-radio link configuration and diagnostics
- Gateway functionality for Modbus TCP and RTU protocols
- Radio communications monitoring
- I/O point naming

Downloading and installing MConfig

The MConfig utility is provided as a zip file from the download section of the Eaton website. Configuration of the 415U-2 module can be performed via USB or Ethernet connection, and all appropriate USB drivers are installed during installation. If you have a problem installing the drivers, you can install them manually using Windows Device Manager.

1. Go to the Eaton website: www.eaton.com/wireless
2. Under **Resources**, click **Technical Resources Library**, and then click **ELPRO Configuration Software**.
3. Download the zip file "915U-2 Wireless Mesh I/0 and Gateway and 415U-2 Configuration" to your PC and extract the zip file.
4. Open the file "INST_CFG_MCconfig<version>.exe."
   This runs the Installation Wizard.
5. Follow the on-screen instructions to install the software (see **Figure 24**).

   Select the "Standard Installation" option unless you need multiple versions of MConfig installed at the same time. Selecting "Standard Installation" replaces any existing installation of MConfig with the version you are installing. Select "Parallel Installation" if you want to keep a version of MConfig that you have installed previously in addition to the new version.

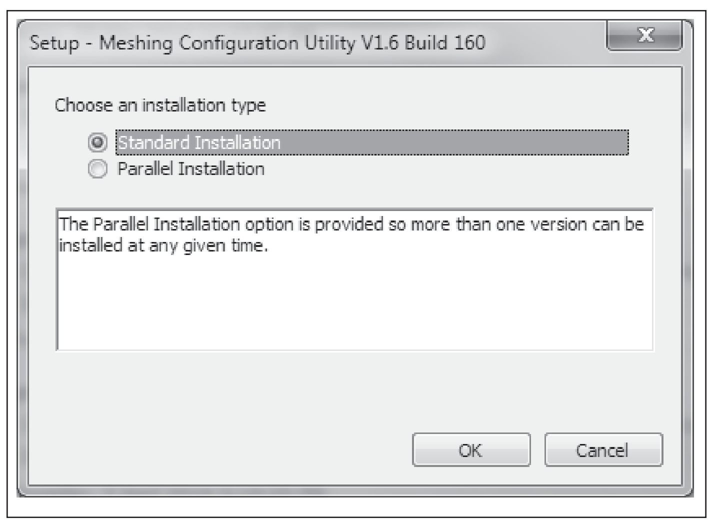


Figure 24. Choosing the installation type

Figure 25 shows the Welcome screen for the standard installation. The screen is similar for the parallel installation.

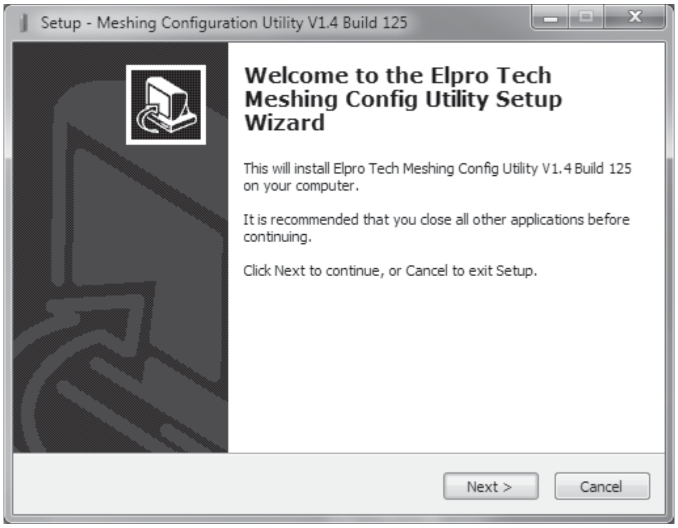


Figure 25. Installation wizard

Starting MConfig

Follow these steps to start the MConfig utility.

1. From the Windows **Start** menu, choose **Programs**-->**Meshing Config Utility**-->**Meshing Config Utility**.
   The Project Selection screen appears.

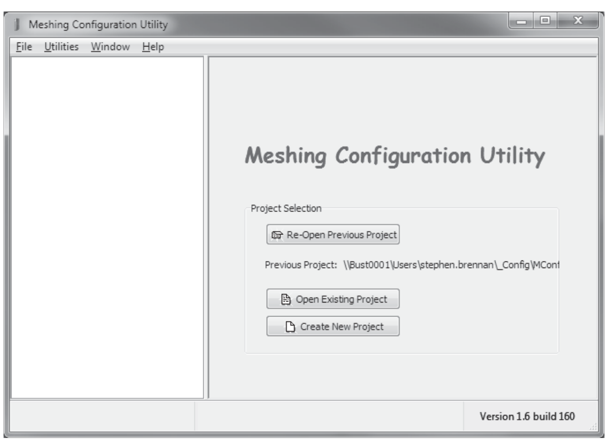


Figure 26. Project selection

2. Click one of the following options:

   Re-open Previous Project—Opens the last configuration project that was used on the PC. All configuration project files are typically stored locally on the PC or on a network drive. The path to the last project used appears below this button.

   Open Existing Project—Opens any previously saved project. This can be a project that was created on the current computer or a configuration that was created elsewhere and sent to you. A dialog box allows you to navigate to the saved project that you wish to open.

   Create New Project—Start a new configuration project. You name the project and also specify the directory location where the project is to be saved. The directory can be on the PC, on a portable drive, or on the network.

⚠ **Note**: For 415U-2 (Ethernet) modules, do not need to select a default location (country code). Select the Skip checkbox in the following screen and click OK.

The project screen appears (see **Figure 28**).

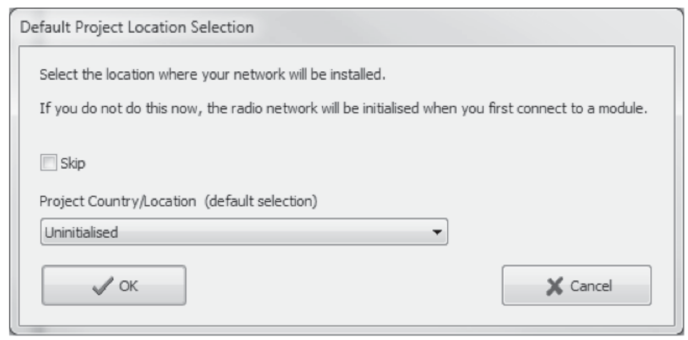


Figure 27. Default project location selection

Project screen

The Project screen is displayed when you open or create a project. The project tree on the left shows the project name, followed by any units that have been added to the project (the project tree is empty when you start a new project). Clicking a module in the project tree opens a list of the module's configurable options. Clicking a configurable option displays the current configuration data on the right side of the screen. This is where you can make changes to current settings.

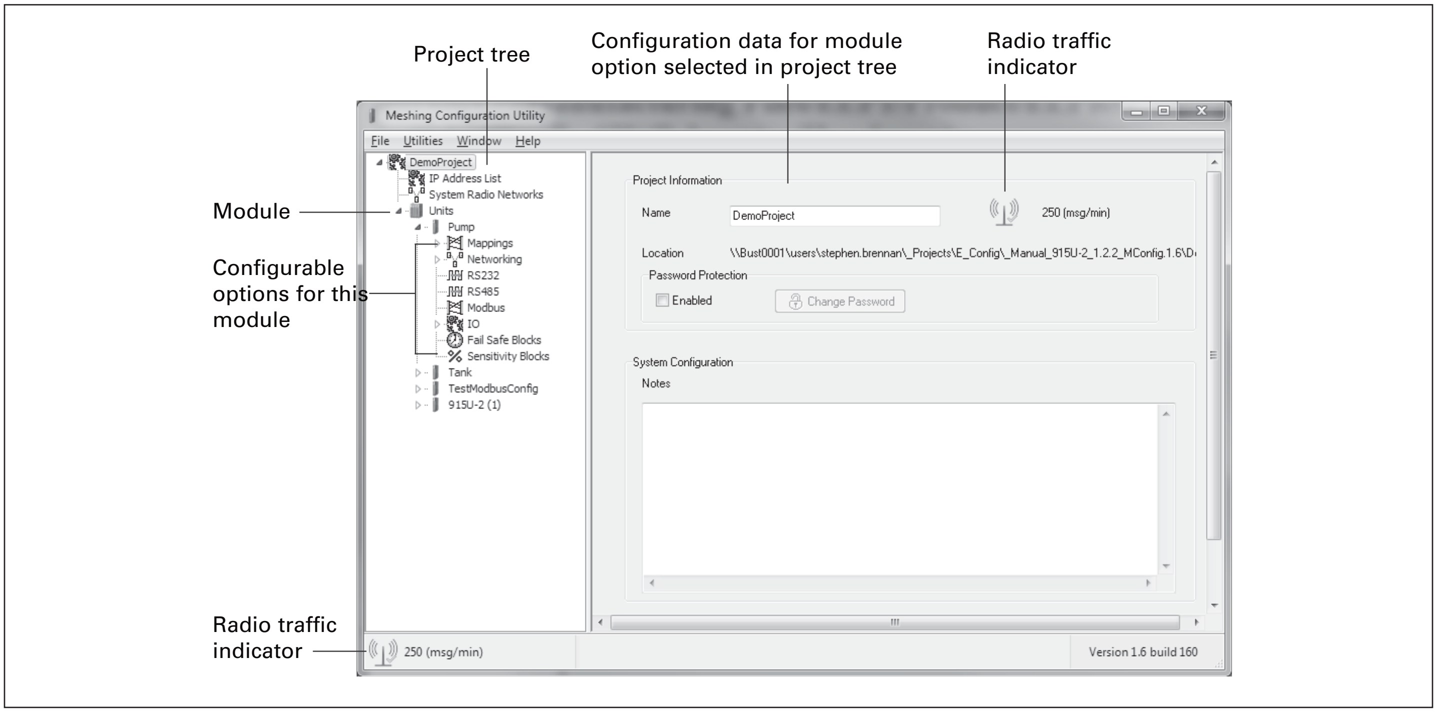


Figure 28. Project information

The project screen contains the following fields.

Project information	Includes the project name and the directory location of the project. You can change the project name by editing the field.
Radio traffic indicator	The radio traffic indicator provides an indication of radio traffic in systems that have radio devices (915U-2 and 415U-2). Ethernet traffic generated by 115E-2 devices does not affect the calculated radio traffic measurement.
Password protection	Allows you to enable or disable the security option. When enabled, a password is required to access the configuration file. The password must be a minimum of six characters. ⚠ **Note**: This password protects the configuration file from unauthorized access. This is not the device password.
Change password	Allows you to change the current password.
Notes	Use this field to record notes about the project.

Displaying the IP address list

Clicking **IP Address List** in the project tree displays the module name and corresponding radio and Ethernet IP address, subnet mask, and network address for each module in the project (the address list is empty when you start a new project). The IP address list is a read-only screen. The radio IP and Ethernet IP addresses are configured within other screens.

The Ethernet IP address is set from the Networking screen. See "Setting the module IP address" on **page 17**.

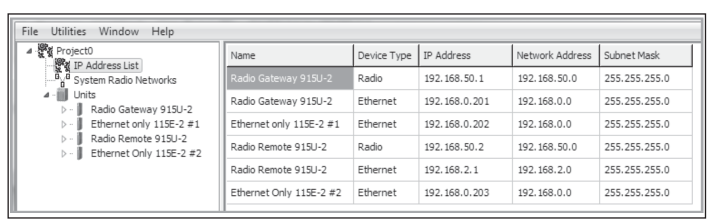


Figure 29. IP address list

Setting the module IP address

The module Ethernet address is not assigned automatically. For the module to operate correctly on your network, you need to set the Ethernet IP address by clicking **Networking** in the project tree and entering an appropriate address and network mask. Additional Ethernet settings are described below.

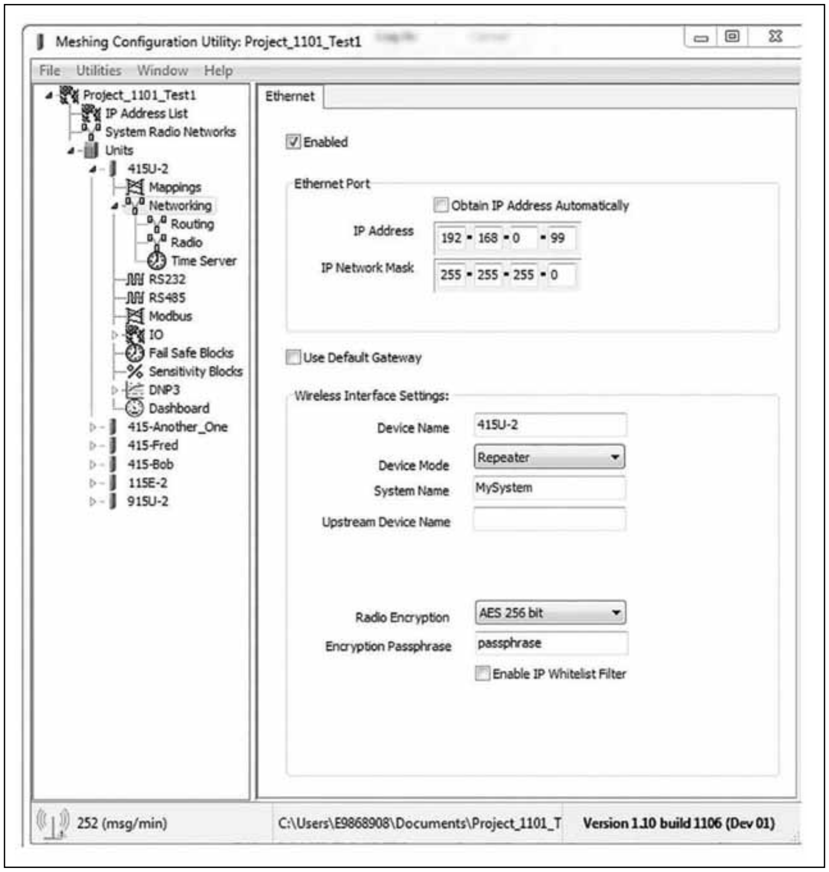


Figure 30. Networking—Ethernet

Enabled	Selecting this checkbox enables the Ethernet interface on the module. Clearing it disables Ethernet on the module.
Obtain IP Address Automatically	Selecting this checkbox enables the module to communicate with a DHCP (Dynamic Host Configuration Protocol) server (if available), which then assigns it an IP address.
IP Address	Module IP address.
IP Network Mask	Network mask for the IP address.
Use Default Gateway	Selecting this checkbox configures the module to always use a particular address as the IP gateway address. Enter the gateway IP address in the IP Address field.

Wireless interface settings

These items configure the device's radio networking setup. Values that you enter here determine how devices will connect and communicate through the network.

Device name: This is a unique name for the individual device. Each device in the system should have a unique name. This needs to be unique for network formation and to allow you to identify devices when performing diagnostics.

⚠ **Note**: This is the same as the device name displayed on the main page.

Device mode: This selects the device operating mode. For most applications, select one of Base, Repeater, or Remote. For advanced applications with unusual connectivity requirements, you can select "Manual" mode for additional networking options. Normally a system will consist of a single "Base", zero or more "Repeater" and multiple "Remote".

System name: This is a name common to every device in the system. This allows Remotes to be configured to connect to any repeater or base station in the system.

Radio encryption: This is the encryption mode. This should normally be set to AES256, which provides high security with low overheads. WPA-PSK mode uses standard 802.11 pre-shared key encryption. This mode uses AES128 encryption and requires more network overhead to establish a connection.

Encryption passphrase: This passphrase sets the encryption used by all devices. All devices in the system must be configured with the same encryption passphrase.

Upstream device name: (Repeater and Remote Device mode only) This option configures networking when the Device mode is set to "Repeater" or to "Remote". This selects how the device will connect to the network. The upstream device name is the name of the device closer to the base. For devices that will connect directly to the base, the upstream device name is the name for the base station. For devices that connect to a repeater, the upstream device name is the name for that repeater station.

802.11 Mode: (Manual device mode only) This option configures additional networking when the device mode is set to "Manual". Select "Access Point" for a central 802.11 Access Point, or "Client (Station)" for a remote.

System address (ESSID): (Manual device mode only) This option configures additional networking when the device mode is set to "Manual". Client stations will attempt to connect to an Access Point with matching ESSID/System Address.

⚠ **Note**: Configuring Manual mode requires understanding of 802.11 networking concepts. For the majority of applications, you will select one of the other operating modes.

Adding units to a project

Click **Units** in the project tree to add a new 415U-2 configuration to the project or import (load) an existing 415U-2 configuration to the project. The new or imported 415U-2 will appear in the project tree. You can import a configuration by directly connecting to a 415U-2 module over Ethernet or USB, or by selecting a pre-saved configuration file from a 415U-2 module.

The Ethernet IP address is not automatically assigned to the 415U-2. You need to set a unique IP address for each 415U-2 in the system. Set the IP address using the "Networking" option in the project tree for the device.

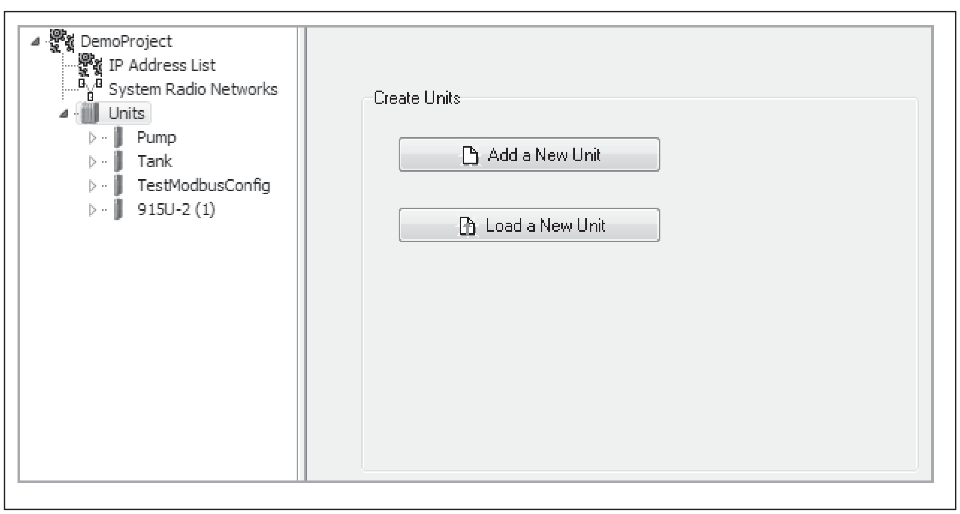


Figure 31. Create units

Unit details

Once a 415U-2 module is added to the project, selecting the module in the project tree displays the Unit Details page where you can enter or change information about the module.

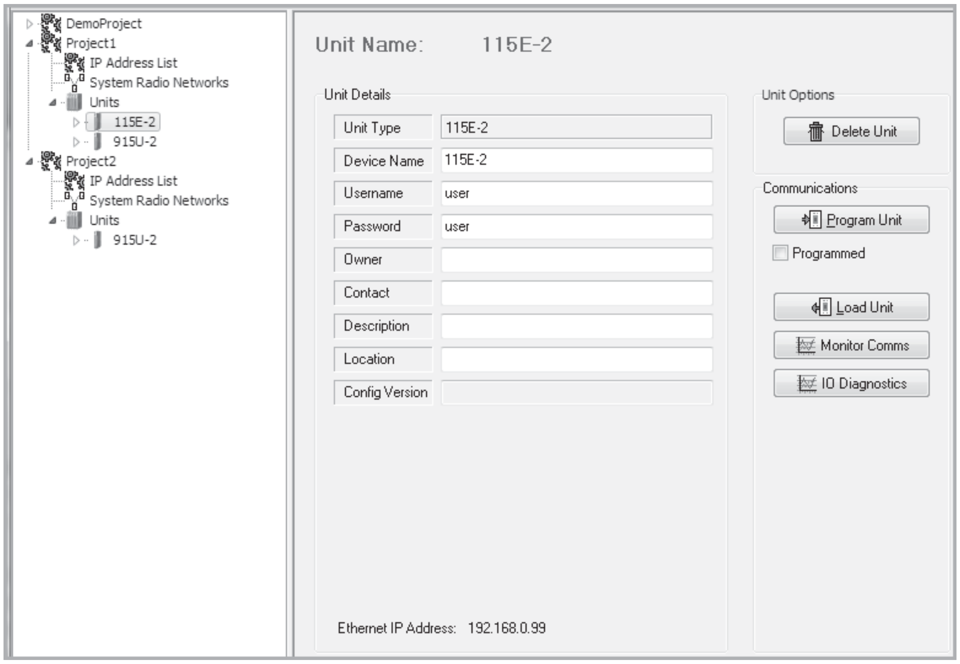


Figure 32. Unit details

Unit Type	Device model.
Device Name	Unique name that you can assign to the software and device.
Username and Password	The Username and Password fields are not relevant. With this firmware, you should use your allocated username to access 415U-2 modules. These fields will be deleted in a future version of this configuration application.
Owner, Contact, Description, and Location	Details that you can add to provide information about the module.
Configuration Version	Displays the time and date when the current device configuration was last updated. This information is not editable and is only updated when the module is programmed or read.
Ethernet Address	IP address of 415U-2 module. Details for setting the IP address are found in "Setting the module IP address" on **page 17**.
Notes	Use this field to record notes about the unit configuration for your own use.
Delete Unit	Removes the 415U-2 from the project (no undo).
Program Unit	Displays the Program Unit screen (see **Figure 33**) where you can choose the method you want to use to configure the module: **Ethernet (local)**—Program the module using the local Ethernet interface displayed in the list. Select IP Address or enter a new address. **Ethernet (over radio)**—Program a remote module connected via radio. For this option to work, you must be connected to a base module. **USB externally powered**—Program the module using a USB interface. You will need to plug in the USB cable and then click **Refresh**. **Configuration file (XML)**—Program the module configuration to an XML file. **User name**—Select the username to access this device. For modules with firmware version earlier than 2.0, the username is always "user." For firmware versions 2.0 and later (which support for user management) you need to select a username that has administrator or manager privileges. For firmware 2.0 and later, the default configuration for the manager login is "user." If you have not changed the administrator configuration the default (user) will work with newer firmware as well. **Password**—Enter the password you configured for this module. The factory default password is "user."

Programmed

This checkbox lets you know whether a device needs to be re-programmed because its configuration has changed.

The checkbox is automatically selected when the module is successfully programmed(see Program Unit) or when the configuration data from the module is successfully loaded into MConfig (see Load Unit), indicating that the module is up-to-date.

The checkbox is automatically cleared when you make a change to the configuration that affects the Units configuration page. A cleared checkbox indicates that the module does not have the most recent configuration.

You can also manually clear the checkbox at any time. For example, you may want to do this as a reminder that the device needs to be re-programmed if the device configuration has been changed by the internal device Web pages.

Load Unit

Allows you to read the configuration data from the module radio and load it into MConfig, replacing the configuration currently in MConfig for this module (see **Figure 34**). Select the method you want to use to read the configuration data from the module:

Ethernet (local)—Load the configuration from the module using the local Ethernet interface displayed in the list. Select IP Address or enter a new address.

Ethernet (over radio)—(This option is only used on the 915U-2.) Load the configuration from a remote module connected via radio. For this option to work, you must be connected to a local module with the IP Gateway Mode checkbox selected in its Units screen, and the remote module must be configured to allow messages out of the radio network.

USB externally powered—Load the configuration from the module using the local Ethernet interface displayed in the list. Select IP Address or enter a new address.

Configuration file (XML)—Load a configuration XML file into the currently selected module in the MConfig utility

User name—Select the username to access this device:

For modules with firmware version earlier than 2.0, the username is always "user."

For firmware versions 2.0 and later (which support for user management) you need to select a username that has administrator or manager privileges. The default configuration for the manager login is "user." If you have not changed the administrator configuration the default (user) will work with newer firmware as well.

Password—Enter the password you configured for this module. The factory default password is "user."

Monitor Comms

Displays a diagnostic tool that allows you to monitor IP traffic received and transmitted by the device's Ethernet port.

IO Diagnostics

Allows you to view the internal registers for the selected module unit (see **Figure 35**).

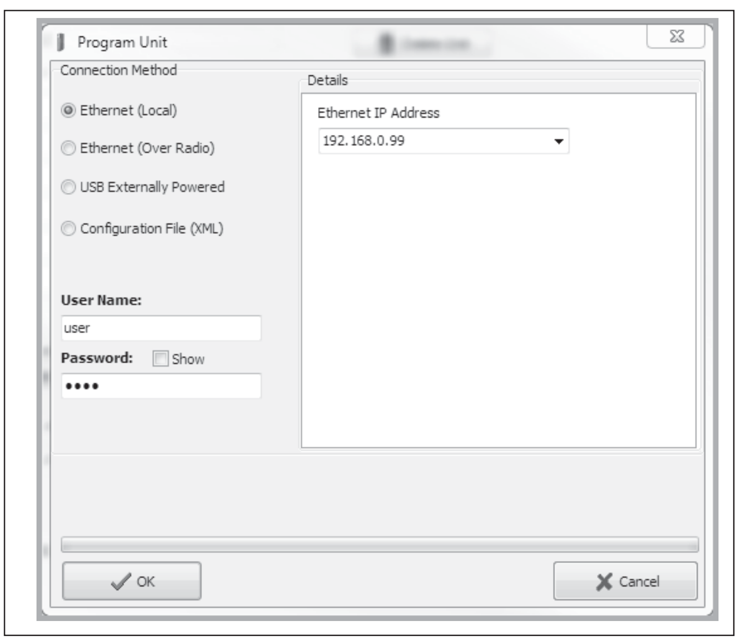


Figure 33. Program unit

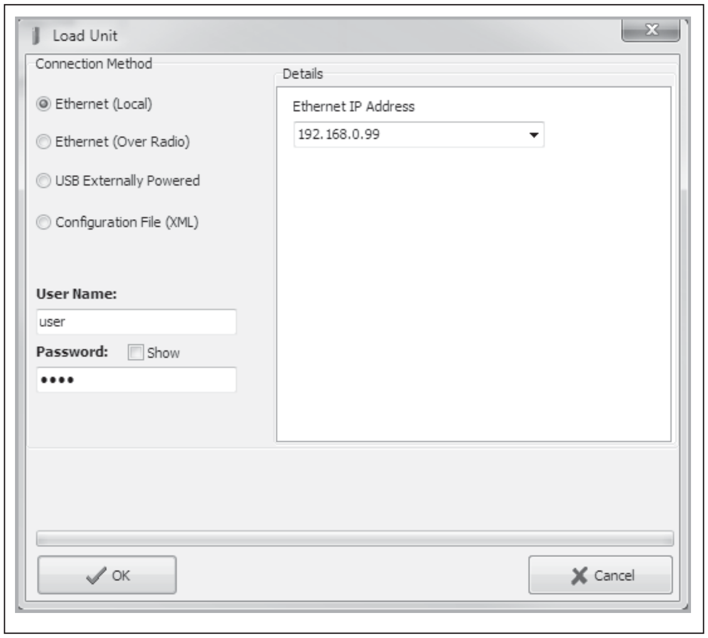


Figure 34. Load unit

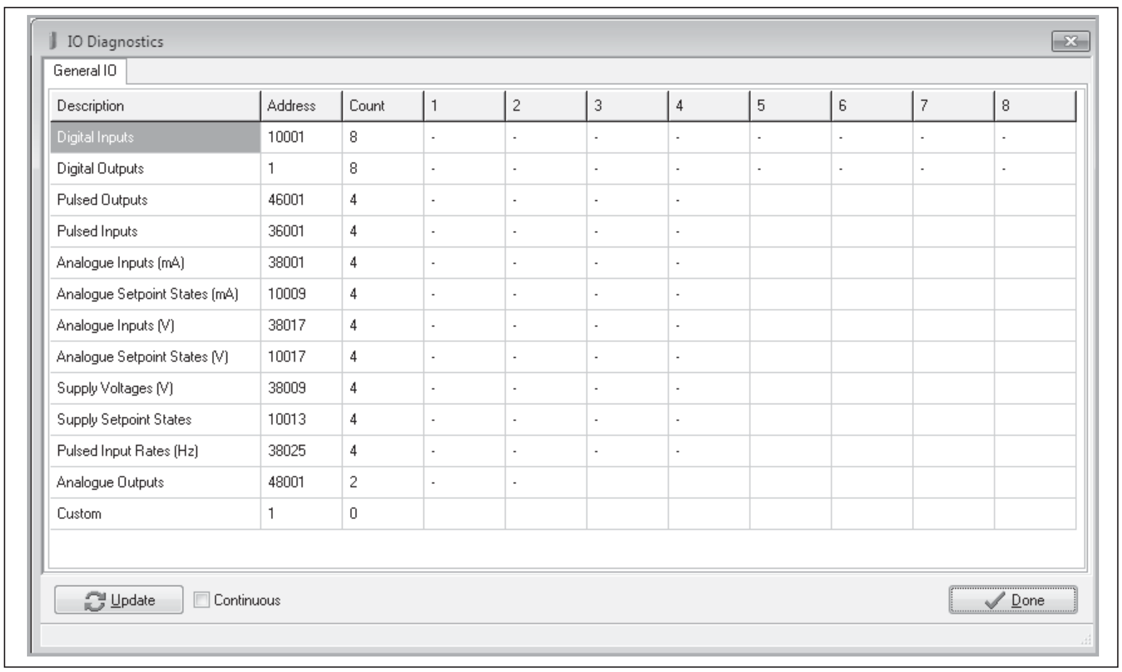


Figure 35. IO diagnostics

Networking

Click **Networking** in the project tree to configure Ethernet, radio, and routing parameters. These parameters are described in detail in this section.

⚠ **Note**: The default networking mode for the 415U-2 uses bridged networking. This connects the radio and Ethernet ports to the same logical sub-net. The 415U-2 device has a single IP address common to the radio and Ethernet ports.

IP routing

The IP routing rules table determines which IP address an outgoing message will be routed through. When the table contains enabled routing rules, the most explicit and exclusive subnet match is used to determine the route for an outgoing message. If there is no match, the 415U-2 checks for a subnet match against its hard-wired Ethernet interface. If that does not match, it attempts to use the default gateway (configured on the Networking page), assuming that the default gateway is configured and accessible.

If no routing rules are configured or enabled in the IP routing rules table, messages are sent according to the subnet of the hard-wired Ethernet interface. If there is no match against the available subnets, the message is passed to the default gateway address, assuming that the gateway is configured and accessible.

In some cases, such as routed networks with more than two routers, it is not practical to have only one default gateway. If more than one next-hop router is required, the 415U-2 allows for the configuration of up to 100 routing rules. A routing rule specifies a destination network (or host) IP address and the corresponding next-hop router (gateway) to which messages for the specified destination will be forwarded. The gateway will then deliver the data to the required destination, or forward it on to another router that will.

⚠ **Note**: IP routing is an advanced user function. If you are not familiar with IP routing and your network consists of multiple sub-networks connected by routers, request assistance from an IT expert.

To display the IP routing rules table, click **Routing** under **Networking**. After configuring routing rules, click the **Program Unit** button on the module's Unit Details screen for the changes to take effect.

The example in **Figure 36** shows an IP routing rule that maps messages to any IP address starting with 10.0.0.0 to the gateway with the IP address 192.168.0.254.

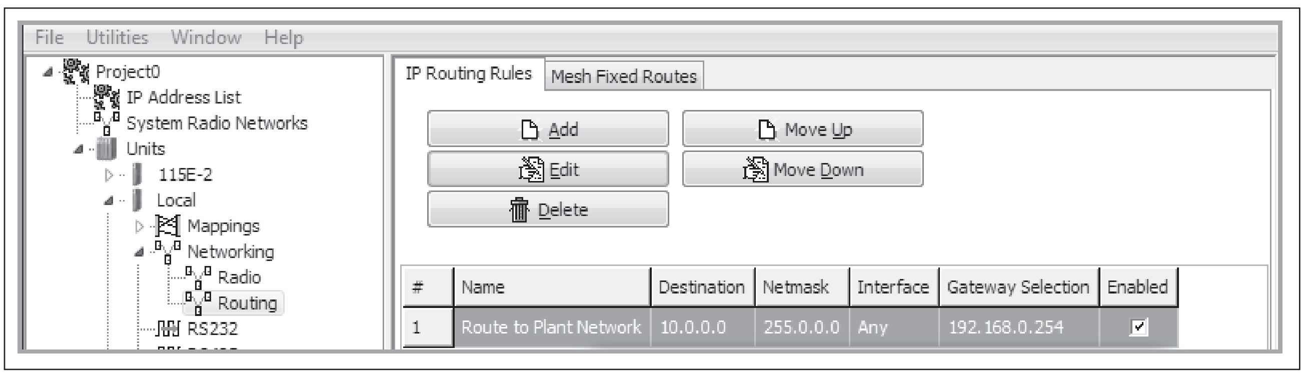


Figure 36. IP routing rules

Add	Adds a new IP routing rule. A new blank entry is added to the table. Enter the information for the new rule, and click **Save Changes.**
Edit	Allows you to edit information for a selected IP routing rule.
Delete	Remove a selected IP routing rule.
Move Up Move Down	Moves a selected IP routing rule within the list.
Name	Name describing the routing rule (maximum 32 characters).
Destination	Destination network or host IP address. You can specify an entire network by entering the IP range 192.168.0.0 with a netmask of 255.255.255.0, or you can specify an individual host IP address by setting the netmask to 255.255.255.255.
Netmask	Subnet mask for the destination network.
Interface	The interface to use for the route. You can choose Radio, Ethernet, or Any.
Gateway	Specifies the IP address of the next-hop router for the specified destination.
Enabled	Select this checkbox to enable the routing rule. Clear this checkbox to disable the routing rule without deleting it.

Radio configuration

These items configure the physical radio setup. Values that you enter here are determined by your radio system design.

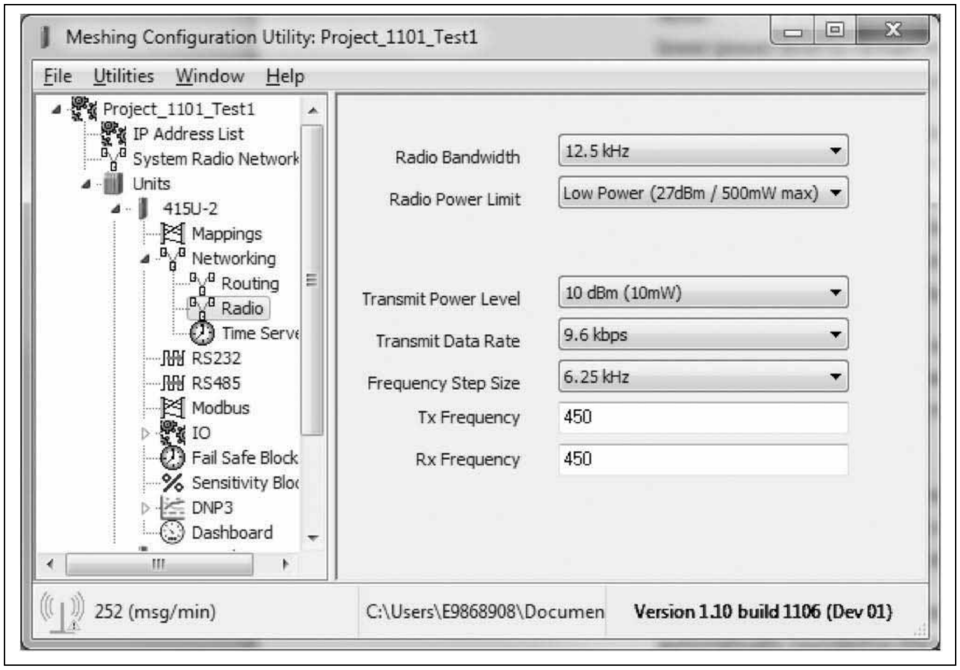


Figure 37. Radio configuration

- **Radio bandwidth and radio power limit**: These two items must be configured to match your radio device. Refer to "Device models and locales" on **page 81**, for a list of model codes and their bandwidth and power level.

⚠ WARNING

THE MCONFIG APPLICATION DOES NOT YET SUPPORT LOCALES THAT RESTRICT THE ALLOWED FREQUENCY AND POWER LEVEL OF THE RADIO ACCORDING TO THE RULES FOR UNLICENSED OPERATION IN YOUR TARGET COUNTRY. TAKE CARE TO SET THE RADIO POWER AND FREQUENCY ACCORDING TO YOUR LOCAL REGULATIONS.

- **Transmit power level**: This selects the transmitter power level. The transmit power level is displayed in dBm. The options here will be limited by the capabilities of your radio model, and by any restrictions for the locale selection you made during Locale configuration. Normally you will select the highest available power level.

⚠ **Note**: If you are using high gain antennas, you may need to select a lower power level to remain inside the restrictions of your radio license, or within the requirements for unlicensed operation within your target locale.

- **Transmit data rate**: You have two options here, depending on your radio bandwidth. For 25 kHz bandwidth radios, the options are 9600 baud and 19,200 baud. For 12.5 kHz bandwidth radios, the options are 4800 baud and 9600 baud. You should select the higher baud rate whenever you expect a signal strength stronger than –90 dBm. For long marginal radio paths, you can select the lower baud rate, while keeping other radios in the system set to the higher baud rate.
- **Frequency step size**: This allows you to adjust the radio's frequency step. This should normally be set to 6.25 kHz. Some countries' Licensing rules require frequencies to be on 10 kHz or 20 kHz boundaries. In these cases, you should select 5 kHz to achieve the desired frequency.
- **Transmit frequency**: This is the radio's transmit frequency in MHz. The number will be automatically rounded to the closest available frequency based on the Frequency Step Size you selected.
- **Receive frequency**: This is the radio's receive frequency in MHz. The number will be automatically rounded to the closest available frequency based on the Frequency Step Size you selected.

⚠ **Note**: For Unlicensed systems, the transmit and receive frequencies will normally be the same. Many licensed systems require transmitting and receiving on a pair of frequencies. For these systems, you need to make sure that the transmit frequency is the same as the receive frequency of the upstream device (Base or Repeater), and that the receive frequency matches the transmit frequency of the upstream device.

Mappings

Mappings are used to send I/O values between modules using the WIB I/O transfer protocol. The I/O is sent to a remote module via the Ethernet connection on the device. To display the current mappings for a module, open the module in the project tree and click Mappings (see **Figure 38**).

Mappings are sent on the following triggers:

- **Change of state (COS)**—This method monitors the state of the input that is being mapped. When the state changes, it triggers a transmission. This is the primary method of sending input values to a destination. As soon as the input change occurs the value is immediately sent to the destination. Digital mappings are triggered when the input changes from on to off, or from off to on. Analog mappings are triggered when the input changes by a predefined value, referred to as "sensitivity." The sensitivity value is set by configuring a sensitivity block for the particular input or a range of inputs. See "Sensitivity blocks" on **page 35** for more information.
- **Updates**—This method sends a message at a pre-configured time regardless of the input value or state. For details, see the Update Time field described in "Adding or editing mapping parameters" on **page 25**.
- **Mapping force**—This method makes use of the Force Mapping Transmit Register configuration on the Advanced page. It allows a mapping to be triggered when a separate register is written to a non-zero value. The register is written back to zero once the mapping has triggered.

There are three types of mappings—write, gather scatter, and read. Each type has advantages and disadvantages. The appropriate mapping to use will depend on the data and requirements of the system.

- **Write mapping**—A write mapping allows multiple sequential values to be sent in one message. If you are mapping analog values, the maximum I/O count is 64. However, if you are mapping digitals it can be as many as 1024 because the digitals values are packed into 16-bit words for transmission. The mapping is sent on a change-of-state of any of the values being monitored, and also on an update period.
- **Gather scatter mapping**—A gather scatter mapping is essentially the same as write mapping, but instead of sequential register it allows different I/O types to be sent in a single message. All I/O types, including digital, analog, long (32-bit registers) and floating point values, can be sent in a single message. A gather scatter mapping has a maximum I/O count of 32 values of any data type (digital, analog, longs, or floats).
- **Read mapping**—Read mappings are similar to write mappings in that they allow multiple sequential values to be sent. However, instead of writing the values to another module, the data is requested from the remote module, which responds with the requested data. This type of mapping is suited to a polling system where the receiving station initiates when it wants to communicate, for example, by sending a read request when it requires the information or by sending a request on a timed basis.

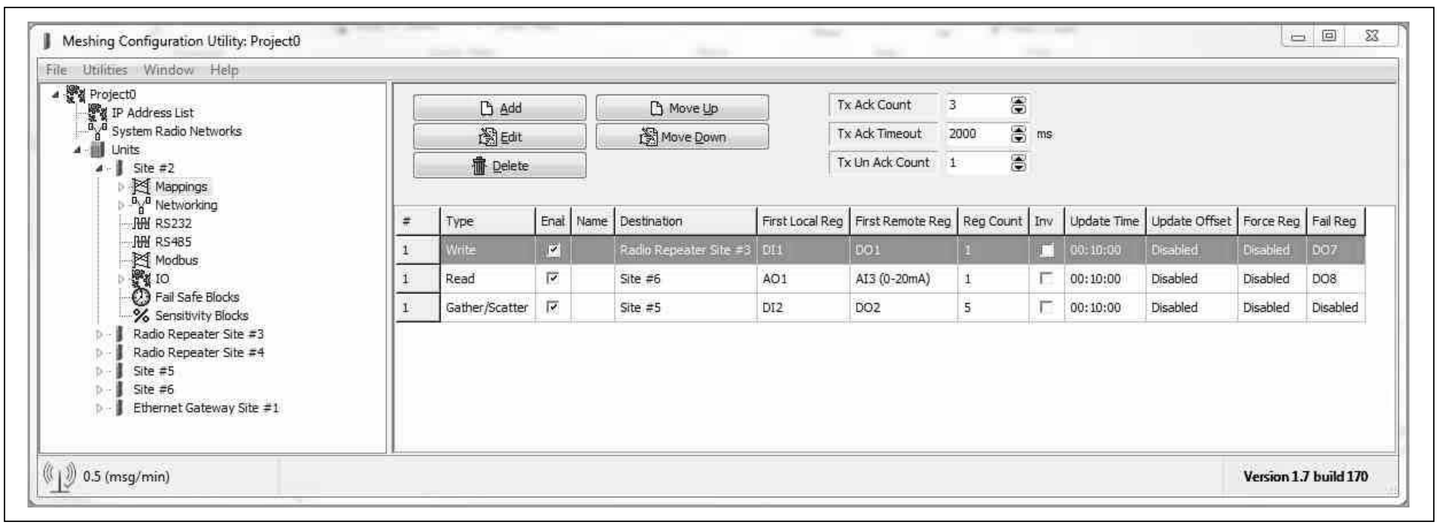


Figure 38. Mappings

WIB configuration options

The following options on the Mappings screen (see **Figure 38**) allow you to fine-tune the operation of the WIB protocol. The default values are appropriate for almost all systems and should not need to be changed.

Tx Ack Count	Total number of attempts to be made to transmit a mapping with its Acknowledge checkbox selected if no acknowledgment message is received. In most cases, the default value of three transmissions is recommended.
Tx Ack Timeout	Time to wait before deeming a mapping message as "unacknowledged" if the Acknowledge checkbox is selected in the mapping. The default value is two seconds.
Tx Un Ack Count	Number of times to send an IO mapping if the Acknowledge checkbox is cleared in the mapping.

Adding or editing mapping parameters

To add a new mapping for a module or to edit existing mapping parameters, open the module in the project tree, click **Mappings**, and then click **Add** (or **Edit**). **Figure 39** provides an example of a gather scatter mapping.

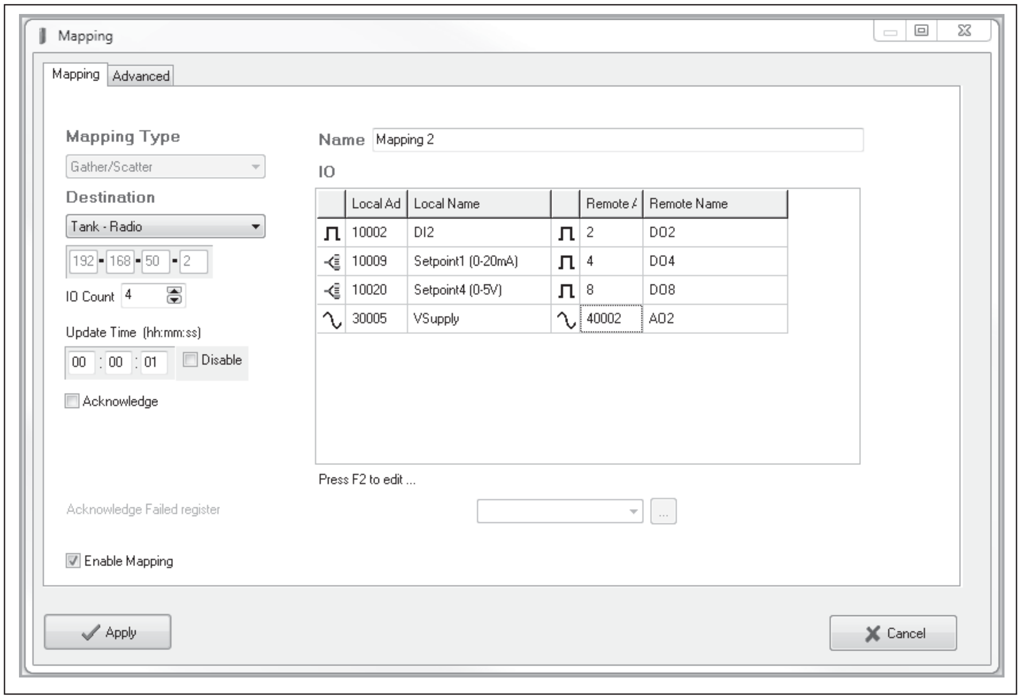


Figure 39. Gather scatter mapping

Name
: You can give each mapping a name for reference purposes.

Destination
: Provides two standard choices, as well as an Ethernet IP address for each 415U-2 module in the project tree and an option of either radio or Ethernet IP address for each 415U-2 in the project tree.

This Unit—This option refers to the module that you are currently configuring. When this option is selected, the IP address changes to the local host loopback address of 127.0.0.1.

Radio IP Address—When the radio IP address is selected, the mapping will be sent over the radio network. This is the most common destination selection.

Ethernet IP Address—When Ethernet IP address is selected, the mapping will be sent to the Ethernet address port of the 915U-2 or 415U-2. Click the Ethernet option in the project tree and ensure that the Ethernet port is enabled for the sending and receiving modules. Also ensure that the IP addresses of the sending module and receiving module are able to communicate to each other. For more information, see "Displaying the IP address list" on **page 16**.

IP Address—This option allows any IP address to be entered in the configuration. It is for advanced users only because the remote name and address location will not show up in the I/O list. Knowledge of the remote module's I/O location and address is required for it to function correctly. Generally this option is only used when a module that is not in the project is loaded or is being mapped to.

IO Table
: Allows you to map each I/O to an output.

Click the **Local Name** field to see a drop-down list of all available I/O, or click the **Local Address** field to view a tabbed I/O selection screen that will allow you to select an I/O point (input) that you want to map.

Select a destination I/O location. Click **Remote Name** for a drop-down list of destination I/O names or **Remote Address** to open a drop-down list of destination I/O locations.

⚠ **Note**: You must select a destination before you can select a remote name or remote address.

I/O Count
: Allows you to add more I/O points to the mapping. If you are using a write or a read mapping, MConfig will automatically select consecutive registers that are shaded and cannot be edited. When using a gather scatter mapping, MConfig will add mapping entries which you must then edit by selecting the sending and destination I/O points.

Invert
: Select this checkbox to allow the mapping to be inverted. For example, if the digital input is "on" and the mapping is inverted, the output will be "off," or if an analog input is 4 mA and the mapping is inverted the output will be 20 mA. The invert applies to all I/O in the mapping. Floating point and long values are not inverted.

Acknowledge	Select this checkbox to allow the mapping to be acknowledged when the end device receives the message. This is an end-to-end acknowledgment, and is in addition to the normal hop-by-hop frame acknowledgment between links. ⚠ **Note**: Enabling this option will increase the amount of radio communications and care should be taken in larger systems.
Update Time	Configures how often the mapping update messages (check signals) are sent. These messages are in addition to the normal change-of-state updates that occur when an input changes. The default update time is 10 minutes, but you can increase the update time to a maximum of over two weeks, or decrease it to a minimum of one second. Updates can also be disabled by entering a time of zero or selecting the checkbox. Note that the updates are only a check signal, and care should be taken when configuring the update values with short update times (less than 5 seconds) because this will greatly increase the amount of radio traffic.
Response Time	(Read mappings only.) The countdown time before the module registers a communications failure for the configured read mapping. When the timeout is complete, the fail register is activated.
Fail Register	Allows you to configure a register location that will indicate a communication failure for the configured remote destination address. ⚠ **Note**: The Acknowledge checkbox must be selected for fail registers to work. Also, the fail register can only be a digital output or internal bit registers (10501, 501, and so on).
Enable Mapping	Select the checkbox to enable this mapping.

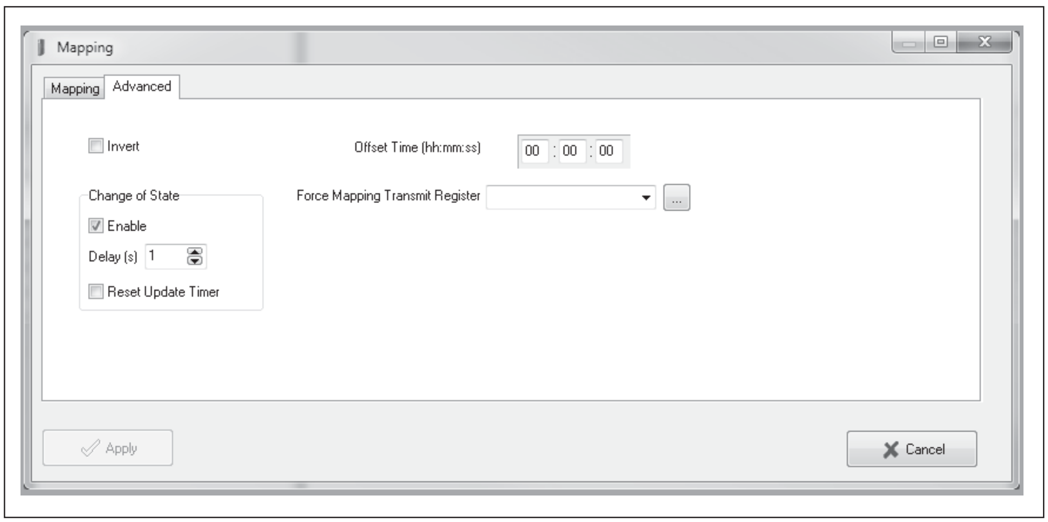


Figure 40. Mapping—advanced tab

Invert	When this checkbox is selected, the signal is inverted before being sent to the remote end. For analog signals, the output signal is inverted around the 12 mA level. For example, after inverting a 12 mA signal is unchanged, an 8 mA signal gives 16 mA, a 4 mA signal gives 20 m, and so on.
Offset Time	Configures an offset time for the update mapping. The offset is used to stagger the update transmissions at startup and at every update period so that the module does not send all mappings at the same time. The default is 0. To stagger transmissions to a predetermined schedule, set a different offset time value for each mapping, and clear the “Reset Update Timer” flag and the “Change of State Enable” flag for these mappings.
Change of State	
Enable	When the Enable checkbox is selected, the values are sent to their configured destination when a change-of-state (COS) occurs and the value complies with any sensitivity blocks. If COS is disabled, messages will only be sent on the update period.
Delay	Allows you to set the time period during which the message is delayed from being sent. The purpose is to reduce the amount of radio traffic by holding off the transmission to allow more I/O COS to the mapping.
Reset Update Timer	If this option is selected, the Update Time period will reset when a COS is received between configured updates. This means that the next update will not be sent until a further update period has elapsed. You can use this option to reduce the amount of radio traffic produced when multiple mappings are configured.

Force Mapping Transmit Register	Allows you to configure an I/O location that will force the mapping to be sent when the I/O location is written to. External devices, such as Modbus Master/Clients, can initiate the transmission of a mapping by writing to an internal register that then forces the transmission to occur. For more information and examples, see "Startup or force configuration". ⚠ **Note**: Digital inputs 1–8 cannot be used as a force trigger because the digital inputs are continually being scanned by the internal processor and each time a scan occurs it would force the mapping to be sent. If a digital input is required to be used as the trigger, map the digital input to a general purpose bit storage register (501, 10501, and so on), and then use this general purpose register to trigger the force mapping.

Startup or force configuration

When a module is first powered on, it transmits update messages to remote modules based on how the input mappings are configured. The module's outputs will remain in the default "off" condition until the module receives an update or change-of-state message from the remote modules—unless a fail-safe block has been configured for the output, in which case it will default to the value configured in the fail-safe block. For more information, see "Fail-safe blocks" on **page 33**.

To ensure that the module outputs are updated with the latest remote input status when the module is first powered on, you can configure the module to transmit a special startup or force message that will write a value into an internal register at the remote module (or modules). The remote module can then use this register to force any mappings that it has configured for the destination. To configure a force register, see the previous section, "Adding or editing mapping parameters" on **page 25**.

When the force register is activated, any mapping configured with this force register will immediately send an update message to the destination so that its outputs can be set to the latest value. It may be necessary to configure a startup or force message for each remote module that sends values back to the module's outputs.

Example

In the example shown in **Figure 41**, site A needs to be configured so that on power-up it writes to a register at Site B. Site B then uses this register to trigger an update of any mappings it has that communicate back to Site A. If the system has multiple remote sites that require startup or force configuration, Site A needs to have configured a startup or force mapping for each remote site. If there were multiple remotes in this example, all mappings from the remote sites that are sent to Site A would use the force register configured for 501.

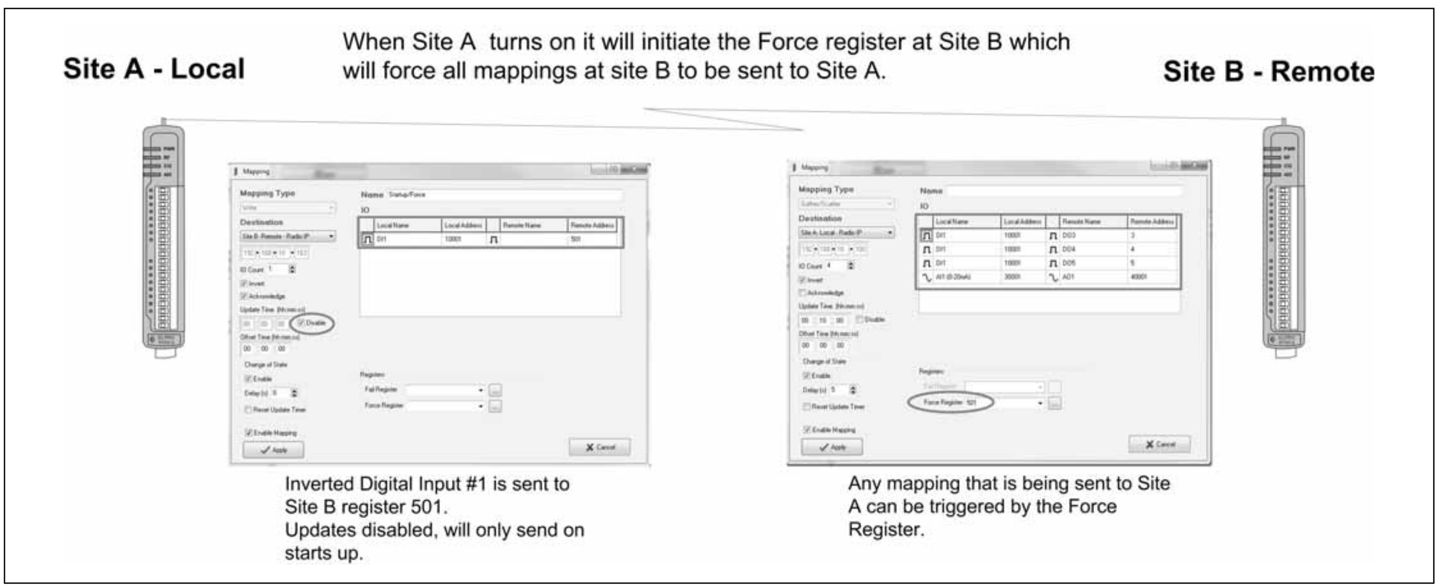


Figure 41. Startup or force configuration

Address map

The I/O data store provides storage for all I/O data, both local data and data received from the system. The I/O store provides four register types—two bit registers, two word registers, two long-word registers, and two floating point registers. In addition, each register type supports both inputs and outputs, making a total of eight register address ranges that are used for physical I/O and gateway storage. These files are mapped into the address range as described in the following table. The addressing uses standard Modbus protocol formatting and is also common to the ELPRO protocol.

Table 9. Address map

Type	Size	Address
Discrete outputs	3000 (bits)	00001
Discrete inputs	2500 (bits)	10001
Word (unsigned) inputs (16-bit)	2500 (words)	30001
Word (unsigned) outputs (16-bit)	2500 (words)	40001
Long inputs (32-bit)	20 (longwords)	36001
Float inputs (32-bit)	20 (floats)	38001
Long outputs (32-bit)	20 (longwords)	46001
Float outputs (32-bit)	20 (floats)	48001

Common I/O registers for the 415U-2

The following table shows the basic on-board I/O registers available in a standard 415U-2 module with no expansion I/O connected to it. For a detailed I/O map showing the full register range, see **page 80**.

Table 10. Address map—inputs / outputs

Address	Input / output description
0001–0008	Local DIO1–DIO8, as outputs
10001–10008	Local DIO1–DIO8, as inputs
10009–10020	Set point status from analog inputs 1 through 12: AI1, 2, 3, 4 current mode Internal supplies AI1, 2, 3, 4 voltage mode
30001–30004	Local AI1–AI4 (current mode): AI1 and AI2, 4–20 mA diff AI3 and AI4, 4–20 mA sink
30005	Local supply voltage (0–40 V default scaling)
30006	Local 24 V loop voltage (0–40 V default scaling)
30007	Local battery voltage (0–40 V default scaling)
30008	115S expansion I/O supply voltage (0–40 V default scaling)
30009–30012	Local AI1–AI4 (voltage mode): AI1 and AI2, 0–20 V AI3 and AI4, 0–5 V
30013–30016	Local pulse input rates PI1–PI4
36001–36008	Local pulsed input counts (PI1 most significant word is 36001 and least significant word is 36002)
38001–38032	Local analog inputs as floating point values (mA, volts, or Hz)
40001–40002	Local AO1–AO2
48001–48002	Local AO1–AO2 as floating point values (mA)

I/O configuration

Each I/O has characteristics that can be tailored to applications. To configure individual I/O settings for a module, click **I/O** in the project tree to display the configurable parameters. These parameters are described in detail in this section.

Digital inputs

To configure digital inputs, click **Digital Inputs** under **IO** in the project tree. Select a digital input from the list on the right, and click **Edit** (see **Figure 42**). This displays the IO Edit screen (**Figure 43**) where you can change settings.

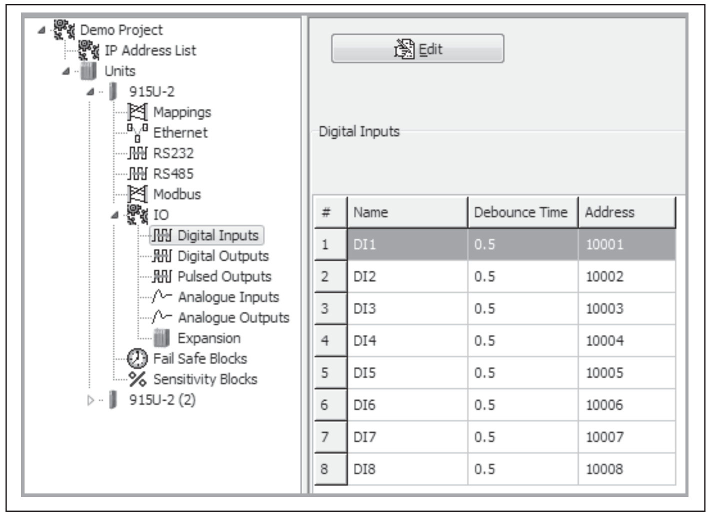


Figure 42. IO—digital inputs

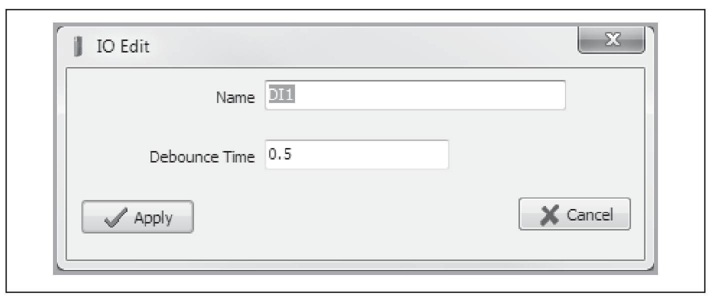


Figure 43. I/O edit (digital inputs)

You can configure following parameters for 415U-2 digital inputs.

Name	Enter a name for the digital input or leave the default name. The name can be up to 30 characters, including spaces.
Debounce Time (sec)	Debounce is the period of time that an input must remain stable before the module determines that a change of state has occurred. If a digital input changes from on to off and from off to on in less than the debounce time, the module will ignore both changes. The default debounce time is 0.5 seconds.

Digital outputs

To configure digital outputs, click **Digital Outputs** under **IO** in the project tree. Select a digital output from the list on the right and click **Edit**. This displays the IO Edit screen (**Figure 44**) where you can change settings.

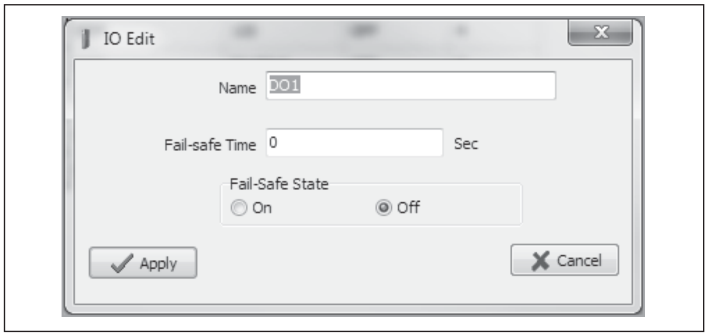


Figure 44. IO edit (digital output)

You can configure the following parameters for 415U-2 digital outputs.

Name	Enter a name for the digital output or leave the default name. The name can be up to 30 characters, including spaces.
Fail-safe Time (sec)	Sets the time the output needs to count down before activating the fail-safe state. Receiving an update or a COS message will reset the fail-safe timer to its starting value. If the fail-safe timer goes down to zero, the output will be set to the fail-safe state (on or off). It is recommend the fail-safe time be configured for a little more than twice the update time of the input that is mapped to it. That way, the output will reset if it fails to receive two update messages in succession.
Fail-safe State	Sets the state that the output will assume after the fail-safe time has elapsed. When the fail-safe state is set to On, the LED flashes briefly off, and the digital output turns on. When the fail-safe state is set to Off, the LED flashing briefly on, and the digital output turns off.

Pulsed outputs

To configure pulsed outputs, click **Pulsed Outputs** under **IO** in the project tree. Select a pulsed output from the list on the right, and click **Edit**. This displays the IO Edit screen (**Figure 45**) where you can change settings.

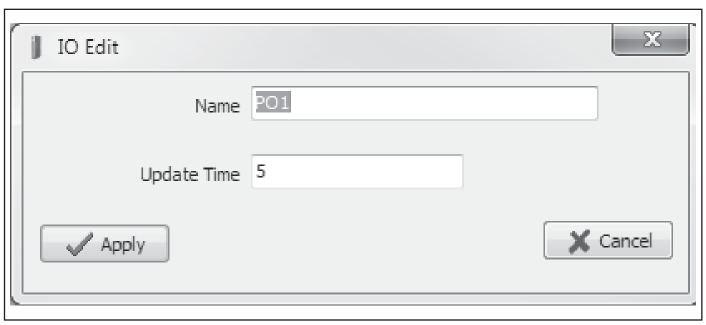


Figure 45. IO edit (pulsed output)

You can configure the following parameters for 415U-2 pulsed outputs.

Name	Enter a name for the pulsed output or leave the default name. The name can be up to 30 characters, including spaces.
Update Time (sec)	Time that the output will be updated with the latest received value. The time is related to the update time of the pulsed input that is mapped to it. For example, if the pulsed input update time at the remote unit is configured for 10 seconds, the number of pulses will be counted and sent to the receiving module every 10 seconds. The receiving module will then output the pulse count over the configured update time (10 seconds).

Analog inputs

Analog inputs each support an associated set-point. Each analog input can also be scaled to convert the analog values to a range suitable for other equipment. Analog inputs can also be used as voltage inputs by selecting DIP switches on the 415U-2 modules (see “DIP switches” on **page 9**).

To configure analog inputs, click **Analog Inputs** under **IO** in the project tree. Select a digital input from the list on the right, and click **Edit** (see **Figure 46**). This displays the IO Edit screen (**Figure 47**) where you can change settings.

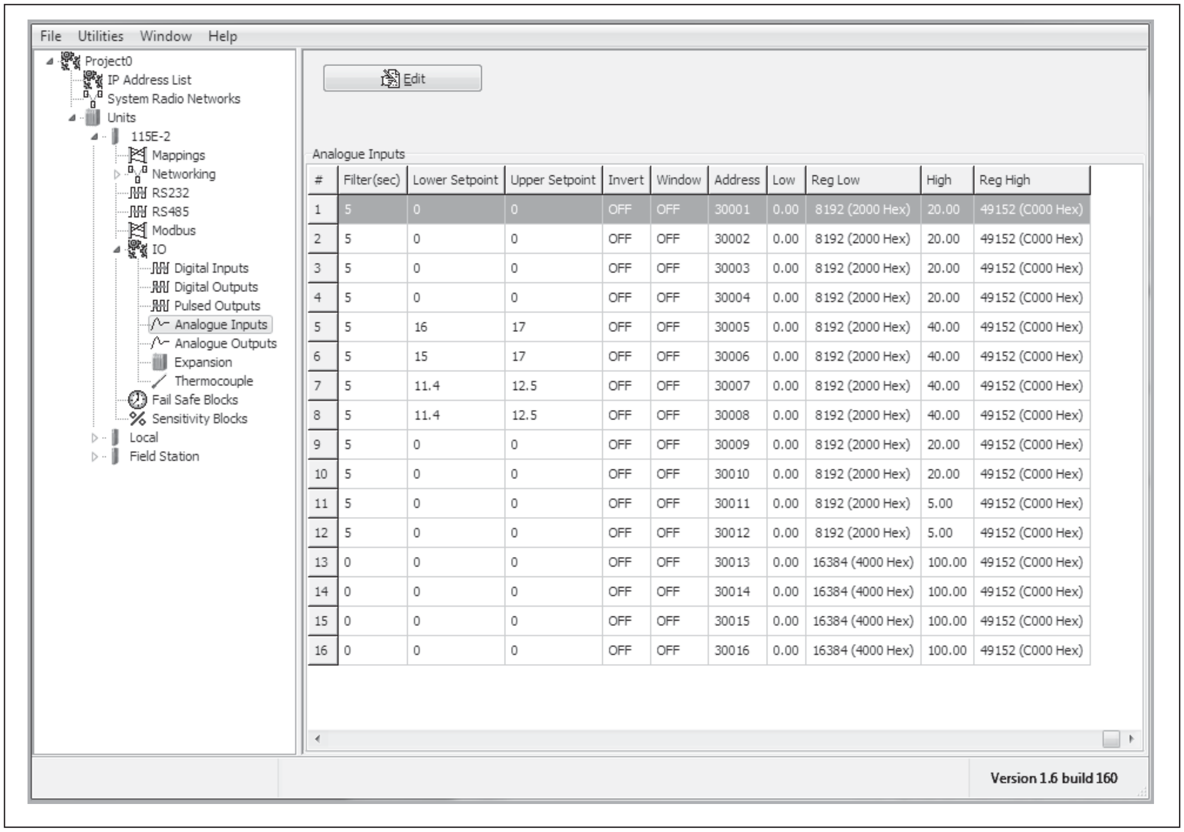


Figure 46. Analog inputs

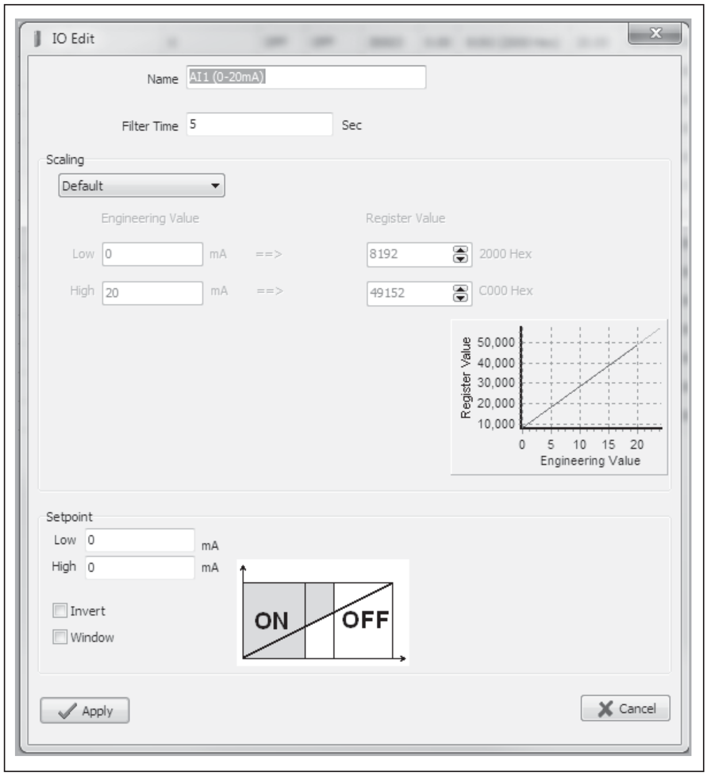


Figure 47. IO edit (analog inputs)

You can configure the following parameters for 415U-2 analog inputs.

Name

Enter a name for the analog input or leave the default name. The name can be up to 30 characters, including spaces.

Filter Time (sec)

Period of time (in seconds) needed by the analog input to settle on a step change of an analog value. By default, all inputs except the pulse rates have a time constant of five seconds. Pulsed input rates are not filtered.

Scaling

You can scale analog inputs to suit data requirements of other systems. When sending analog inputs to outputs on other 915U-2/415U-2 devices, select Default. Other scaling options provide support for systems that need data ranges of 8-bit, 12-bit, and 16-bit (signed and unsigned). Use the Custom setting to configure other scalings for systems that cannot be accommodated with any of the other options.

The graph shows how the scaling affects the relationship between the measured value (Engineering Value) and the corresponding scaled 16-bit Register Value.

Lower and Upper Set Points

These set points are the upper and lower control point values that will be used to turn on and off the analog set point digital signals located at register 10009–10020.

⚠ **Note**: Set point values are entered in the scale of the input. For example, analog input 1–4 should be in mA, analog inputs 9–12 should be volts, and so on.

To control the set points, use the Invert and Window control options described below. All set points have these controlling options.

Invert

Selecting this option inverts the set point control logic. The function does not change—only the operation is inverted. For example, if the set point is “on” in its normal state, inverting the signal causes the set point to be “off” in the normal state. By default, the checkbox is cleared and the set point logic is not inverted.

Window

Selecting this checkbox sets the set point operation to Window mode. Clearing this checkbox sets the set point operation to default mode.

Window Mode—In this mode, if the analog value is inside the upper and lower set points, the set point will be active (on, “1”), and if the analog value is outside of these set points, the set point will be reset (off, “0”).

Default Mode—In this mode, the set point operates in default mode. If the analog input is greater than the upper set point, the set point status is active (on, or “1”). When the analog input is less than the lower set point, the set point is reset (off, or “0”). When the analog value is between the upper and lower set points, the previous value is maintained.

⚠ **Note**: The upper set point must always be higher than the lower set point.

Analog outputs

To configure analog outputs, click **Analog Outputs** under **IO** in the project tree. Select an analog output from the list on the right, and click **Edit** (see **Figure 48**). This displays the IO Edit screen (**Figure 49**) where you can change settings.

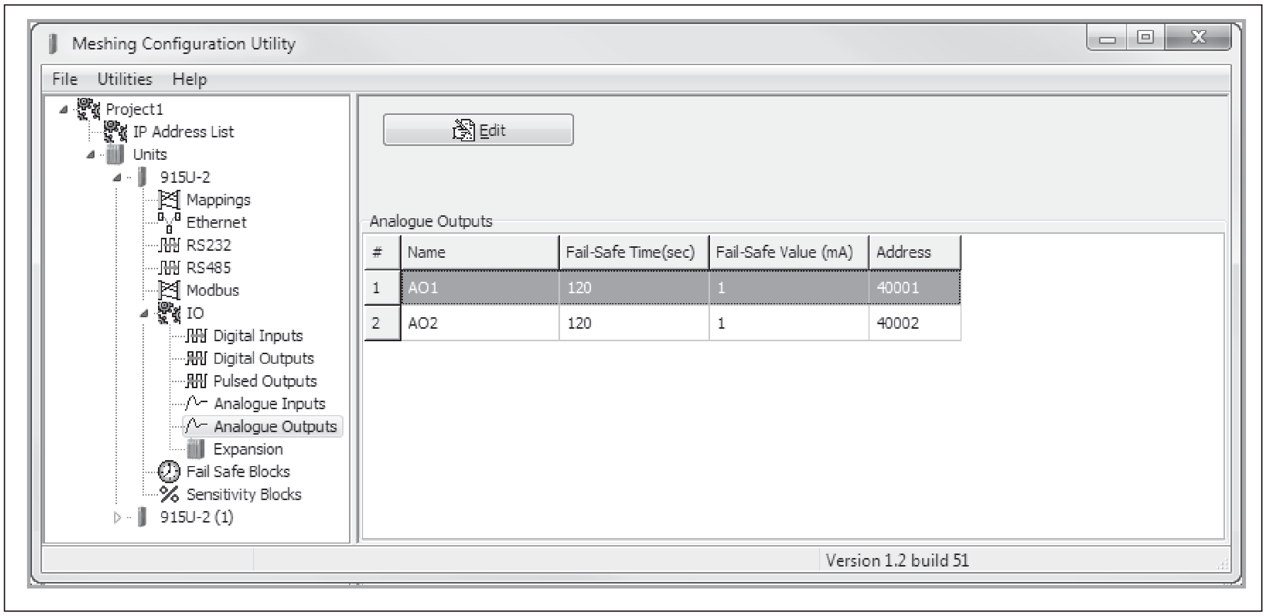


Figure 48. Analog outputs

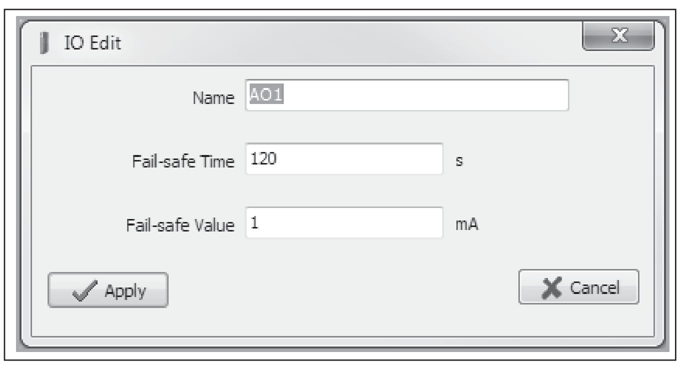


Figure 49. IO edit (analog outputs)

You can configure the following parameters for 415U-2 analog outputs.

Name	Enter a name for the analog output or leave the default name. The name can be up to 30 characters, including spaces.
Fail-safe Time (sec)	Sets the time the output needs to count down before activating the fail-safe state. Receiving an update or a COS message will reset the fail-safe timer to its starting value. When the fail-safe time elapses, the output is set to the fail-safe value (mA). It is recommend the fail-safe time be configured for a little more than twice the update time of the input that is mapped to it. That way the output will reset if it fails to receive two update messages. Entering a zero as the fail-safe time will disable fail-safe.
Fail-safe Value (mA)	Sets the value that the output will be set to when the fail-safe time elapses.

Adding expansion I/O modules

You can connect additional 115S serial expansion I/O modules to the 415U-2 module if more I/O is required. The RS-485 serial port on the 415U-2 is configured by default to communicate with 115S expansion modules using the Modbus protocol. The default serial parameters of the RS-485 port on the 415U-2 are 9600 baud, no parity, 8 data bits, 1 stop bit, which match the default settings of the 115S serial expansion modules. You can change these parameters to increase poll speeds in larger systems, but the serial module's parameters must match that of the 415U-2 RS-485 port.

If more than three serial expansion I/O modules are added to the 415U-2 module, you will need to adjust the Maximum Connections setting for RS-485 or RS-232. To display these configuration screens, select the module in the project tree and click **RS-485** or **RS-232**.

⚠ **Note**: Reducing the Maximum Connections setting will slightly improve the serial scan time. However, you need to make sure that the slave addresses fall within the Maximum Connections. If the Slave address is above the Maximum Connections, it will not be polled.

When you connect the serial expansion module, before powering on, set the expansion module address using the rotary switches on the bottom of the module. Assign addresses sequentially, starting at address 1. Make a note of the module address. This address will be used as an offset to locate the I/O within the 415U-2. Also make sure that the termination switch is "on" (down) for the last module in the RS-485 loop.

⚠ **Note**: Failure to terminate the RS-485 correctly will result in modules not operating correctly.

115S Expansion I/O Memory Map

The I/O data on the 115S module is read into memory locations according to their Modbus address. The maximum supported Modbus address is 19. Each 115S module has an offset that applies to the location of its registers. This offset is equal to the units Modbus address (selected on the rotary switch on the end of the 115S expansion I/O module), multiplied by 20.

If the modules Modbus address is 15, the offset value will be 15 X 20 = 300.

For example, if connecting a 115S-11 (16 x DIO) with address #15:

- Digital input 1 will be at register location 10301
- Digital Output 1 will be at register location 301

If using a 115S-12 (8 x DIO and 8 AIN) with address 16:

- Digital input 1 will be at register location 10321
- Analog input 1 will be at register location 30321

For a detailed address map of the serial expansion I/O modules, see **page 77** and **page 78**.

When adding expansion I/O modules to the 415U-2, there are two inbuilt registers indicating the communication status of the expansion I/O module:

- **Communication Fail**—Located at register location 10019 + offset value. This register indicates "1"when the module is in failure.
- **Communication OK**—Located at register location 10020 + offset value. This register indicates "1"when the module is communicating properly.

Adding an expansion I/O to MConfig

To add a 115S expansion I/O to the MConfig utility, open the module in the project tree and click **Expansion**, and then click **Add** (see **Figure 50**).

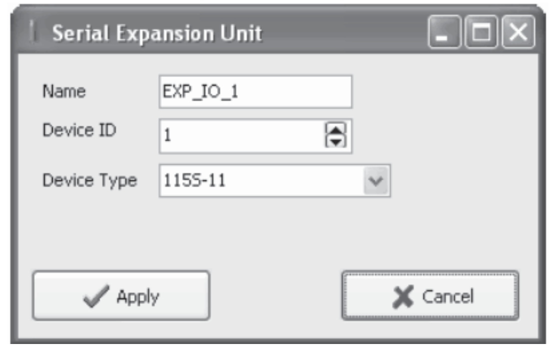


Figure 50. Serial expansion unit

Name	Enter a name for the 115S expansion I/O module, or leave the default name. The name can be up to 30 characters, including spaces.
Device ID	Select the address of the expansion I/O module. The address is found on the rotary switch on the bottom of the 115S expansion I/O module.
Device Type	Select the module type from the drop down list.

Fail-safe blocks

To configure fail-safe blocks for a module, open the module in the project tree and click **Fail-safe Blocks**. The Fail-safe Block configuration screen (**Figure 51**) allows you to set registers to a pre-configured value on startup and configure the outputs to reset to a predefined value after a timeout period has elapsed. When the actual value is received, the register is automatically updated with this value. If the value is lost because of a communication problem, the register can be configured to set the register to a fail-safe value after the pre-configured time. You can have a maximum of 50 fail-safe blocks.

In the example shown in **Figure 51**, register 40501 holds an analog value that has been mapped from another module and is updated every 60 seconds. The fail-safe block is configured so that on startup the module will write a value of 16384 into register 40501, and then start counting down the fail timeout period (in this case, 130 seconds), which is a little over two times the update period from the sending module. If the module has not received an update from the other module after 130 seconds, register 40501 will be set to the fail value (in this case, Invalid). If the "Invalidate" option is selected, the value will be set to a null or invalidated value (~). If this register happens to be mapped to another module and the state is "Invalid," the mapping will be inhibited until the invalid value is updated with an actual value.

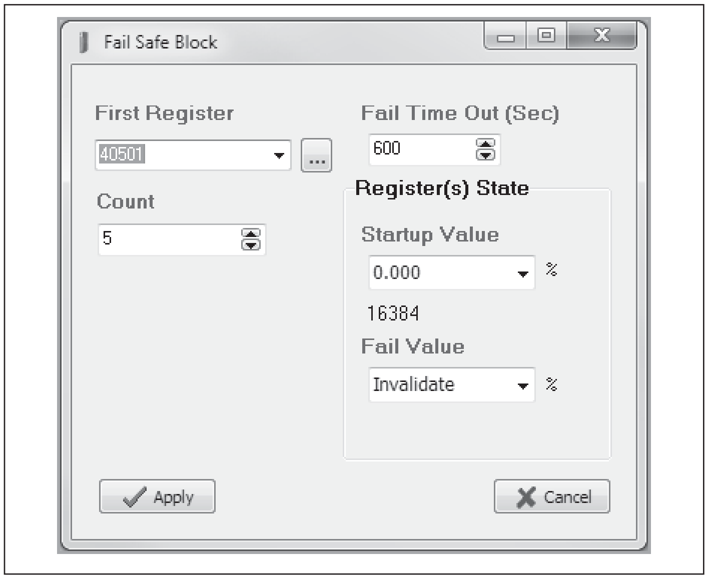


Figure 51. Fail-safe block analog

In the example shown in **Figure 52**, digital outputs 1–8 will be initialized on startup (turned on) and then start the fail timeout countdown from 60 seconds after which time the outputs will be set to the fail value (off) unless the output is updated.

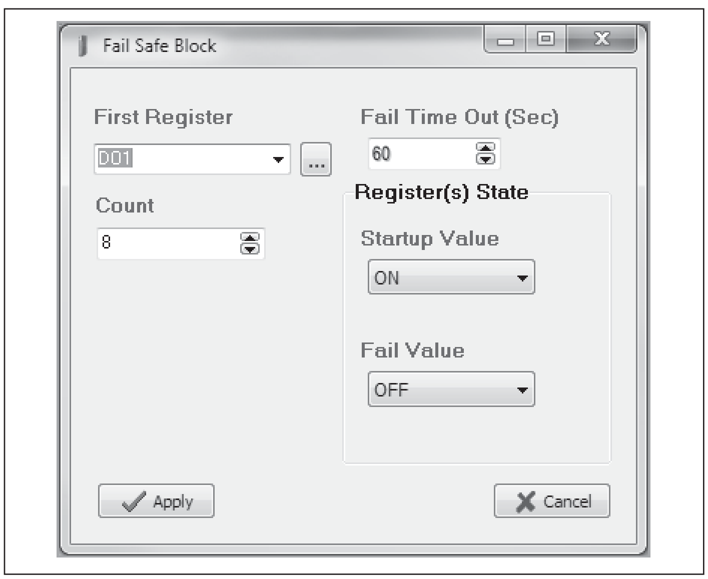


Figure 52. Fail-safe block digital

First Register	Starting register to which the fail-safe block applies.
Fail Timeout	Time period before the fail-safe state will be activated. Set this value to zero to disable the fail timeout (the startup value will still be set).
Count	Number of outputs to which the fail-safe block applies.
Startup Value	Value the registers are set to when the module is powered on. Select "Invalid" or a desired value. For digital registers, the value can be either ON or OFF. For analog registers, select "Enter Value" and enter the desired value. The value is set as a milli-amp value or as a percentage. The actual register value is displayed below the value setting.
Fail Value	Value that the registers are set to if an update is not received before the fail timeout period expires. Select "Invalid" or a desired value. For digital registers, the value can be either ON or OFF. For analog registers, select "Enter Value" to enter a value. The value is set as a milli-amp value or as a percentage. The actual register value is displayed below the percentage setting.
Apply	Saves the settings.

⚠ **Note**: Don't use the failsafe for physical outputs. For Physical outputs, use the fail safe feature attached to the output.

Invalid register state

All registers within the module can have different states, depending on the type of register and the type of value it holds. A typical analog range is between 0 and 65535, and a digital can be 0 or 1. Registers that are not associated with a physical I/O can also be in the "invalid" state, which means that the register has not been written to and holds a non-value or null value. If you use I/O diagnostics to read the registers, an invalid register will read "~" as shown in **Figure 53**. For information on I/O diagnostics, see "I/O configuration" on **page 28**.

⚠ **Note**: Any mapping with an invalid register will be inhibited from sending. This is to ensure that the data sent to the destination is valid and not the default values the module has on startup. See "Fail-safe blocks" on **page 33** for information on configuring registers with a valid value at startup.

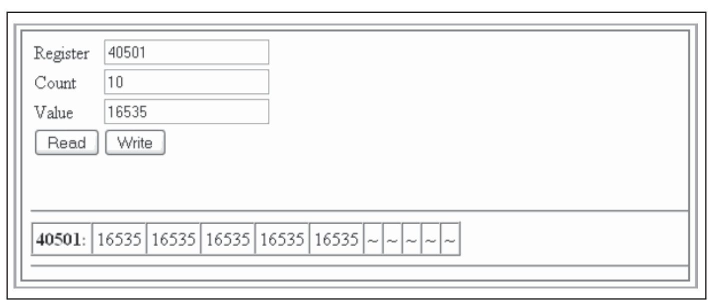


Figure 53. Invalid register state

Sensitivity blocks

All I/O registers have a configurable sensitivity value that determines how much the register needs to change before a change-of-state" (COS) message is sent. All registers except the following have a default sensitivity value of 1:

- The 12 analog inputs have a sensitivity of 1000 counts, or approximately 3% (1000 counts from a total range of 32768 = 3.05%).
- The 24 floating point values have a default sensitivity of 0.5 units.
- Inputs 38001–38004 will be 0.5 mA, inputs 38005–38012 will be in volts, and inputs 38013–38016 will be in hertz.

A sensitivity value is needed for analog inputs in order to prevent the module from sending every single-bit change of an analog value, and subsequently saturating the radio channel with unwanted COS messages. If a lower sensitivity is required, you can adjust the sensitivity block. However, take care not reduce the sensitivity to the point where radio messages are so frequent (due to a sensitivity change) that it saturates the radio network. There is a fine line between adjusting system parameters to receive up-to-date data and overloading the radio communications. A total of 50 sensitivity blocks can be configured for different registers or different values.

To change sensitivity blocks for a module, click **Sensitivity Blocks** in the project tree (see **Figure 54**). The screen lists existing sensitivity blocks for this module. To add a new sensitivity block, click **Add**. To edit an existing sensitivity block, select it in list on the right, and click **Edit**. This displays the IO Edit screen (see **Figure 55**) where you can change settings. To delete a sensitivity block, select it in the list and click **Delete**.

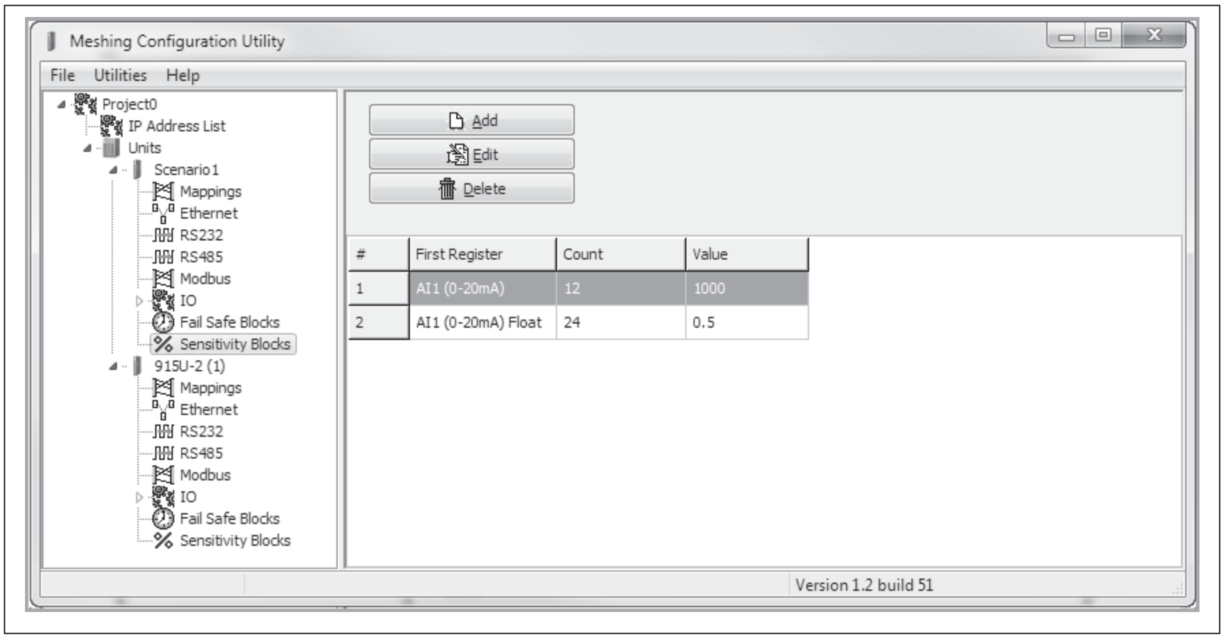


Figure 54. Sensitivity block

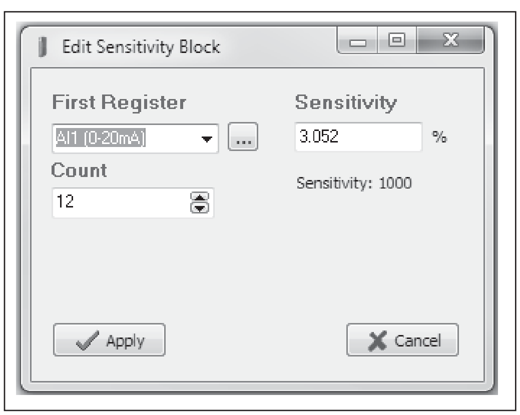


Figure 55. Editing sensitivity block

First Register	Select the starting register for the sensitivity block.
First Register	Select the actual register number within the register group range.
Count	Select the number of consecutive registers to which the sensitivity applies.
Sensitivity	Select the amount that the register needs to change before a COS trigger occurs.

Dashboard configuration

The 451U-2 provides a dashboard feature to allow users to remotely access a view of the status of the device's I/O and registers. Any authorized user can access the device's dashboard remotely using a Web-browser. You configure which registers will be displayed on the dashboard, and how they will be displayed.

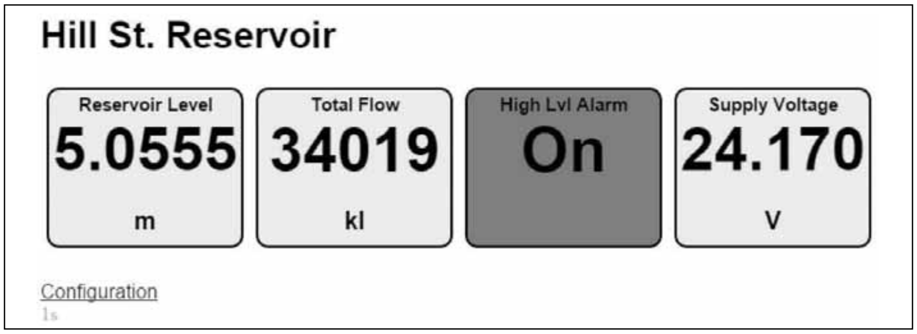


Figure 56. Example dashboard display

To access the dashboard, use a Web-browser to browse to the device's IP address. The dashboard display updates automatically.

To configure the dashboard display, select the "Dashboard" tree node under the device that you want to configure.

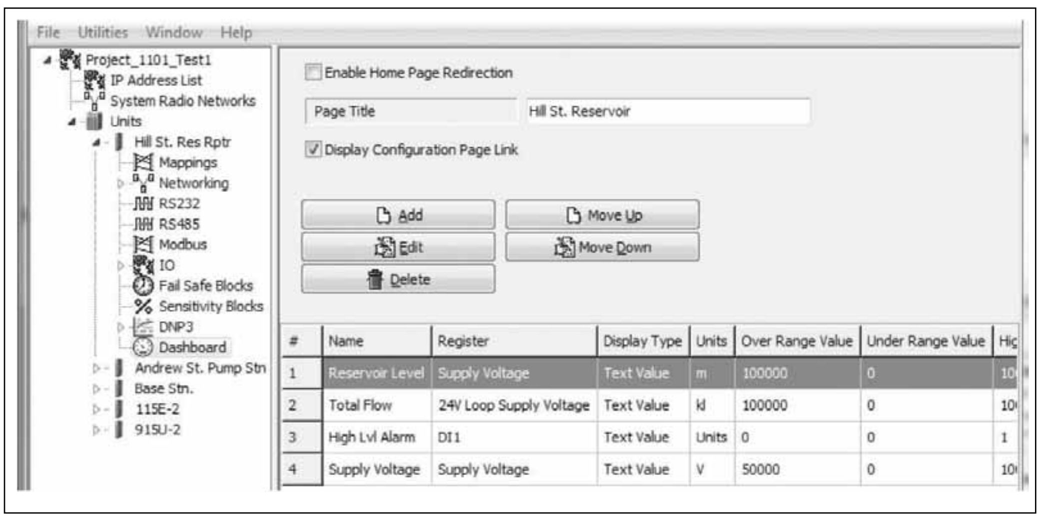


Figure 57. Dashboard configuration

You configure these items for the entire dashboard page:

Enable home Page Redirection: Checking this button makes future access to the devices IP address directly to the dashboard. This simplifies access to the dashboard for users that are unfamiliar with the product. If this button is left unchecked, accessing the device will take users to the devices home page. (From the home-page, you can still access the dashboard by clicking a link to view the dashboard).

Page Title: This is the title that will be displayed at the top of the dashboard view.

Display Configuration Page Link: If this is selected, the dashboard view provides a link labeled "Configuration". This provides a link to the device's regular home page. If you don't want your users to have easy access to the device's home page, then un-check this button.

⚠ **Note**: You can still access the home page by typing in full address to your browser bar: http://<Device_IPAddress>/operator/main.asp

Add" and "Delete" buttons: These let you add and delete table rows. Each row corresponds to an item on the dashboard display.

"Move Up" and "Move Down" buttons: These let you adjust the order items are displayed on the dashboard. Items are displayed on the dashboard in the same order as they are listed in the table.

"Edit" Button: This lets you edit the settings for the currently selected table row. This activates the Edit dialog box.

Name: The item name displayed on the dashboard display

Register: This is the register that will be displayed on the dashboard. Use the drop-down to select from named registers, or use the ... button to display a full dialog to select any device register.

Display Type: Currently the "Text Value" option is only supported. Future firmware releases may support graphical display of analog values

Units: (Analog registers only) Enter the text to display for units.

Over/Under Range Value: (Analog registers only) If the displayed value moves beyond these thresholds, the text "Ovr" or "Und" is displayed instead of the displayed value.

High / Low Alarm: If the displayed value moves beyond these values, the dashboard item displays in red. For Digital registers, set these both to 0 to disable. Set High alarm to 1 to alarm with ON state, and set Low alarm to 1 to alarm with OFF state.

Invert: For digital registers, use this to invert the state, so that ON displays when the input is off, and vice-versa.

Register/ Display Point 1/2: For Analog registers, these four values set the display scaling. You configure two points which define what value will be displayed as the register value changes. Refer to section "Internal I/O" and "Analog Inputs" for more detail on how the measured value is represented in the registers.

Figure 58. Edit window

Serial configuration

The 415U-2 module has an RS-232 and an RS-485 port for serial communications. These ports are used to connect ELPRO 115S-11, 115S-12, and 115S-13 serial expansion I/O modules. The ports can also be used to connect external Modbus RTU master or slave devices. The port operating mode and the normal serial parameters, baud rate, data format, flow control, and so on, all need to be selected from the drop-down lists, depending on the type of device connected and how it will operate.

⚠ **Note**: An error is displayed if the operating mode selection is incompatible with the configuration. For example, you will see an error if Modbus mode is not selected when Modbus mappings are configured.

Each serial port can be configured to operate in one of the following operating modes:

- **Modbus RTU Master**—This mode should be configured when the port is operating as a Modbus master, for example, when Modbus RTU slave devices are connected directly to the serial port.
- **Modbus RTU Slave**—This operating mode should be used when the port is being used as a Modbus RTU slave, for example, when a Modbus master (such as DCS, or SCADA) is connected to the serial port.
- **Expansion I/O**—This operating mode should be selected when ELPRO serial expansion modules are connected to the module.

Modbus RTU master

To configure a module serial port as a Modbus RTU master, click the serial port (**RS-485** or **RS-232**) in the project tree, and then select **Modbus RTU Master** from the **Operating Mode** drop down menu (see **Figure 59)**.

The Modbus RTU master should be configured if the 415U-2 is acting as a Modbus RTU master and polling Modbus slave devices via the selected serial port. It also allows Ethernet Modbus/TCP clients connected to the 415U-2 Ethernet port to communicate with Modbus RTU slave devices connected to the configured serial port. The 415U-2 makes this possible by internally performing the necessary protocol conversion. The conversion is performed by the 415U-2 that is directly connected to the Modbus serial device (only this module needs to have Modbus TCP to RTU gateway enabled).

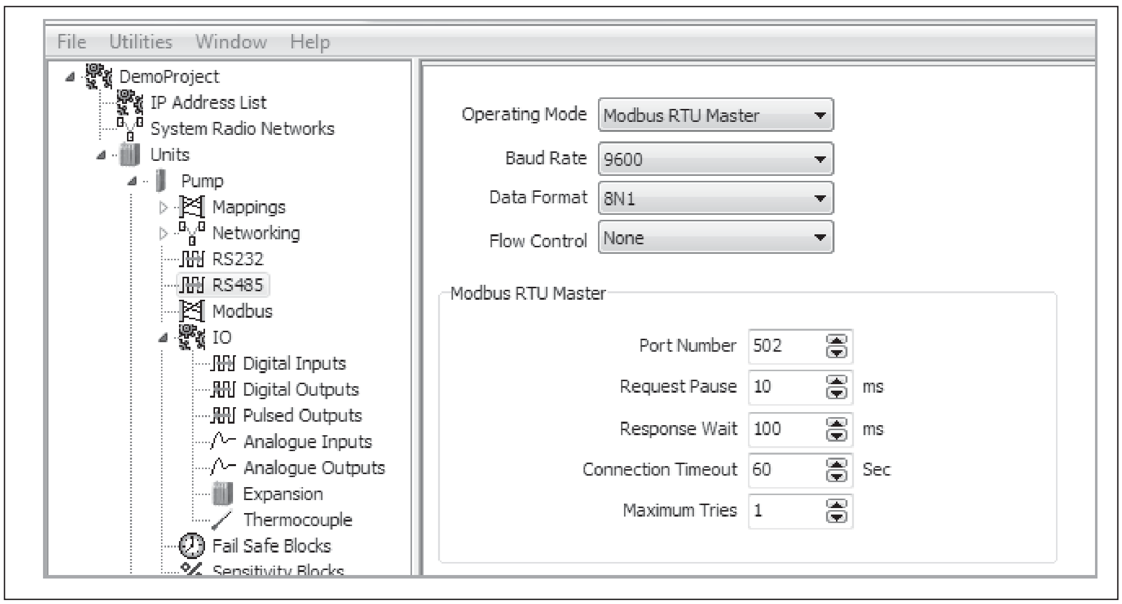


Figure 59. Modbus TCP/RTU

When a serial port is configured as a Modbus RTU master there are a number of parameters (such as baud rate, data format and flow control) that you can adjust, depending on the devices connected.

Port Number	TCP Port number configured for the serial port. A standard port number will be assigned. The default port number for Modbus is 502. Generally, these port numbers only need to be changed if the TCP client is using a non-standard port number. ⚠ **Note**: Firmware versions earlier than 2.0 require that the RS-232 and RS-485 ports have different TCP port numbers. This may mean that you can only connect one of the serial ports to the Modbus TCP server.
Request Pause	Delay between serial requests, in milliseconds.
Response Wait	Serial response timeout period, in milliseconds. A serial retry is sent if a response is not received within this timeout period.
Connection Timeout	TCP connection timeout period, in seconds. If no Modbus/TCP data is received within this timeout period, the TCP connection will be dropped. Set this field to zero for no timeout.
Maximum Tries	Maximum number of request retries that are performed on the serial port.

Serial expansion I/O

To change serial port parameters for expansion I/O, click the serial port (**RS-485** or **RS-232**) in the project tree, and then click **Expansion I/O** in the **Operating Mode** drop down menu (see **Figure 60**).

By default the RS-485 port is automatically enabled for expansion I/O. This is to allow you to connect serial expansion I/O modules with minimal or no module configuration. When you add an ELPRO Expansion I/O module (such as an 115S-11, 115S-12, or 115S-13) to the RS-485 port of the 415U-2, the I/O is automatically available from within the I/O store of the 415U-2. See **page 80** for location addresses, or refer to the 115S Expansion I/O User Manual.

The default data rate and data format are standard 9600, N81 with no flow control, which matches the default serial baud rate and data format of the 115S serial expansion module. You can adjust serial parameters for compatibility or faster serial performance. If you change the baud rate or data format, the serial port parameters on the expansion I/O module also need to be changed. To do this use the Modbus Serial I/O Module option from the MConfig Utilities menu.

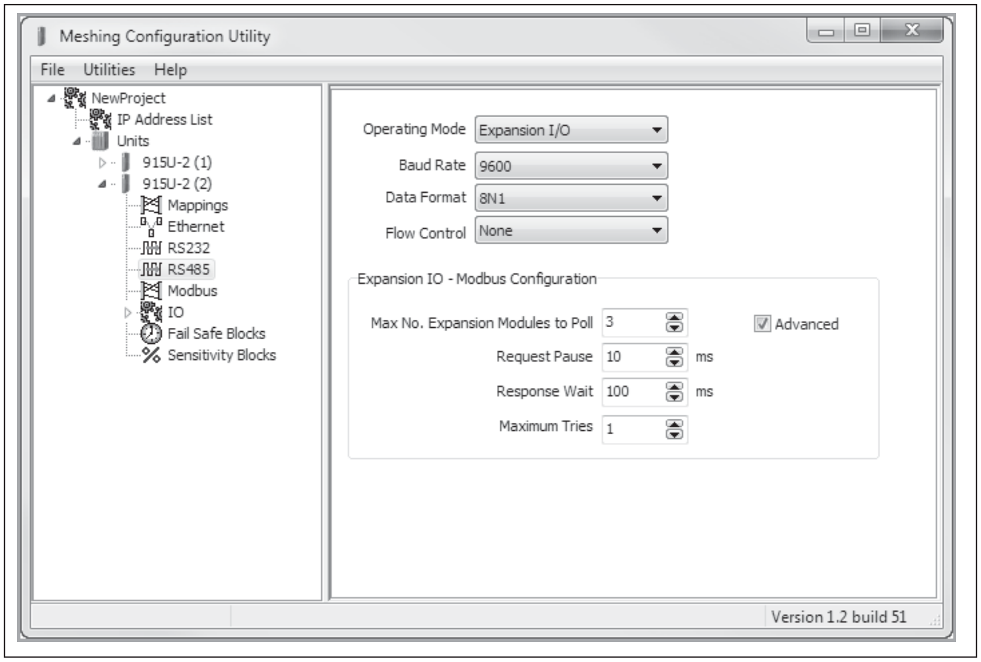


Figure 60. Expansion I/O

Maximum No. Expansion Modules to Poll	Maximum number of slave addresses that the 415U-2 will scan or poll. Default is 3. If adding more than 3 x 115S expansion I/O module or the address used are greater than 3, this number will need to be increased to match the largest address.
Advanced	Selecting the Advanced check-box displays the Request Pause, Response Wait, and Maximum Time fields. If a 115S module is directly connected to the 415U-2, it will operate correctly using the default settings. You may need to change the default settings if the 115S is located remotely from the host module.
Request Pause	Delay between serial requests, in milliseconds
Response Wait	Serial response timeout, in milliseconds. A serial retry is sent if a response is not received within this timeout period.
Maximum Tries	Maximum number of request retries performed on the serial port. This should be set to 1 (no re-tries) for directly connected expansion I/O.

Serial Modbus RTU slave

When a serial port is configured as a Modbus RTU slave, the only parameters that need to be configured are data rate, data format, and flow control. To configure these parameters, click the serial port (**RS-485** or **RS-232**) in the module project tree, and then click **Modbus RTU Slave** in the **Operating Mode** drop down menu. The Modbus slave device ID is configured by clicking Modbus in the project tree (see the next section).

Modbus configuration

The 415U-2 provides Modbus TCP client/server and Modbus RTU master/slave functionality for I/O transfer. Modbus TCP client, Modbus RTU master, and Modbus TCP server/RTU slave can all be supported simultaneously. When combined with the built-in Modbus TCP-to-RTU converter, the 415U-2 can transfer I/O to and from almost any combination of Modbus TCP or RTU devices.

The 415U-2 has predefined data areas for inputs and outputs and the different I/O types (bits, words, long, floats, and so on), which include the onboard input/outputs and are shared for both client and server. For a full list of the available I/O and address locations see .

To change Modbus configuration parameters, click **Modbus** in the project tree. The Modbus configuration screen (**Figure 61**) is arranged in tabs. The main tabs are:

- **Modbus TCP Server and RTU Slave**—Used for configuring Modbus TCP Server or RTU Slave parameters.
- **Modbus TCP Client and RTU Master**—Used for any Modbus TCP Client and Modbus RTU Master Configuration parameters.

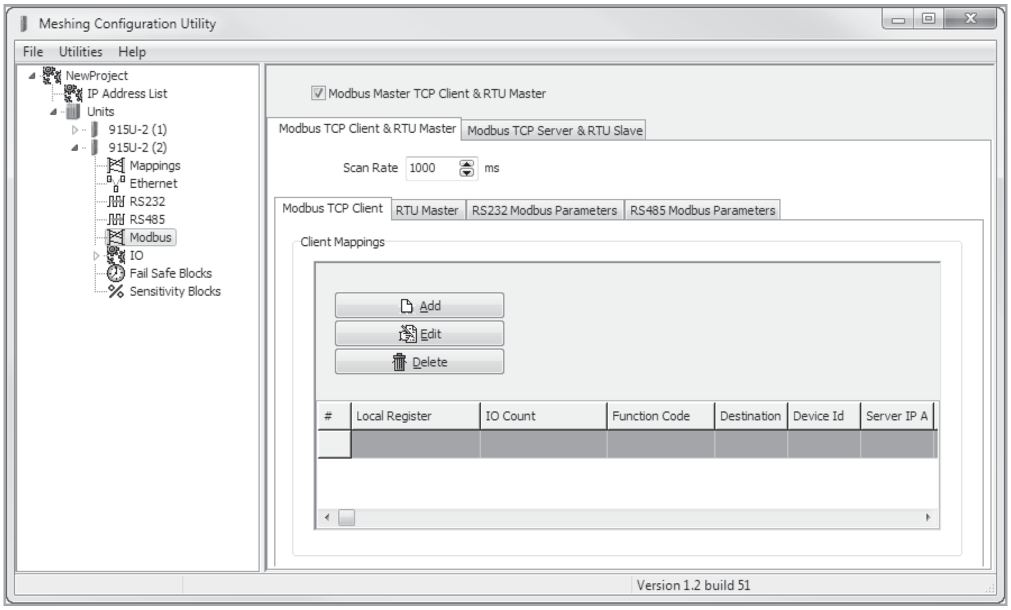


Figure 61. Modbus configuration

Modbus Master TCP Client and RTU Master	Used to enable the Modbus master TCP client and RTU master. When this is disabled the screen appears as in **Figure 62**.
Scan Rate	Allows you to adjust the Modbus polling scan rate. The scan rate is the delay between the completion of one request and the initiation of the next request.

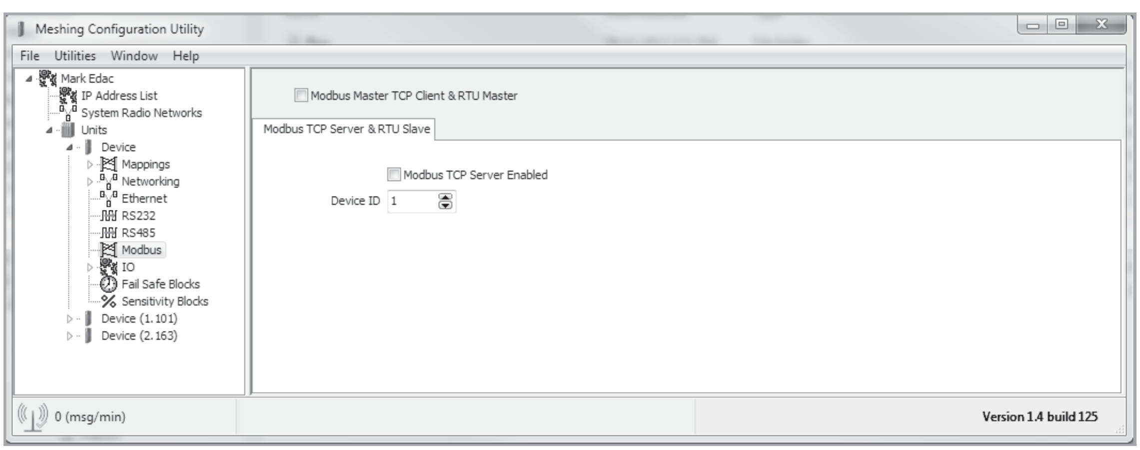


Figure 62. Modbus master TCP client and RTU master disabled

Modbus TCP server and RTU slave tab

Click this tab in the Modbus configuration screen to change parameters for the Modbus TCP server or RTU slave (see **Figure 63**).

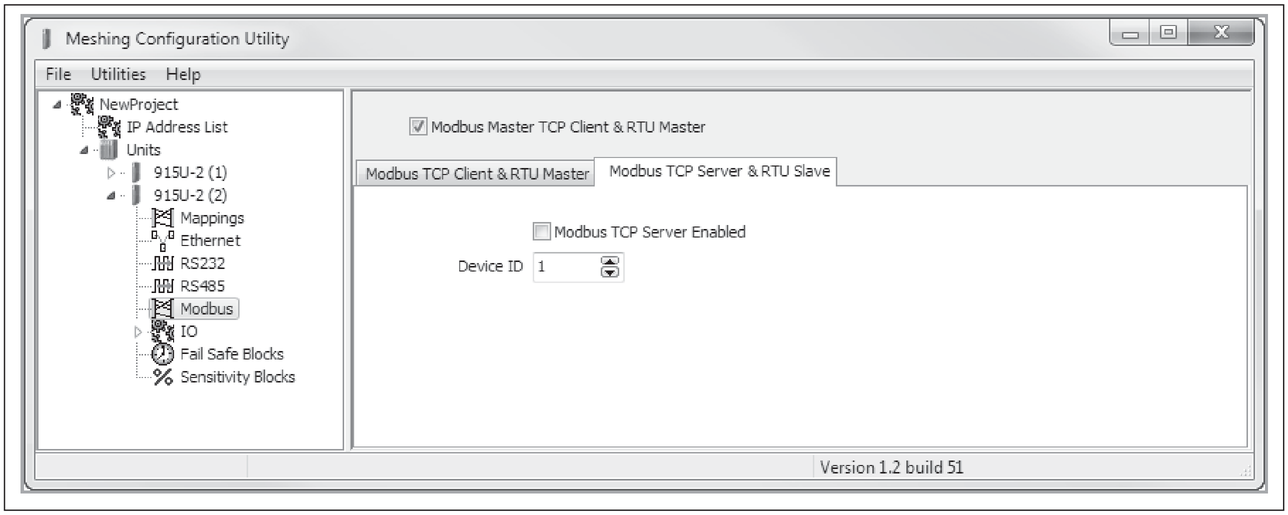


Figure 63. Modbus TCP server and RTU slave tab

Modbus TCP Server enabled	Allows the 415U-2 to accept connections from one or more Modbus TCP clients via Ethernet or RTU masters via the RS-485 or RS-232 serial interfaces. All Modbus transactions routed to the on-board Modbus TCP server/RTU slave are directed to/from the on-board general purpose I/O registers. The Modbus TCP server is shared with the Modbus TCP to RTU converter, so that the Modbus device ID is used to determine if a Modbus transaction is to be routed to the on-board Modbus TCP server or to a Modbus RTU device connected to the serial port. Care should be taken to ensure that all serially connected Modbus devices use different device IDs (for example, Modbus slave address), and the device ID is different than the onboard device ID. Up to 32 separate connections to the Modbus TCP server are supported.
Device ID	The device ID for the modules own Modbus server/slave. This is the ID that any external Modbus client or Modbus master would require to allow it to read values from the internal Modbus registers (for example, if a DCS or SCADA computer needs to poll the 415U-2 via TCP or serial connection).

Modbus TCP client and RTU master tab

Click this tab in the Modbus configuration screen to set the Modbus client scan rate, which is common to both the Modbus TCP client and Modbus RTU master (see **Figure 64**). The default rate is 1000 msec. Each mapping is configured with a response timeout, which is the period of time that the master will wait for a response before indicating the failure on the Comms Fail Register.

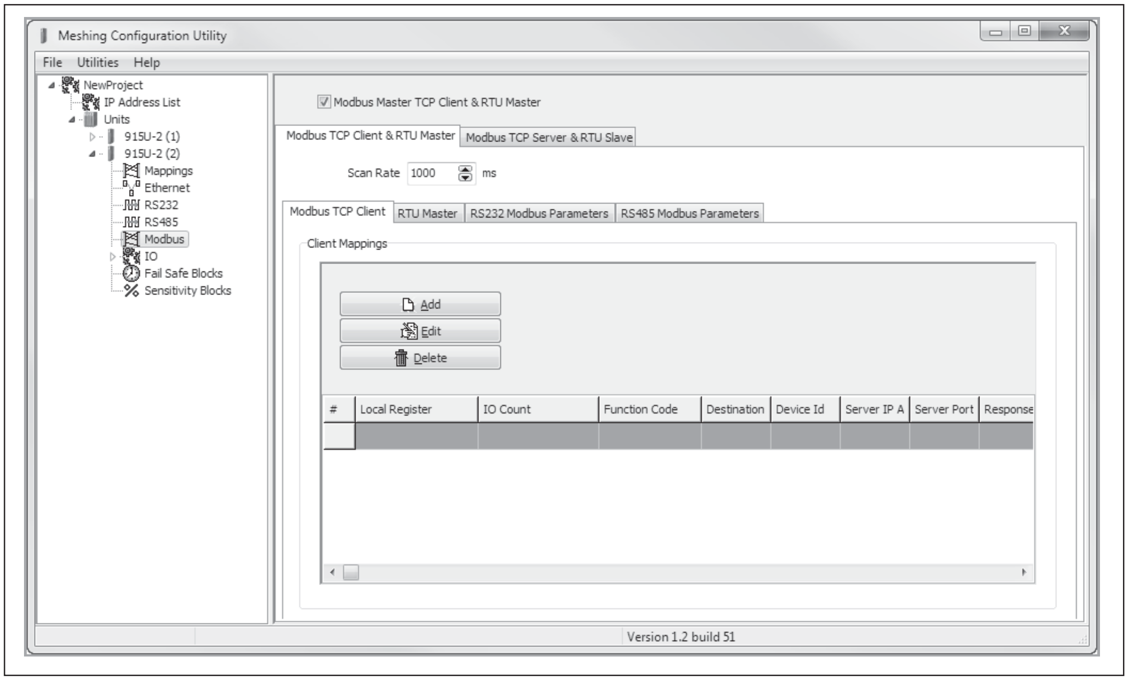


Figure 64. Modbus TCP client and RTU master tab

The Modbus TCP Client and RTU Master tab contains the following subtabs.

Modbus TCP Client	Allows you to configure the Modbus client mappings to communicate with remote TCP devices. Modbus TCP client functionality allows connections to a maximum of 24 different Modbus TCP servers, and up to 100 mappings can be configured. For more information, see "Adding mapping parameters" on **page 43**.
RTU Master	Allows you to configure Modbus RTU mappings to communicate with remote serial Modbus devices. For more information, see "Adding mapping parameters" on **page 43**.
RS-232 Modbus Parameters	Shows the configuration parameters for RS-232 ports. See "RS-232/RS-485 Modbus parameters" on **page 45**.
RS-485 Modbus Parameters	Shows the configuration parameters for RS-485 ports. See "RS-232/RS-485 Modbus parameters" on **page 45**.

All Modbus mappings are directed to and from the onboard I/O registers, depending on configuration (see the following section). The Modbus TCP client can poll Modbus TCP servers on the local Ethernet network.

Adding mapping parameters

Before adding or modifying a module's TCP or RTU mappings, make sure that the Modbus Master TCP Client and RTU Master checkbox is selected at the top of the Modbus configuration screen (see **Figure 64**). Click the Modbus TCP Client or the RTU Master subtab, depending on the connected device. Then, click **Add** to add a new mapping, **Edit** to edit a selected mapping, or **Delete** to delete a selected mapping. Clicking Add or Edit displays the screen in **Figure 65**, where you can specify mapping parameters.

Both Modbus TCP client and RTU master mappings have similar parameters, the only difference will be the slave communication path. For example, Modbus TCP client mappings will use a network address and port while RTU master mappings will use a serial port.

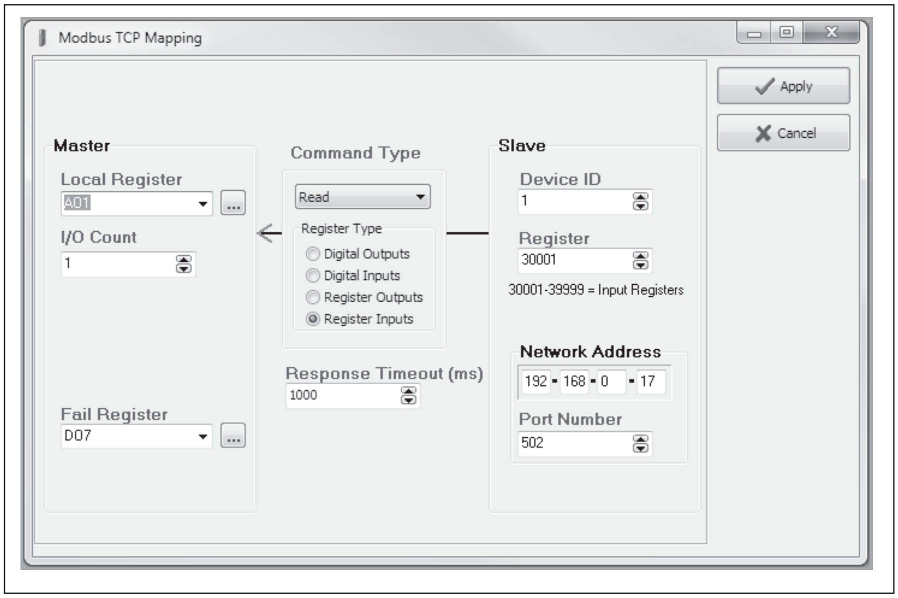


Figure 65. Modbus TCP client mapping

Local Register (Master)	When the Function Code Modbus command is "Read" the Local Register field will be the destination register(output location) on the local device. When the Function Code command is"Write" the Local Register field will be the originating register (input location) on the local device.
I/O Count	The number of consecutive I/O values in the mapping.
Function Code (Command Type)	The Function Code Modbus command determines if the command will be "Read" or "Write" and what type of register will be used. When entering a mapping, you need to select "Read" or "Write" from the drop-down list in the Command Type field, and then select one of the four radio buttons representing the register types. Selecting the register type will change the Destination (slave) register address range to a suitable range.
Destination Register (Slave)	The register location on the TCP server/RTU slave device. The register selection offered will be appropriate for the Modbus command selected in the Command field.
Device ID	The unit address (device ID) of the Modbus TCP server or Modbus RTU slave.
Server IP Address Network Address	(TCP client only.) The IP address of the Modbus TCP server.
Server Port (TCP Client only)	The server port of the slave device, Modbus TCP will usually be the standard port address of 502.
Serial Port (Modbus RTU only)	This is the serial port used to connect to the device. Select the port from the drop-down list.
Response Time	The amount of time the TCP client or Modbus master waits for a response from a TCP server or an RTU slave device before registering a Communications Fail.
Fail Reg	The Comms Fail indication register can be a physical output, such as DIO #1–8 (Reg 1-8), which will turn on a digital output when in fail. It can also be configured as an internal holding register (Reg 30501), which will show the fail indication as well as any Modbus error codes. This is useful for diagnosing communication problems. For Modbus error code descriptions, see "Modbus error codes" on **page 84**.

Modbus TCP mapping examples

In the example in **Figure 66**, the first mapping (#1) shows the Modbus client (master) is configured to read analog values from a device connected on the LAN. The mappings function code is "Read" and is reading a count of four values (analogs) from the Ethernet address 192,168.0.17, device ID #10, starting at address 30001, and then writing these values into its own local registers, starting at 40501. The server port is 502, which is a standard Modbus TCP port address. If the mapping fails to communicate to the TCP server, it will write a value of "1" into local register 508, indicating a communications failure.

#	Local Register	IO Count	Function Code	Destination	Device Id	Server IP Address	Server Port	Response Timeout	Comm Fail Register
1	10501	1	Read	1	1	192.168.0.17	502	1000	DO8
2	AO1	1	Read	30001	1	192.168.0.17	502	1000	DO7
3	10502	1	Read	10001	1	192.168.0.17	502	1000	DO6
4	AO2	1	Read	40001	1	192.168.0.17	502	1000	DO5
5	10503	1	Read	10001	1	192.168.10.101	502	1000	DO4
6	10504	1	Read	10001	2	192.168.10.101	503	1000	DO3

Figure 66. Modbus TCP mapping table

The second mapping (#2) shows something similar, but instead of analog values, the values are digital. The Function code is "Read" from IP address 192.168.0.17 and device ID #10. It will read eight values starting from address 10001, and write them to the local address, starting at 501. Again, it is using the same server port of 502. If the mapping fails to communicate to the TCP server, it will write a value of "1" into local register 507, indicating that mapping failed to communicate.

The third mapping (#3) is similar to the second mapping, but instead of reading from the local Ethernet subnet (LAN) it is reading from an IP address on the radio network (another 415U-2 module). The Function code is "Read" from IP address 192.168.10.101 and device ID #1. It will read four values, starting from address 10001, and write them to the local address, starting at 509. A Comms Fail register is configured at local register 506.

The fourth mapping (#4) is configured to write the values from the local analog input #1 and #2 across to a TCP server at IP address 192.168.0.17. It will write the values into the destination address 40001 and 40002 at device ID of 10. It is using the TCP server port 502 and is configured with a response time of 1000 msec. If it fails to communicate, it will turn on local register 505.

Modbus RTU master

Modbus RTU functionality allows connections to Modbus RTU slave devices via the RS-232 or RS-485 ports. Up to 100 mappings can be configured. All Modbus mappings are directed to or from the onboard I/O registers depending on the configuration (described below). The Modbus RTU master polls the slave devices via the serial port configured in the mappings.

Modbus RTU (serial) devices can also be polled if connected to remote 415U-2 serial ports. To enable this feature the remote 415U-2 serial port must be set to "Modbus RTU Master" mode and the TCP mappings must reflect the correct server IP address and port number of the remote 415U-2. Polling TCP servers or RTU slaves over the radio network will greatly increase radio communications and is not recommended for busy systems.

Example

The Modbus RTU mapping is very similar to the Modbus TCP mapping except that the destination is a serial interface instead of an Ethernet address and port.

In the example in **Figure 67**, the first mapping (#1) shows a read mapping from a serial device connected on the RS-485 port with a device ID of 5. It is reading one I/O point, starting at remote address 30001, and writing the value into the local address 40501. It is configured with a response timeout of 1000 msec, and local register 508 will indicate a failure to communicate with this device.

#	Local Register	IO Count	Function Code	Destination	Device Id	Serial Port	Response Timeout	Comm Fail Register
1	40501	1	Read	30001	5	RS485	1000	508
2	501	16	Read	10001	5	RS485	1000	507
3	VBatt	1	Write	40001	6	RS232	1000	506

Figure 67. Modbus RTU example

The second mapping (#2) shows a read mapping from a serial device connected on the RS-485 port with a device ID of 5. It is reading 16 I/O points, starting at remote address 10001, and writing the value into the local address 501. It is configured with a response timeout of 1000 msec, and local register 507 will indicate a failure to communicate with this device.

The third mapping (#3) is a write mapping that will write the local battery voltage (Reg 30007) to register 40001 on a serial device connected on the RS-232 with a device ID of 6. Again, the response timeout is 1000 msec, and it has a communications fail register of 506.

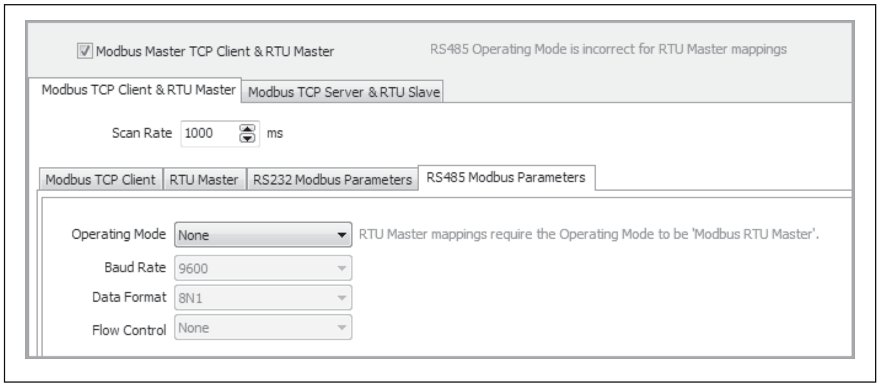


Figure 68. Operating mode error

⚠ **Note**: MConfig will indicate whether the serial port "Operating Mode" is not set, or set to the wrong mode. To change the mode, click the RS-232 or RS-485 Modbus Parameter tab.

RS-232/RS-485 Modbus parameters

The RS-232 and RS-485 Modbus Parameters tabs show the configuration parameters for the RS-232 and RS-485 ports. These parameters are exactly the same as the serial parameters described in "Serial configuration" on **page 38**. These parameters are displayed under the Modbus tab for convenience.

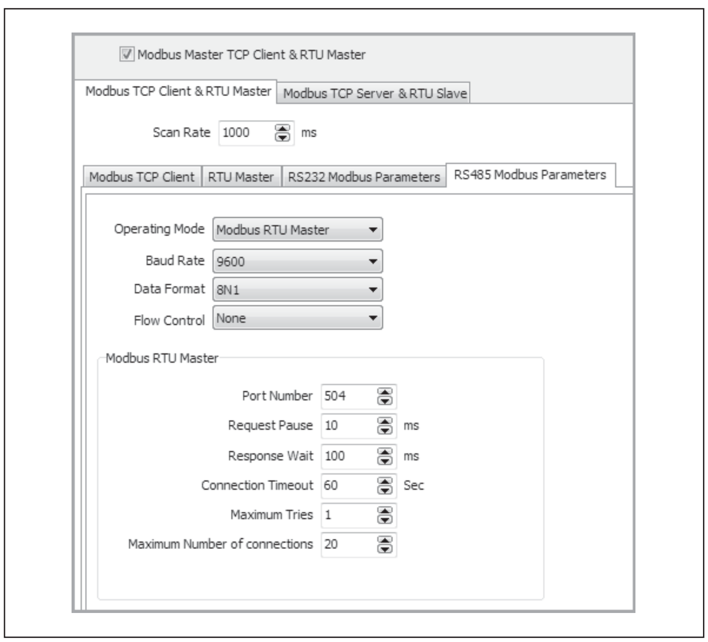


Figure 69. Modbus parameters

DNP3 protocol configuration

The DNP3 protocol is widely used in many industries to provide monitoring and control of remote plants and equipment. You can enable support for DNP3 in 415U-2 version 2.1 modules with the purchase of a feature license key (see "Feature license keys" on **page 60**). This chapter describes how to use the MConfig utility to configure DNP3 settings once you have enabled the DNP3 feature in the 415U-2.

Address configuration

The following are the factory default DNP3 settings for the 415U-2. You may find that you can use these default settings for simple applications without further configuration.

- **Device IP Address**—192.168.0.1xx (xx is the last two digits of the serial number).
- **Master IP Address**—Any (the device accepts connections from any IP address)
- **Connection Mode**—TCP Listen (the master initiates the connection)
- **DNP3 TCP Port**— 20000
- **Device DNP3 Addr**—4 (outstation)
- **Master DNP3 Addr**—3

For most systems, you will only need to enable the DNP3 outstation function and set the outstation DNP3 address and connection type. To access DNP3 configuration, click **DNP3** in the MConfig project tree to display the screen in **Figure 91**.

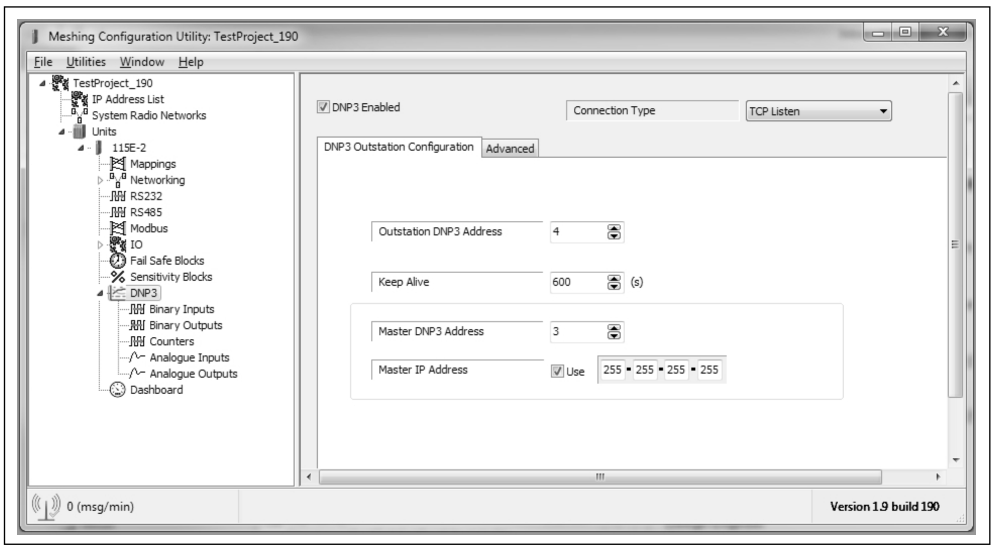


Figure 70. DNP3 address configuration

DNP3 Enabled
: Select this checkbox to enable the DNP3 function. Clear the checkbox to disable DNP3.

Connection Type
: Sets the connection type to match your DNP3 master connection:

UDP—Uses UDP Protocol to communicate with the master.

TCP Listen—(Default) This option uses TCP protocol to communicate with the master. The device waits for a connection from the master.

TCP Dual—Uses TCP protocol to communicate with the master. If the device loses connection it attempts to connect to the master at the configured IP address.

Outstation DNP3 Address
: Sets DNP3 address of this 415U-2 device. Set this address to match the address configured in the DNP3. Valid values are 1–65531.

Keep Alive
: Sets the keep alive time. The outstation (this device) sends a check transmission to the DNP3 master if there is no communication from the master within the keep alive time. To avoid unnecessary check transmissions, set the keep alive time to a longer period than the master poll time.

⚠ **Note**: If you are using a TCP connection, this parameter controls how long the outstation waits before it resets its TCP connection after the link is lost. If the master station drops its TCP connection through lost communications it cannot reconnect to the device until this timeout is completed. Setting the keep alive to a short time reduces the time to re-establish a connection. However, it also increases the number of check transmissions from outstations. For large networks with limited bandwidth, we recommend using the UDP connection type with a keep alive time that is longer than the master poll time.

Master DNP3 Address
: Sets the DNP3 address of the master station that will control the 415U-2 device.

Master IP Address	Sets the IP address of the DNP3 master station. You do not need to set this parameter if the Connection Type is set to TCP Listen because the device will accept connections from any DNP3 master station with the address you specified in the Master DP3 Address field. If you are using TCP Listen and do not want to select a DNP3 master IP address, clear the Use checkbox to disable the Master IP Address. The Master IP Address parameter is required if the Connection Type is set to UDP or TCP. ⚠ **Note**: You also need to set the devices IP address to match the requirements of your system. For more information, see “Address configuration” on **page 46**.

Advanced port settings

DNP3 protocol typically uses TCP and UDP port number 20000 for all communications. You may need configure nonstandard port numbers to match the requirements of your system.

To configure DNP3 ports, click DNP3 in the project tree and then click the Advanced tab.

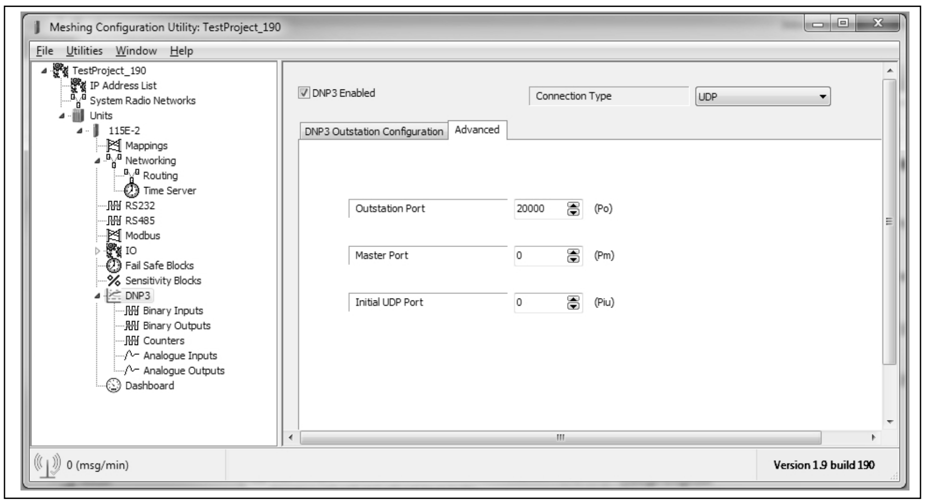


Figure 71. DNP3 advanced port settings

Outstation Port	Sets the TCP or UDP port number to use for the DNP3 outstation (this device). The standard port number for DNP3 is 20000. You only need to change this if your system uses a non-standard port number.
Master Port	Sets the TCP or UDP port number of the master station. If the Connection Type is set to UDP or TCP Dual, you need to set this value to the port number that the DNP3 master uses to receive incoming connections. This parameter is not available if the Connection Type is set to TCP Listen.
Initial UDP Port	Sets the UDP port that the remote station uses to send UDP messages to the master station before there is a connection from the master station. This parameter is only available when the Connection Type is set to UDP.

I/O configuration

You can change the way that I/O data is reported by the 415U-2 DNP3 outstation. By default, all the on-board I/O report as polling class 0 only (integrity poll). To enable event reporting of the I/O, you need to configure the I/O polling class. You may also want to change the dead band parameter for analog and counter inputs, and scaling for analog inputs and for analog outputs.

To configure a DNP3 I/O, click the I/O type under **DNP3** in the project tree. There are five supported I/O types:

- Binary Inputs
- Binary Outputs
- Counters
- Analog Inputs
- Analog Outputs

⚠ **Note**: The 415U-2 has a large number of registers that are not listed in the I/O configuration. By default, only physical I/O points can be accessed from the DNP3 master. You can add additional registers to the DNP3 point list by adding entries to the appropriate I/O configuration section.

When you add 115S Expansion I/O modules to a 415U-2 device configuration, the I/O of the 115S device are automatically added to the DNP3 I/O list. You can add 115S expansion I/O devices by clicking IO in the MConfig project tree. For more information, see “Adding an expansion I/O to MConfig” on **page 33**.

Every DNP3 I/O needs to be configured with a polling class and register number:

- **Polling Class**—The following options are available for polling class:
  - **No Class**—Points with this class can only be retrieved via an explicit read from the master. They are not reported in response to class polls from the master
  - **Class 0**—Points with this class have their current value reported in response to a class 0 poll from the master (integrity poll). No events are recorded for this class.
  - **Class 1, Class 2, Class 3**—Points in these classes are reported to the master station with time-stamped events in response to a corresponding poll from the master. Additionally, they have their current value reported in response to a class 0 poll in the same manner as for points configured with polling Class 0.

- **Register Number**—The register number relates the DNP3 I/O point to the register location within the device. You can determine the DNP3 point index of an I/O point by subtracting the base register number for that type of register. For example, the DNP3 point index for analog input #4 (register number 30004) is 30004 – 30001 = 3.

Register type	Base index
Binary Input	10001
Binary Output	1
Counters	36001
Analog Input	30001
Analog Output	40001

Binary inputs and binary outputs

You can select which discrete input registers and output registers appear in the DNP3 point list. Discrete inputs appear in the 415U-2 memory map in the range 10001–19999. Discrete outputs are in the 415U-2 memory map in the range 1–9999. Use the Add, Edit, and Delete buttons to edit the list.

To configure binary inputs or binary outputs, click the option under DNP3 in the project tree.

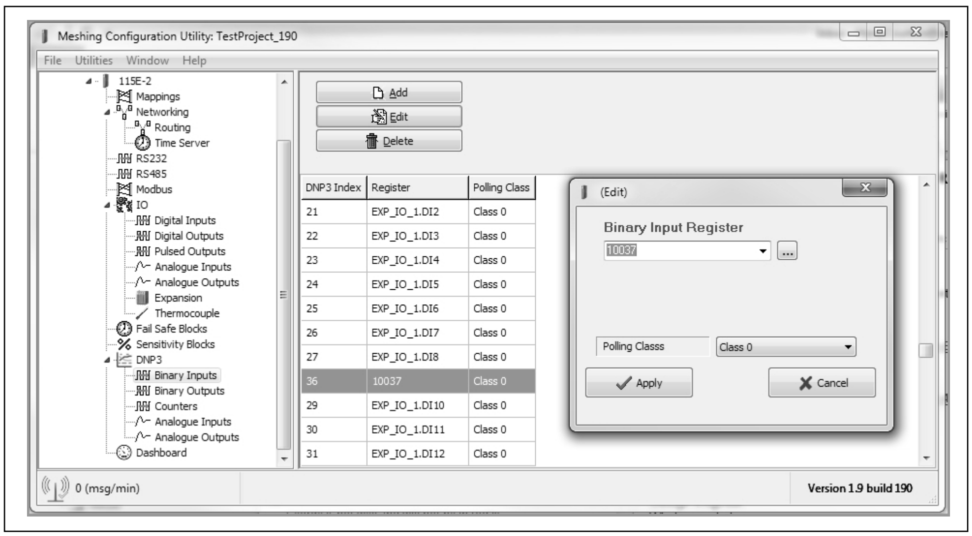


Figure 72. Binary inputs and binary outputs

DNP3 Index	This is the DNP3 point index used to access the I/O data from the DNP3 master device.
Register	The I/O point register in the 415U-2 device. For a detailed description, see “I/O configuration” on **page 47**. Select the register by name from the drop-down menu in the Edit dialog box, or click the ... button to list all registers by number.
Polling Class	See “I/O configuration” on **page 47**.

Counter inputs

Counter inputs appear in the 415U-2 address map in the range 36001–37999. Configure counter inputs in the DNP3 point list the same as you would digital inputs and digital outputs. For counters, you need to specify a dead band parameter in addition to a register number and polling class.

To configure counter inputs, click the Counters option under **DNP3** in the project tree.

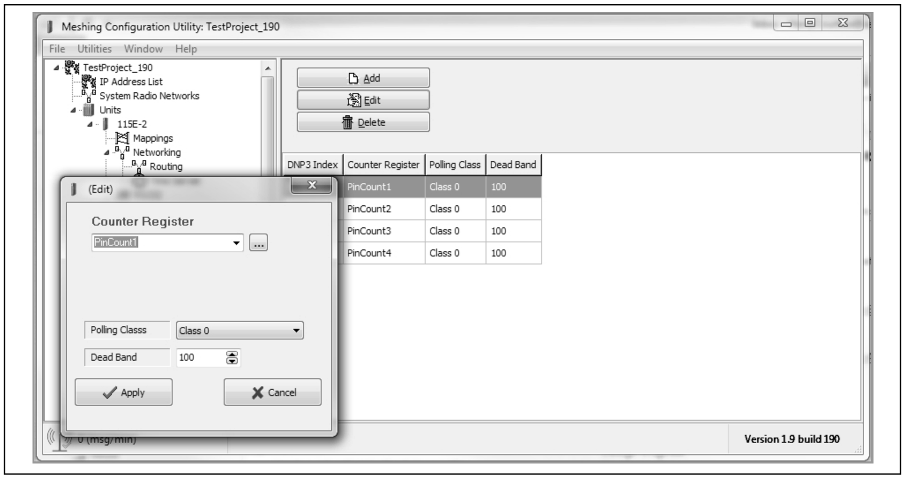


Figure 73. DNP3 counters

DNP3 Index	This is the DNP3 point index used to access the I/O data from the DNP3 master device.
Counter Register	The I/O point register in the 415U-2 device. For a detailed description, see "I/O configuration" on **page 47**. Select the register by name from the drop-down menu in the Edit dialog box, or click the [...] button to list all registers by number.
Polling Class	See "I/O configuration" on **page 47**.
Dead Band	The dead-band value limits the number of DNP3 event reports generated by the counter input when the counter is configured in polling class 1, 2, or 3. Once the counter generates a change event, no additional events are generated until the counter value has changed by more than the dead-band value.

Analog inputs

The configuration for analog inputs defines how change events are reported (dead band) and how the value is scaled when it is reported. The dead-band value limits the number of event reports generated by the analog input when the input is configured in polling class 1, 2, or 3. Once the analog input generates a change event, no additional events are generated until the register value has changed by more than the dead-band value.

To configure how a DNP3 variable is scaled, you can select from a list of commonly used scaling values or configure your own custom scaling by entering two reference points. A graph provides feedback on the configured scaling and the configured dead band (see **Figure 74**).

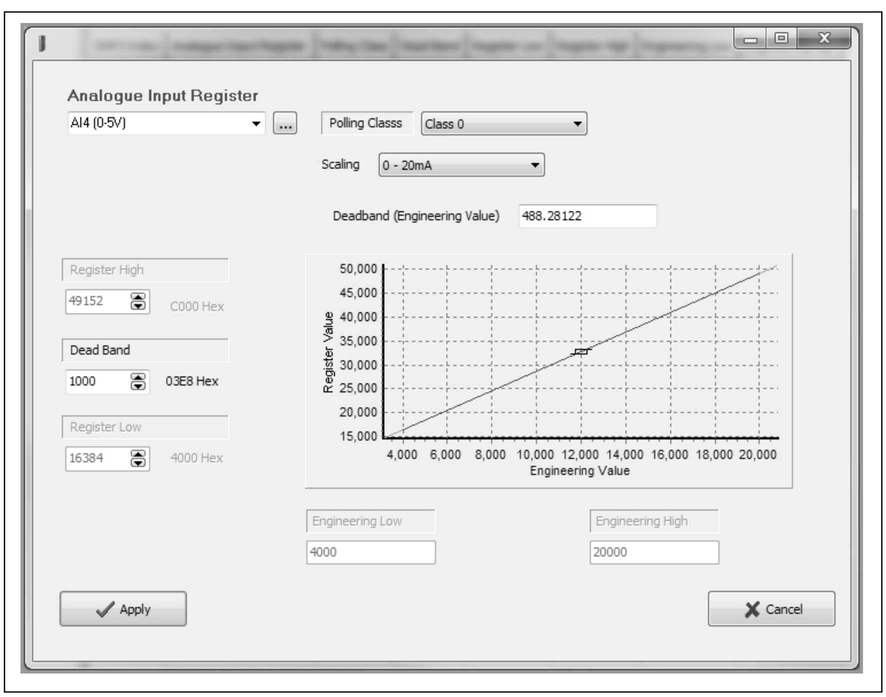


Figure 74. DNP3 analog inputs

Analog Input Register

The I/O point register in the 415U-2 device. For a detailed description, see “I/O configuration” on **page 47**. Select the register by name from the drop-down menu in the Edit dialog box, or click the ... button to list all registers by number.

Polling Class

See “I/O configuration” on **page 47**.

Scaling

Select automatic scaling to match the available input types or select custom scaling if you want to report data in your system engineering values.

0–20 mA—Use this scaling to report the value from a 0–20 mA analog input such as analog inputs 1–4 in current mode. The value is reported in microamps (20 mA reports in DNP3 as 20,000 µA).

0–5 V—Use this scaling to report the value from a 0–5 V analog input such as analog inputs 3 and 4 when used in voltage mode. The value is reported in millivolts (5 V reports in DNP3 as 5,000 mV).

0–20 V—Use this scaling to report the value from a 0–20 V analog input such as analog inputs 1 and 2 used in voltage mode. The value is reported in millivolts (5 V reports in DNP3 as 5,000 mV).

0–40 V—Use this scaling to report a value from a supply voltage input, such as battery voltage or supply voltage. The value is reported in millivolts (24 V reports in DNP3 as 24,000 mV)

⚠ **Note**: When reading this value as a DNP3 integer value, it will not measure voltages above 32.768 V since the integer value is limited to a maximum of 32768.

0–100 Hz—Use this scaling for pulse rate inputs configured for full-scaled to 100 Hz.

No Scaling—Use this option when you want DNP3 to report the raw register value without any scaling.

Custom—Use this option to apply custom scaling. Select the scaling option closest to the desired scaling, then select Custom, and enter values for Register High, Register Low, Engineering High, and Engineering Low fields described below.

⚠ **Note**: If you change the device’s analog input scaling using the I/O option in the project tree, it will affect the scaling of DNP3 analog input points. The DNP3 values are derived by applying this scaling to the register values after they are scaled by the device’s analog scaling.
For more information on analog input scaling, see “Analog inputs” on **page 30**.

Dead Band

The dead-band value for the analog input, expressed as a desired change in the register value. The dead-band value limits the number of event reports generated by the analog input when the input is configured in polling class 1, 2, or 3. Once the analog input generates a change event, no additional events are generated until the register value has changed by more than the dead-band value.

Dead Band (Engineering Value)

The dead-band value for the analog input, expressed as a desired change in the measured value. Changes to this field are reflected in the Dead Band field described above. You can edit either of these fields to set the dead band.

Register Low

The register value for the first reference point. Default scaling on 4–20 mA analog inputs sets this to 16384 for 4 mA input current, and 49152 for 20 mA input current.

Register High

The register value for the second reference point.

Engineering Low

The desired DNP3 value for the first reference point. Default scaling results in voltages being reported in mV, and currents being reported in microamps.

Engineering High

The desired DNP3 value for the second reference point.

Analog outputs

The configuration for analog outputs defines any additional scaling that must be applied to the DNP3 value to set the correct register value. You can select default scaling to suit most applications, or configure custom scaling for the analog output if you need the value scaled to particular engineering units. A graph provides feedback to show the configured scaling (see **Figure 75**).

Physical analog outputs generate 4 mA for a register value of 16384, and 20 mA for a register value of 49152. The default scaling allows the DNP3 values to be sent as a µA value. For example, a DNP3 value of 4000 results in 4 mA; a DNP3 value of 20000 results in 20 mA output current.

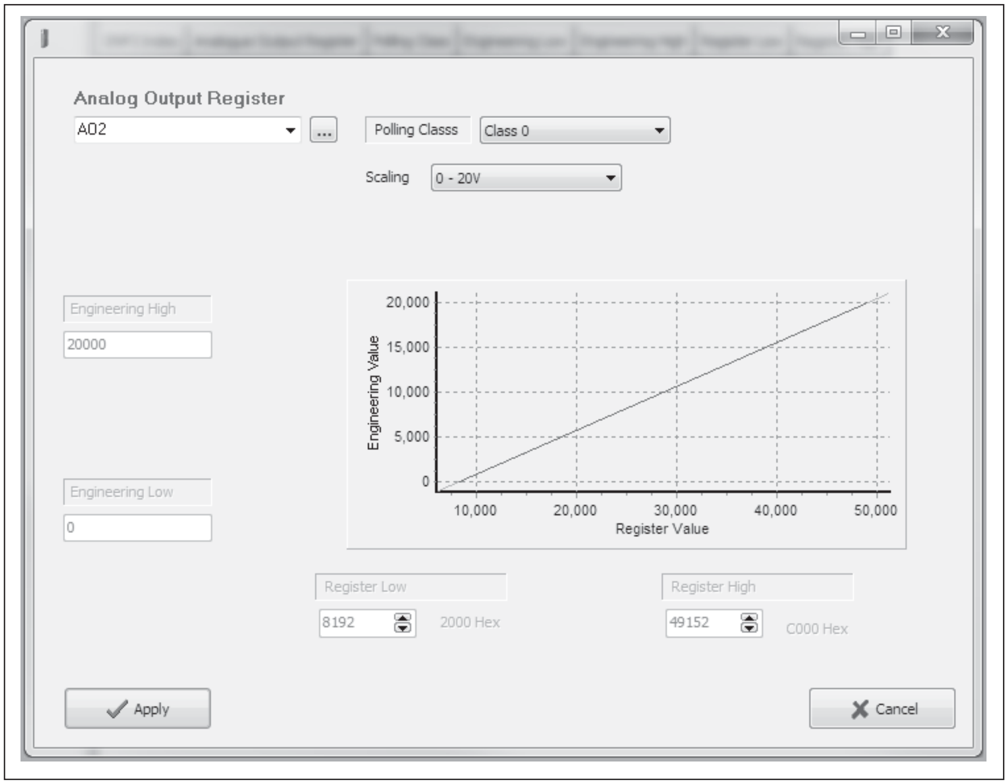


Figure 75. DNP3 analog outputs

Analog Output Register	The I/O point register in the 415U-2 device. For a detailed description, see "I/O configuration" on **page 47**. Select the register by name from the drop-down menu in the Edit dialog box, or click the ... button to list all registers by number.
Polling Class	See "I/O configuration" on **page 47**.
Scaling	Select automatic scaling to match the available output types, or select custom scaling if you want to report data in your system engineering values. **0–20 mA**—Use this scaling to send the value from a 0–20 mA analog output such as analog outputs 1 and 2. The value is set in microamps. Set the DNP3 register to 20,000 in order to set the output to 20 mA (or 20,000 µA). **0–5 V**—Use this scaling to report the value from a 0–5 V analog input such as analog Inputs on 115S-13 configured for 0–5 V mode. **No Scaling**—Use this option when you want to write the raw register value from the DNP3 master without any scaling. **Custom**—Use this option to apply custom scaling. Select the scaling option closest to the desired scaling, then select Custom, and enter values for the Register High, Register Low, Engineering High, and Engineering Low fields described below.
Engineering Low	The DNP3 value for the first reference point. When this value is written by the DNP3 master, the 415U-2 register receives the value in Register Low.
Engineering High	The DNP3 value for the second reference point. When this value is written by the DNP3 master, the 415U-2 register receives the value in Register High.
Register Low	The register value set in the 415U-2 for the first reference point. The 415U-2 memory register receives this value when the DNP3 master writes the value listed in Engineering Low.
Register High	The register value for the second reference point, corresponding to the DNP3 value in Engineering High.

Web-based configuration utility

The 415U-2 module provides an embedded Web-based configuration utility. This section focuses on configuration and management tasks that can only be performed using the Web-based configuration utility. Use this utility to manage wireless connection links between all 415U-2 modules in the system through a standard browser, such as Microsoft® Internet Explorer®. The Web-based configuration utility supports Internet Explorer version 8.0 or later. For all other configuration tasks, we recommend using the MConfig utility for ease of use. MConfig is described in "MConfig utility" on **page 14**.

Connecting and logging on

The default IP address, subnet mask, gateway, username, and password for the 415U-2 module are as follows:

- **IP Address:** 192.168.0.1XX (shown on the printed label on the side of the module)
- **Subnet Mask:** 255.255.255.0
- **Default Gateway:** 192.168.0.1
- **Username:** user
- **Password:** user

Use these steps log on to the Web-based interface:

1. Follow the steps in "Connecting to the module" on **page 14** to connect the PC to the module.
2. Open Internet Explorer on the PC.
3. Type "http://" followed by the IP address of the module, and then press **Enter**.
4. If the PC uses a proxy server, ensure that Internet Explorer will bypass the proxy server for local addresses.
   This option may be modified by opening **Tools** ->**Internet Options** ->**Connections Tab** -> **LAN Settings** -> **Proxy Server** -> bypass proxy for local addresses.
5. Type the username and password. The home page appears (**Figure 78**).

⚠ **Important**: Remember to set DIP switch #6 to "off" and power cycle the module to return to normal operation after you have completed configuration. Otherwise, the module will continue to boot into the default IP address.

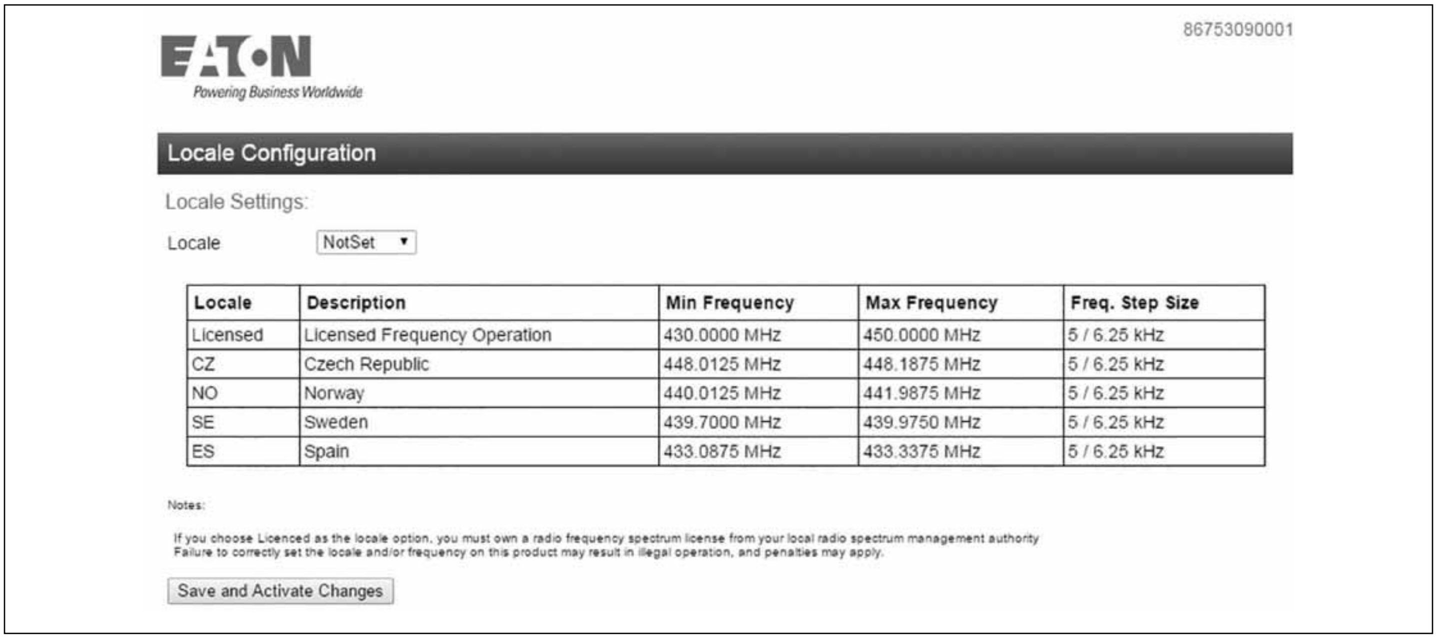
Configuring the locale

When the 415U-2 module is shipped from the factory, the radio is not configured. At power-up, the OK LED will glow RED to indicate that the device is not configured. The radio will not send any transmissions until the initial provisioning has been completed.

To configure the device's radio for the first time, you must configure the radio Locale and radio Quick Start to set the radio to meet regulations at its target location.

The Locale only needs to be set when the device is first configured from the factory. The Quick Start screen is available at any time to change the device's radio configuration.

Connect to the device using Ethernet or USB connection. See "Connecting and logging on" on **page 52** for instructions to connect to the module.


86753090001

Powering Business Worldwide

Locale Configuration

Locale Settings:

Locale NotSet

Locale	Description	Min Frequency	Max Frequency	Freq. Step Size
Licensed	Licensed Frequency Operation	430.0000 MHz	450.0000 MHz	5 / 6.25 kHz
CZ	Czech Republic	448.0125 MHz	448.1875 MHz	5 / 6.25 kHz
NO	Norway	440.0125 MHz	441.9875 MHz	5 / 6.25 kHz
SE	Sweden	439.7000 MHz	439.9750 MHz	5 / 6.25 kHz
ES	Spain	433.0875 MHz	433.3375 MHz	5 / 6.25 kHz

Notes:

If you choose Licenced as the locale option, you must own a radio frequency spectrum license from your local radio spectrum management authority
Failure to correctly set the locale and/or frequency on this product may result in illegal operation, and penalties may apply.

Save and Activate Changes

Figure 76. Locale configuration

The available options for the device's operating locale on this screen will depend on the exact radio device you have chosen. Different devices support radio operation on different unlicensed bands. Refer to the appendix for a list of supported Locales for each radio type.

If you intend to use the device in unlicensed operating mode, select the appropriate Locale name from the table (e.g. one of CZ, NO, SE, ES in the example above).

⚠ WARNING

USE OF UNLICENSED BANDS IS LIMITED TO THE LISTED PHYSICAL LOCALES ONLY. ENSURE YOU SELECT A LOCALE THAT IS ALLOWED BY THE RADIO REGULATORY AUTHORITY IN YOUR TARGET LOCATION.

If you intend to use the device in Licensed operating mode, select the "Licensed" Locale. This gives access to the full radio band available to the module.

⚠ WARNING

WHEN YOU SELECT "LICENSED" LOCALE, YOU MUST HAVE A RADIO LICENSE FROM THE RADIO REGULATORY AUTHORITY IN YOUR LOCATION. THIS LICENSE WILL BE FOR A SINGLE FREQUENCY OR A RANGE OF FREQUENCIES. ENSURE THE RADIO IS CONFIGURED FOR A PROPERLY LICENSED FREQUENCY (REFER FOLLOWING SECTION) BEFORE TRANSMITTING.

⚠ **Note**: Once the Locale is set this screen will not be displayed again. To set the device to a new locale, you must perform a Factory Default Configuration (Available under the System Tools menu item).

Once you have completed the Locale configuration, press the "Save and Activate Changes" button to progress to the next stage. You will be taken to the Quick Start page. You need to configure the items on the quick-start page before the radio will operate.

Quick start—basic device configuration

This page allows you to configure everything required to setup basic radio communication with the device. You can return to this configuration page at any time by selecting "Quick Start" from the device's main menu.

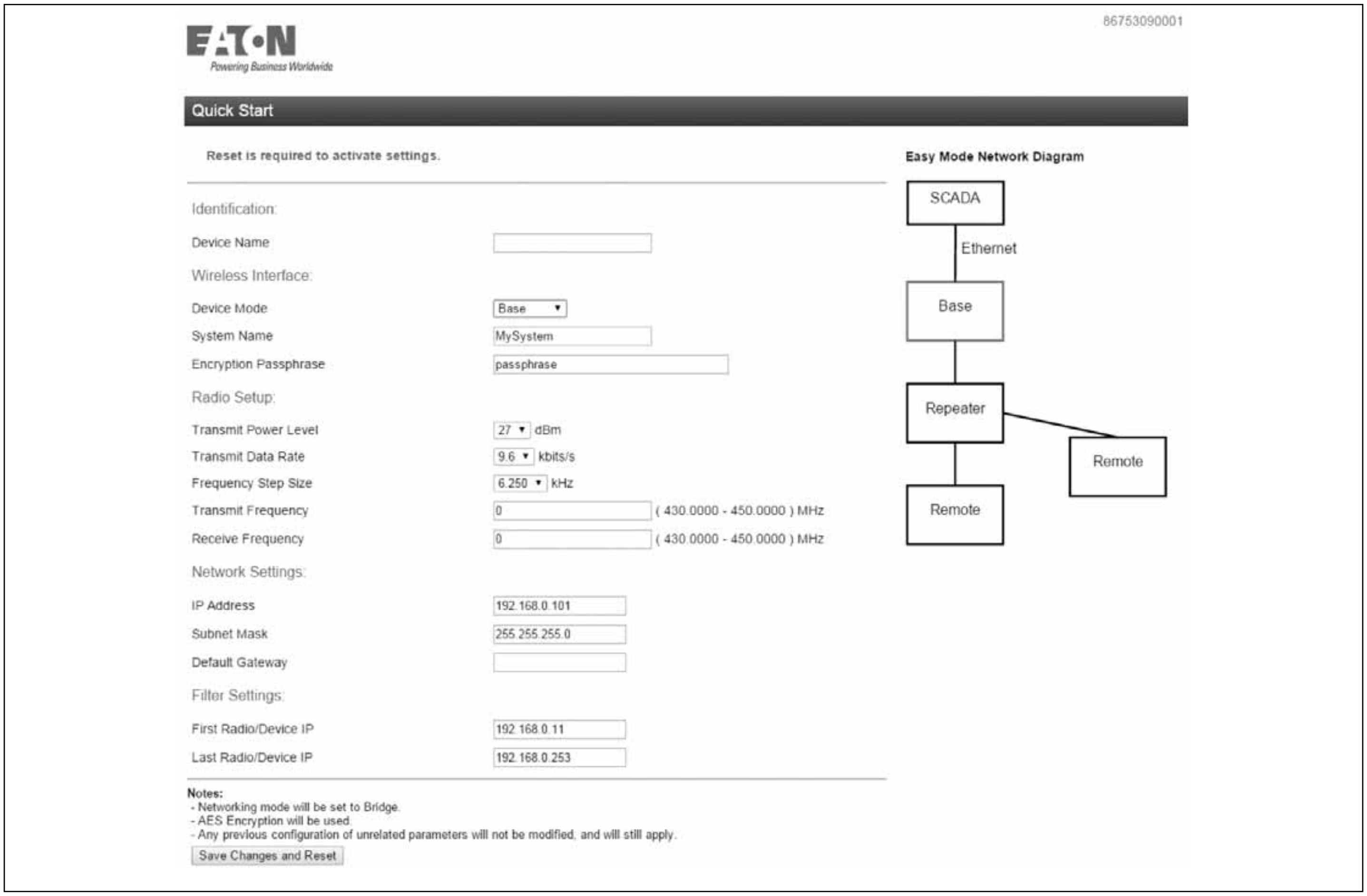


Figure 77. Quick start configuration

Follow the guide below to configure your device.

Wireless networking configuration

These items configure the device's networking setup. Values that you enter here determine how devices will connect and communicate through the network.

Device Name:	This is a unique name for the individual device. Each device in the system should have a unique name. This needs to be unique so for network formation and to allow you to identify devices when performing diagnostics.
Device Mode:	This selects the device operating mode. For most applications, select one of Base, Repeater, or Remote. These correspond to the roles in the image on the right of the screen. For advanced applications with unusual connectivity requirements, you can select "Manual" mode for additional networking options. Normally a system will consist of a single "Base", zero or more "Repeater"s and multiple "Remote"s.
System Name:	This is a name common to every device in the system. This allows Remotes to be configured to connect to any device in the system.
Encryption Passphrase:	This passphrase sets the Encryption used by all devices. Encryption is set to AES256 bit by default. All devices in the system must be configured with the Encryption Passphrase.
Upstream Device Name:	(Repeater and Remote Device mode only) This option configures networking when the Device Mode is set to "Repeater" or to "Remote". This selects how the device will connect to the network. The Upstream device name is the name of the device closer to the Base. For devices that will connect directly to the Base, the upstream device name is the name for the Base station. For devices that connect to a repeater, the upstream device name is the name for that repeater station.

802.11 Mode: (Manual Device Mode Only) This option configures additional networking when the device mode is set to "Manual". Select "Access Point" for a central 802.11 Access Point, or "Client (Station)" for a remote.

System Address (ESSID): (Manual Device Mode Only) This option configures additional networking when the device mode is set to "Manual". Client stations will attempt to connect to an Access Point with matching ESSID/System Address.

⚠ **Note**: Configuring Manual mode requires understanding of 802.11 networking concepts. For the majority of applications, you will select one of the other operating modes.

Radio configuration

These items configure the physical radio setup. Values that you enter here are determined by your radio system design.

Transmit Power Level: This selects the transmitter power level. The transmit power level is displayed in dBm. The options here will be limited by the capabilities of your radio model, and by any restrictions for the locale selection you made during Locale configuration. Normally you will select the highest available power level.

⚠ **Note**: If you are using high gain antennas, you may need to select a lower power level to remain inside the restrictions of your radio license, or within the requirements for unlicensed operation within your target locale.

Transmit Data Rate: You have two options here, depending on your radio bandwidth. For 25 kHz bandwidth radios, the options are 9600 baud and 19,200 baud. For 12.5 kHz bandwidth radios, the options are 4800 baud and 9600 baud. You should select the higher baud rate whenever you expect a signal strength of more than –90 dBm. For long marginal radio paths, you can select the lower baud rate, while keeping other radios in the system set to the higher baud rate.

Frequency Step Size: This allows you to adjust the radio's frequency step. This should normally be set to 6.25 kHz. Some countries' Licensing rules require frequencies to be on 10 kHz or 20 kHz boundaries. In these cases, you should select 5 kHz to achieve the desired frequency.

Transmit Frequency: This is the radio's transmit frequency, in MHz. The number will be automatically rounded to the closest available frequency based on the Frequency Step Size you selected.

Receive Frequency: This is the radio's receive frequency, in MHz. The number will be automatically rounded to the closest available frequency based on the Frequency Step Size you selected.

⚠ **Note**: For Unlicensed systems, the transmit and receive frequencies will normally be the same. Many licensed systems require transmitting and receiving on a pair of frequencies. For these systems, you need to make sure that the Transmit frequency is the same as the receive frequency of the upstream device (Base or Repeater), and that the receive frequency matches the transmit frequency of the upstream device.

Network settings

Values that you enter here configure the Device's IP networking operation, and how it connects to other IP networking devices.

IP Address: This is the IP address you use to access the 415U-2 device. This IP address is part of the same sub-net as the Ethernet network.

⚠ **Note**: The 415U-2 default networking configuration bridges between the Radio and the Ethernet networks. This simplifies network configuration as a single IP address is used to access the device from either Ethernet or Radio networks.

Subnet Mask: This is the net-mask for the device's IP address. This is the same net-mask as configured for other devices on the network.

Default Gateway: This field configures a default gateway for messages addressed to IP addresses that are not on the same subnet as the device. This can be left blank if all communication will be within a single subnet.

⚠ **Note**: The 415U-2 default networking configuration bridges between the Radio and the Ethernet networks. This simplifies network configuration as the Ethernet and radio networks share a single sub-net, and a single IP address is used to access the device from either Ethernet or Radio networks. In most applications it is not necessary to configure any IP routing.

IP filter settings (base only)

This section is only displayed if the device Mode is set to "Base". For the Base device, you should configure an IP filter to block unwanted traffic from leaking from the Ethernet network to the radio network. To make best use of this you should plan your network so that all of the devices on the radio network (both radio devices and connected equipment) have IP addresses in a range that is separate from other IP addresses connected to your Ethernet network. For example, you could configure your SCADA PC and other devices on the base station Ethernet Network with IP addresses 192.168.10.1 through 192.168.10.50, Radio devices with addresses 192.168.10.51 through 192.168.10.100, and other devices connected to the radio devices with addresses 192.168.10.101 through 192.168.10.254.

First Radio Device IP: This is the lowest IP address of the devices connected to the radio network. For the example above, this would be 192.168.10.51

Last Radio Device IP: This is the highest IP address of the devices connected to the radio network. For the example above, this would be 192.168.10.254

⚠ **Note**: If you need to configure more complex filtering, or if you need to configure an IP Filter for Field Station or Repeater Devices, you can access this functionality from the "IP filter" configuration web-page.

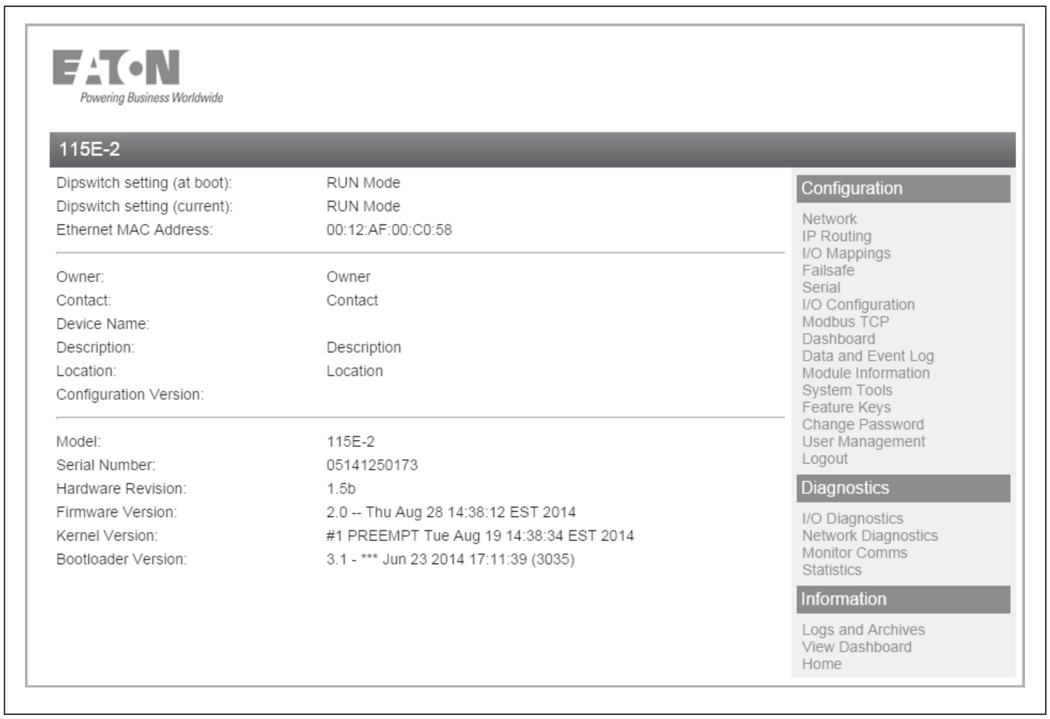


Figure 78. Home page

Module information web page

Click **Module Information** from the menu to change the following information for the module. With the exception of the password, the information entered here is displayed on the module's home configuration Web page.

Username Password	The Username field is not used in firmware version 1.3 and later. For firmware versions earlier than 1.3, the default username is "user" and the default password is "user". If you change the default settings, take care to remember the new username and password because you will need this information to access the module in the future.
Password	The Password field is not used in firmware version 1.3 and later. For firmware versions earlier than 1.3, this is the password used to access configuration on the module. The default is "user". If you change the password, take care to remember the new password because you will need it to access the module in future.
Device Name	Allows you to label the module. This is also the DNS host name given to the module if it is used with a DHCP client.
Owner	Module owner name.
Contact	Contact details can include a phone number, email address, and so on.
Description	Description of the module.
Location	Physical location of the module.
Configuration Version	The date and time when the module was last programmed.

System tools

Click **System Tools** on the menu to perform administrative tasks, such as clearing the system log, reading or writing the module configuration, or performing firmware upgrades.

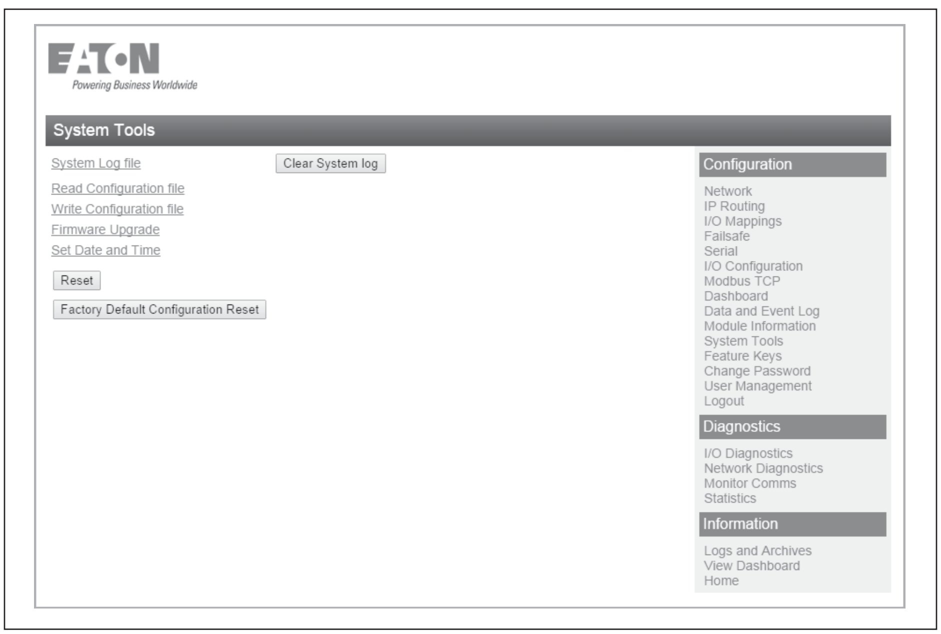


Figure 79. System tools

System Log File	Logs system instructions and other information to the screen. The log screen can then be saved to a file that may be used by ELPRO technical support to diagnose problems.
Clear System Log	Clears the log screen.
Read Configuration File	Reads the module configuration to an XML file. To save this file, select "Save As" from the File menu.
Write Configuration File	Loads a previously saved XML configuration file into the module.
Firmware Upgrade	Upgrades the module firmware. For details, see "Patch file firmware upgrade" below.
Set Date and Time	Allows you to set the date and time for the device. This feature available in firmware versions 2.0 and later, and is associated with the logging function.
Reset	Resets the module.
Factory Default Configuration Reset	Resets the module and restores its factory default configuration.

Patch file firmware upgrade

To upgrade the module firmware locally using a firmware patch file, click **System Tools** on the menu, and then click **Firmware Upgrade** and browse for the saved firmware patch file. When you locate the file, click **Send** to upload the file to the module. A status message appears. If the upgrade was successful, click **Reset**. If it was not successful, repeat the process. (The module must verify that the file is valid before you can initiate a reset.)

⚠ **Note**: All existing configuration parameters will be saved. However, if any new parameters are added to the firmware, the default values will be used.

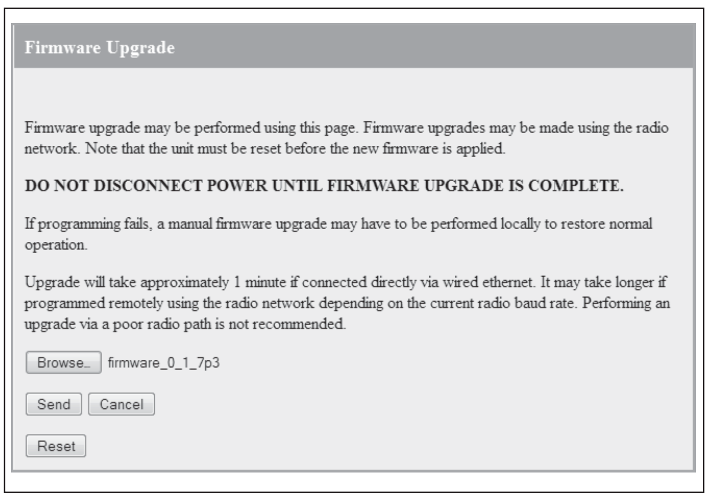


Figure 80. Firmware upgrade

Setting the date and time

This feature is associated with data logging. The module needs access to the current date and time to make effective use of data logging if this feature is enabled on the module (see "Data logging" on **page 67**).

To configure the date and time, click **System Tools** on the menu, and then click **Set Date and Time**. This displays the page in **Figure 81**. There are two ways you can set the date and time on this page:

- Manually enter the date and time.
- Enable Network Time Protocol (NTP) to retrieve the time and date from a remote time server. This method requires network access to an NTP server.

If you set the date and time manually, keep in mind that the date and time function does not support time zones or daylight savings time. Normally you should set the time to UTC (Universal Time). You can set the time to your local time, but you will need to remember to change the time if your location uses daylight savings. When the time is set manually, the module uses an internal real-time-clock to keep time during loss of power. This real time clock has power to run for at least twelve hours (typical 3-5 days). If the duration of the power loss is too long, the time at power restoration will be the time that power was lost.

To use the NTP feature, you need network access to an NTP server. You can use a public server, or set up your own server. Most modern operation systems (such as Microsoft® Windows and Linux) can be configured to operate as an NTP server. If the NTP server is on a different sub-network, you may need to configure routing rules to allow the device to reach the NTP server. Use the "Ping" command on the Network Diagnostics page to check if you have connectivity to the NTP Server IP address.

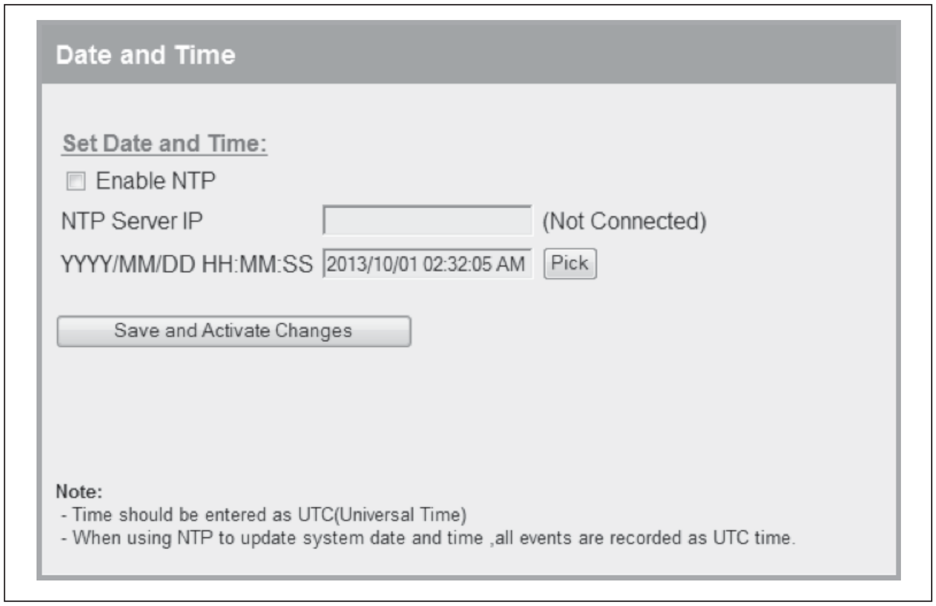
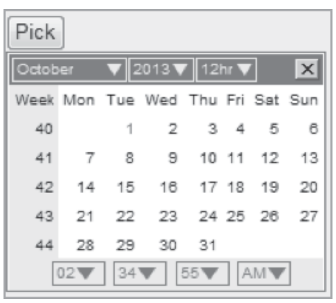


Figure 81. Date and time

Enable NTP	Select this checkbox to automatically set the time and date in the device from an external NTP server. You will also need to enter the IP address of the NTP server in the NTP Server IP field.
NTP Server IP	Enter the IP address of the NTP server if you selected the checkbox to Enable NTP.
YYY/MM/DD HH:MM:SS	Use this field to set the time manually if there is no access to an NTP server. Click **Pick** to display a date and time selection pop-up. Select the day, month, year and hour, minute and second, and click **Pick** again to set the time and close the pop-up. To set the time more precisely, try selecting a time a little in the future and waiting until that time to click **Pick**.



Save Changes and Activate

After configuring settings, click **Save Changes and Activate**.

For manual time, clicking this button sets the clock with the new time.

For NTP time, after a short delay the message next to the NTP Server IP field updates to show whether the module successfully connected to the NTP server. If the message is "Not Connected," check that the NTP server is configured correctly, and use the Ping command on the Network Diagnostics page to check that the module can reach the NTP server. After connecting to the NTP server, the displayed time changes to match the NTP server. This is normally UTC time.

Feature license keys

Feature license keys allow you to upgrade the 415U-2 module with enhanced features or to a more advanced model (for example, by enabling the Modbus option). You can purchase the feature license keys by contacting your sales representative or local distributor. To complete the purchase, you will need to provide the module serial number so that the feature license key can be generated for the module. The module serial number can be found on the home page (see **Figure 78**).

After receiving the feature key certificate, follow the instructions in "Enabling a feature license key" on this page to install the feature on the module. You can also temporarily enable all feature license options by placing the module in demonstration mode. See the following section, "Using demonstration mode."

Click **Feature Keys** in the menu to enable or demo feature license key options (**Figure 82**).

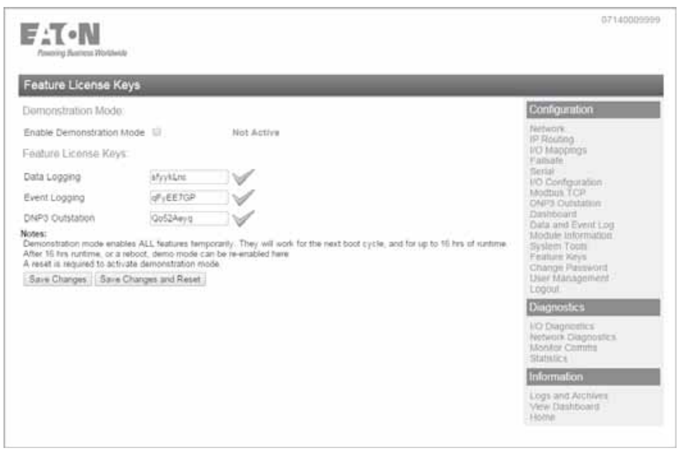


Figure 82. Feature keys

Demonstration Mode	Allows you to temporarily enable all feature license options. See the following section, "Using Demonstration Mode."
Feature License Keys	Allows you to enable advanced features after purchasing a feature license key. See "Enabling a feature license key" on this page.

Using demonstration mode

The demonstration mode option on the Feature License Keys page (**Figure 82**) temporarily allows full operation of all feature license options for 16 hours, or until the module is restarted. This allows you to try out the feature without purchasing the feature key. When the demonstration period is up, the module is restarted and demonstration mode is turned off.

To enable demonstration mode

1. Click **Feature Keys** on the menu.
2. Click to select the **Enable Demonstration Mode** checkbox.
3. Click **Save Changes and Reset**.
4. Wait for the module to complete the restart, and then click **Continue**.
   After the module resets, the message "Active" appears, indicating that the demonstration mode is activated.

Enabling a feature license key

Use the following procedure to enable a purchased feature license key (see "Feature license keys" on this page.

To enable a feature license key

1. Make sure that the module serial number on the feature key certificate (**Figure 83**) matches the serial number on the label on the left side of the module.


Certificate

Thank you for purchasing a Feature Code.

Date: 28 April 2015

Module Serial Number: 08141255150

Modbus Feature Code:

Logging Feature Code:

DNP3 Feature Code: 9e2TA7X

Feature Code Certificate

Product functionality can be enabled by providing a code that is specific to the unit and to the feature being enabled (The Feature Code). This certificate provides a record of the feature codes that have been purchased for the product with the serial number listed above.

If these codes were purchased at the time of ordering the module, these features may have already been enabled in the module. In this case the Feature Code will be documented on the module test report. If the codes were purchased subsequent to purchasing the module, refer to the user manual for instructions on how to enable the additional features.

Retain this certificate, as it may be necessary to re-enter the feature codes for this device at some stage in the future.

Figure 83. Example feature key certificate

2. Click **Feature Keys** on the menu.
3. Enter the key value from the certificate into the field next to the feature.
4. Click **Save Changes**.
   If the feature license key is valid, a green checkmark appears next to the key. If the key is invalid, a red cross appears. Feature license keys are retained even if the module is returned to factory default settings.

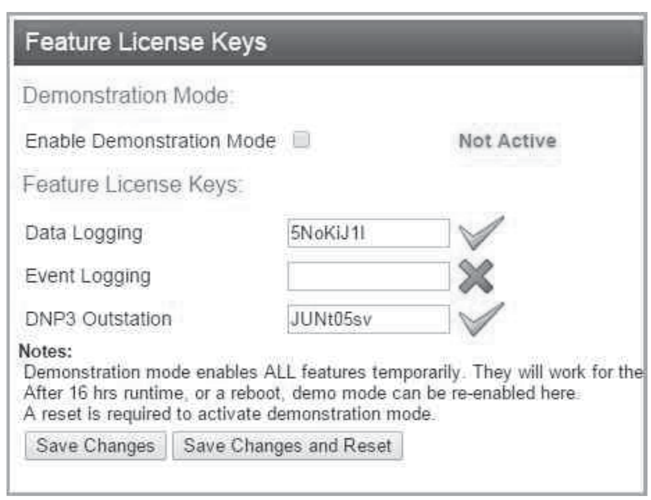


Figure 84. Feature license keys

5. If the code is valid, activate the feature by clicking **Save Changes and Reset**.

Changing your password

You can change your password by clicking **Change Password** on the menu and entering the new password in both password fields. Click **Save and Activate Changes** to change your password. Passwords must be at least eight characters.

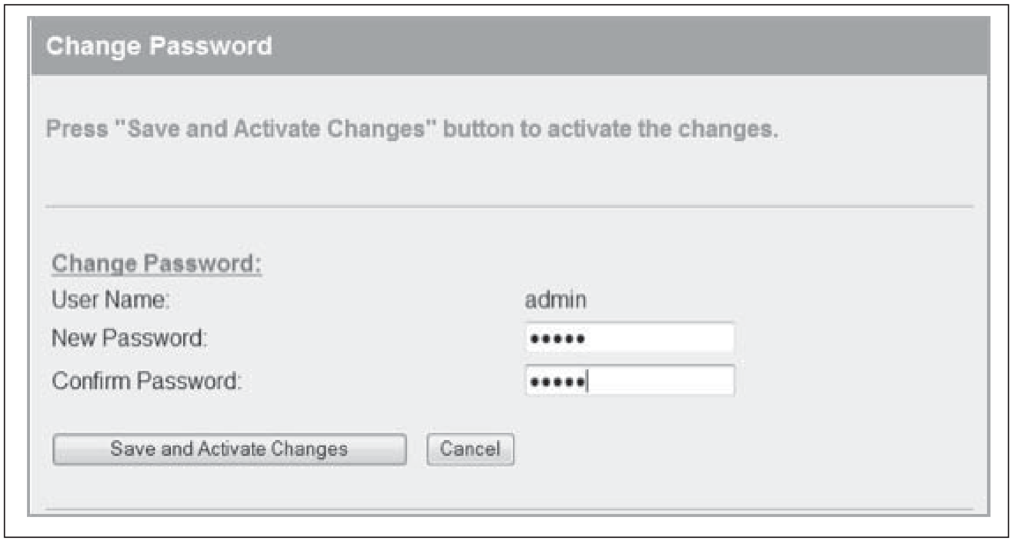


Figure 85. Change password

User management

Users with Admin privileges can click **User Management** on the menu to configure access to the module (see **Figure 86**). An Admin can add new users, change user passwords, or retire (deactivate) user access. The Admin assigns each user a "role" which limits the functions available to them according their operational needs.

⚠ **Note**: You cannot delete individual users from the system, but can deactivate user access by "retiring" the user. If you need to delete all user information from the module and restore the factory default user settings, see "Restoring the factory default user configuration" on **page 62**.

There are three user roles:

- **Operator**—Can view information on the device, but cannot change configuration.
- **Manager**—Can view information and change the device configuration, but cannot modify the list of users allowed to access the device.
- **Admin**—Has all of the permissions of a Manager, plus the ability to modify the user list, user passwords, and access levels. (All users can change their own passwords.)

The module comes from the factory with two default users.

Table 11. Users

Default user name	Default password	Role
admin	admin	Admin
user	user	Manager

Access to menu items is restricted by the user's role, as shown in the following table. If you click a menu item and do not have sufficient access privileges, you are prompted to enter a username and password with the necessary access privileges.

Table 12. Access privileges

Menu item	Operator	Manager	Admin
Network	—	Yes	Yes
IP Routing	—	Yes	Yes
I/O Mappings	—	Yes	Yes
Fail Safe Configuration	—	Yes	Yes
Serial	—	Yes	Yes
I/O Configuration	—	Yes	Yes
Modbus	—	Yes	Yes
Module Information	—	Yes	Yes
System Tools	—	Yes	Yes
Feature Keys	—	Yes	Yes
Data and Event Log	—	Yes	Yes
Change Password	Yes	Yes	Yes
User Management	—	—	Yes
I/O Diagnostics	Yes	Yes	Yes
Connectivity	Yes	Yes	Yes
Logs and Archives	Yes	Yes	Yes
Home	Yes	Yes	Yes

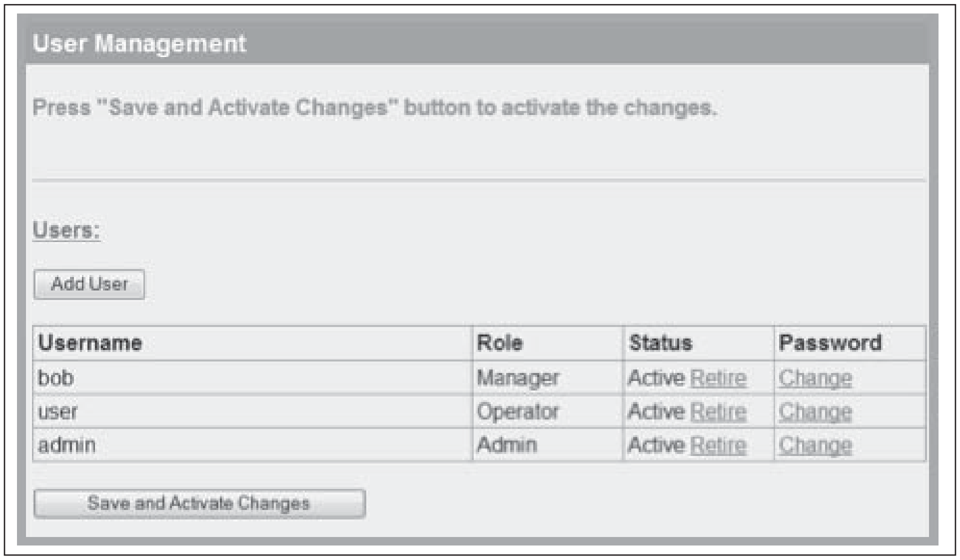


Figure 86. User management

To add a user

1. Click **User Management** on the menu.
2. Click **Add User**.
3. Enter a username and password, and confirm the password. Passwords must be at least eight characters.
4. Select a role for the user.
5. Click **Create** to add the user.
6. To add additional users, repeat steps 2 through 5.
7. When you have finished adding users, click **Save and Activate Changes**.

To retire a user

1. Click **User Management** on the menu.
2. In the Status column for the user, click **Retire**.
3. Click **OK** to confirm.
   The user's status changes from "Active" to "Retired."
4. Click **Save and Activate Changes**.
   This disables access to the module by the retired user.

To change a user password

1. Click **User Management** on the menu.
2. In the Password column for the user, click **Change**.
3. Enter a new password for the user and confirm the new password.
4. Click **Apply**.
5. Click **Save and Activate Changes**.

Recovery after lost admin password

If you lose the password for your admin account you can temporarily restore the factory users using DIP switch 6, located under the cover on the right side of the module.

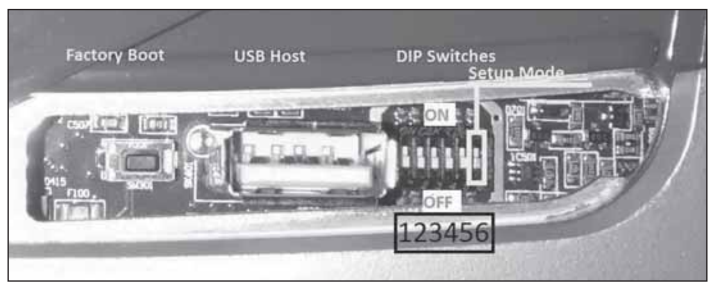


Figure 87. Factory boot DIP switch

To restore factory users

1. Set DIP switch 6 to the ON position.
2. Remove power, and then restore power to the module.
3. Wait until the green OK LED turns ON.

   The LED is located on the front panel.
4. Access the module using the Setup Mode IP address (printed on the left side label) and the username "admin" and password "admin".
5. Make any required changes to passwords to allow access to the module.
6. Return DIP switch 6 to the OFF position.
7. Remove power, and then restore power to the module.
8. Check that you can access the device using your new password.

Restoring the factory default user configuration

Contact technical support if you need to remove the entire list of users (both active and retired users) from the module and restore the factory default user configuration. This may be necessary if you need to use the device for a different application.

Diagnostics

This chapter describes network diagnostic tools and information available from the module's Web-based configuration utility. To access this utility, see "Connecting and logging on" on **page 52**.

IO diagnostics

Click **IO Diagnostics** from the home page of the Web-based configuration utility to read and write I/O store registers within the module.

To read a register location, enter an address location (for example, 10001 for digital inputs), enter a count (number of consecutive registers), and then click **Read** (see **Figure 88**). The returned address location and the returned values appears at the bottom of the page.

To write to outputs, enter the address location, count, and value, and then click **Write**. You will see the outputs change to the value you entered. For example, write to Register 1 with a count of 8 and a value of 1 will turn all the local digital outputs on. Write to Register 40001 with a count of 2 and a value of 49152 will set the two local physical analog outputs to 20 mA.

⚠ **Note**: If the value "~" appears at the bottom of the page when reading a register, it indicates that the register has been initialized to the "Invalid" state through the fail-safe configuration and therefore has no value (not even zero).

A mapping will only be sent when all registers have a value. To set an initial value for registers upon startup, use the Fail-safe Block Configuration menu in the Web-based configuration utility or use the MConfig utility (see "Fail-safe blocks" on **page 33**). If there is a mapping configured and any one of the source register values has the value "~" the mapping will not be sent (see "Invalid register state" on **page 34**).

Using the I/O Diagnostics page, you can check the register locations for the "~" values and even write values if required. If you see the value "3" when reading the status of the DIO on the module it indicates that the DIO is being used as an output in the "on" state.

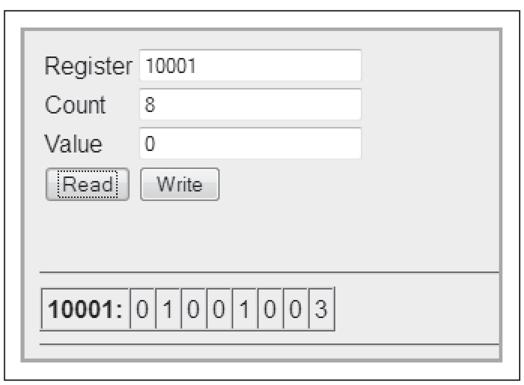


Figure 88. I/O diagnostics

Register	Register address location.
Count	Number of consecutive registers, starting from the register location specified in the Register field.
Value	Value to be written.
Read	To read a register location, enter an address location (for example, 10001 for digital inputs), enter a count (number of consecutive registers), and then click **Read**.
Write	To write to outputs, enter the address location, count, and value, and then click **Write**.

Watchdog error log

The module uses a various processes to control aspects of its internal functions, such as radio operation, I/O functionality, Ad hoc On-Demand Distance Vector (AODV) communications, and Modbus communications. Each process runs independently, and can interact with the other processes to provide a robust wireless I/O product.

All processes are monitored by an internal "watchdog." If a processes has a problem and stops running, the watchdog will identify the problem and restart the module. The watchdog also creates a text file showing which process had the problem. This text file is stored in a directory called "dog" off the main root IP address of the module. To display this text file in your browser, enter http://XXX.XXX.XXX.XXX/dog/, where XXX.XXX.XXX.XXX is the IP address of the module.

If the watchdog directory continues to show text files, it may indicate a problem with the module or its configuration. If this happens, save the module configuration (see "System tools" on **page 57**) and the list of watchdog files, and then contact Eaton technical support.

The following table describes the different watchdog processes.

Table 13. Watchdog process

Watchdog process	
A00	Internal process monitor
A01	I/O processing application
A02	Fail-safe manager application
A03	Modbus application
A04	I/O mapping application
A06	AODV meshing protocol application
A07	Data logging application
A15	Warm restart backup

Module information registers

Certain registers in the module show modules characteristics, such as the serial number, firmware version, and so on. This information is available on the home page of the module's Web-based configuration utility. However, having the information available in registers allows a host system to read the values via Modbus, if Modbus has been activated.

- Register 30494, 30495 and 30496 = Module serial number
- Register 30497, 30498 and 30499 = Module firmware version
- Register 30500 = Firmware patch level

Expansion I/O error registers

The 415U-2 has diagnostics registers allocated for each expansion I/O module. These registers indicate the module type, error counts, error codes, and so on. Each expansion I/O module has the following registers.

- 30017 + Offset = Modbus error counter (number of errors the modules has had)
- 30018 + Offset = Last 115S status code / Modbus error code

Register 30018 will display one of the following 115S status codes (hexadecimal code 1–5 and 129), as well as displaying Modbus response codes similar to what is shown on **page 88**, but with the most significant byte being one of the following values, 82, 84, 8F or 90.

Table 14. Expansion I/O error registers

Dec code	Hex code	Name	Meaning
1	0001	No Response	No response from a poll
2	0002	Corrupt/invalid	Corrupt or invalid data
3	0003	CRC Fail	CRC error check does not match the message. Indicates this a different message or possible data corruption.
4	0004	Response did not match request	The response heard was not the correct ID; possibly heard other RS-485 traffic.
5	0005	Message type did not match request	The response heard did not match the requested poll (different command response); possibly heard other RS-485 traffic.
81	0129	Problem accessing local memory	Could not access register location, possibly because the register is not initialized.
??01- ??0B	Standard Modbus Error Codes	As per **page 84**	

- 30019 + Offset = Modbus Lost Link Counter (number of Communication Errors)
- 30020 + Offset = Modbus Module Type:

  dec 257 (101 hex) indicates a 115S-11
  dec 513 (201 hex) indicates a 115S-12
  dec 769 (301 hex) indicates a 115S-13

Diagnostic registers—device statistics

Commonly used statistics for diagnostics and system monitoring can be logged to onboard I/O Registers. These registers may then be accessed via an external device using any of the supported I/O transfer protocols (WIB, MODBUS, DNP3). By default, logging of statistics to I/O registers is enabled.

When statistics logging is enabled, the statistics are logged to Analog Input Registers. These are listed in detail in “Input registers” on **page 75**.

Statistics registers provide the following information about the upstream connection (Towards the base station). If the module is configured as a base, or configured in manual mode without any Client functionality, then these registers will be zero.

RSSI: The signal strength to the upstream device (Repeater or base station)

Connected Time: The amount of time the current upstream connection has been established (in hours)

Generation Count: The number of times the current upstream connection has been established. This value is 1 when the device first connects, then if the link is lost it increments once each time the link is re-established. Note that if both the upstream device and the local device are re-started, the Generation count will reset to 1. If only one device is re-started, then the generation count is designed to be retained.

Upstream IP Address: The address of the Upstream device (Base, Repeater or Manual Mode Access Point).

The following information about the device uptime is available for all devices:

Module Uptime: The amount of time the module has been powered on. You can compare this against the connected time to determine if the module has been losing link.

Channel and radio statistics are available for all devices, and are available averaged over the last minute, last hour, and last 60-hour periods.

Channel Utilization: This is the percentage of time the radio channel has been busy with radio transmissions from any devices within receiving range of this device.

Background Noise: This is the background noise level on the radio channel when the radio is not receiving valid data.

Retried Transmissions: This is the percentage of radio transmissions that were successful, but required at least one re-transmission before they were acknowledged. This statistic does not apply to broadcast transmissions, which are not acknowledged.

Failed Transmissions: This is the percentage of transmissions that were unsuccessful due to not receiving an acknowledgement message to any of the re-transmissions. This statistic does not apply to broadcast transmissions, which are not acknowledged.

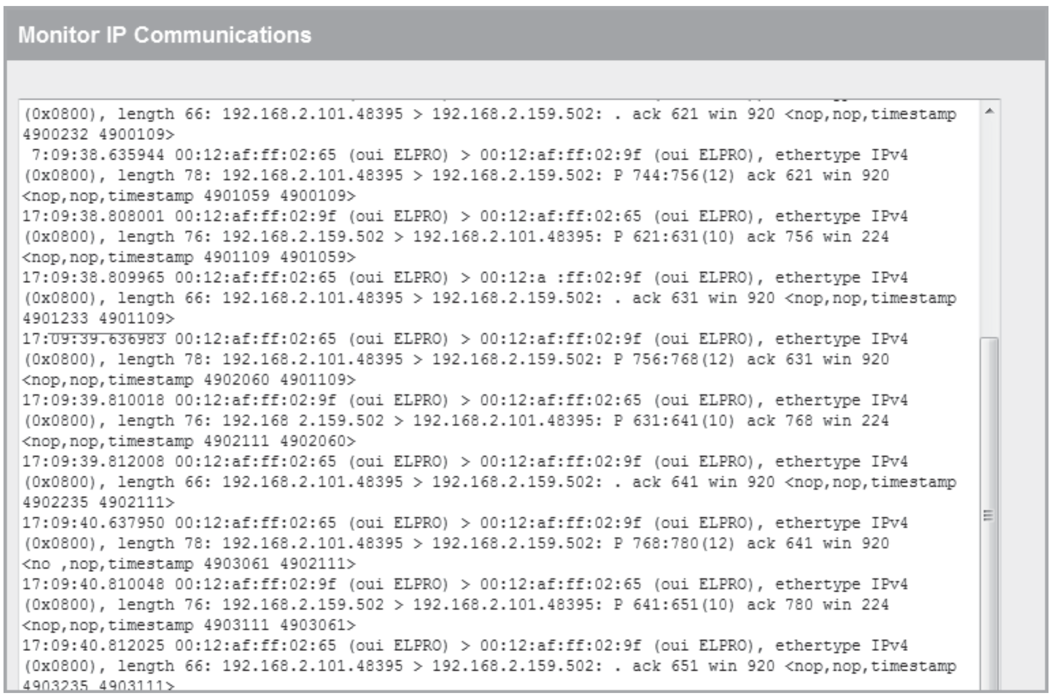
Statistics registers also record information about downstream connections. These registers are used by all devices that have downstream connections—Base station, Repeater, and Manual Mode Access Points. For Manual Mode clients, and for Field Station devices, these registers are unused and available as general purpose storage.

RSSI List:	This is a block of 255 register locations. For each downstream device, the last byte of the device's IP address is used to determine which location to store the signal strength. For example, a downstream device with IP Address 192.168.0.199 will have its RSSI stored in I/O register offset 199. If no device is connected with the IP address, the register has the value Zero.

Monitoring communications

Monitor IP comms on Ethernet port

Click **Monitor IP Comms** on the home page of the Web-based configuration utility to view the IP communication data frames. From here you can decode the data frame and read the transmitted and received I/O values.



Monitor IP Communications

```
(0x0800), length 66: 192.168.2.101.48395 > 192.168.2.159.502: . ack 621 win 920 <nop,nop,timestamp
4900232 4900109>
 7:09:38.635944 00:12:af:ff:02:65 (oui ELPRO) > 00:12:af:ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 78: 192.168.2.101.48395 > 192.168.2.159.502: P 744:756(12) ack 621 win 920
<nop,nop,timestamp 4901059 4900109>
17:09:38.808001 00:12:af:ff:02:9f (oui ELPRO) > 00:12:af:ff:02:65 (oui ELPRO), ethertype IPv4
(0x0800), length 76: 192.168.2.159.502 > 192.168.2.101.48395: P 621:631(10) ack 756 win 224
<nop,nop,timestamp 4901109 4901059>
17:09:38.809965 00:12:af:ff:02:65 (oui ELPRO) > 00:12:a :ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 66: 192.168.2.101.48395 > 192.168.2.159.502: . ack 631 win 920 <nop,nop,timestamp
4901233 4901109>
17:09:39.636983 00:12:af:ff:02:65 (oui ELPRO) > 00:12:af:ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 78: 192.168.2.101.48395 > 192.168.2.159.502: P 756:768(12) ack 631 win 920
<nop,nop,timestamp 4902060 4901109>
17:09:39.810018 00:12:af:ff:02:9f (oui ELPRO) > 00:12:af:ff:02:65 (oui ELPRO), ethertype IPv4
(0x0800), length 76: 192.168 2.159.502 > 192.168.2.101.48395: P 631:641(10) ack 768 win 224
<nop,nop,timestamp 4902111 4902060>
17:09:39.812008 00:12:af:ff:02:65 (oui ELPRO) > 00:12:af:ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 66: 192.168.2.101.48395 > 192.168.2.159.502: . ack 641 win 920 <nop,nop,timestamp
4902235 4902111>
17:09:40.637950 00:12:af:ff:02:65 (oui ELPRO) > 00:12:af:ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 78: 192.168.2.101.48395 > 192.168.2.159.502: P 768:780(12) ack 641 win 920
<no ,nop,timestamp 4903061 4902111>
17:09:40.810048 00:12:af:ff:02:9f (oui ELPRO) > 00:12:af:ff:02:65 (oui ELPRO), ethertype IPv4
(0x0800), length 76: 192.168.2.159.502 > 192.168.2.101.48395: P 641:651(10) ack 780 win 224
<nop,nop,timestamp 4903111 4903061>
17:09:40.812025 00:12:af:ff:02:65 (oui ELPRO) > 00:12:af:ff:02:9f (oui ELPRO), ethertype IPv4
(0x0800), length 66: 192.168.2.101.48395 > 192.168.2.159.502: . ack 651 win 920 <nop,nop,timestamp
4903235 4903111>
```

Figure 89. IP communication monitoring

The following table describes two data frames from the communications log screen in **Figure 89**.

Table 15. Data frames from communications log screen

Time	Source IP	Dest IP	Len	Type	Seq	Ack	Dest	Cnt	Val
03:02:45.073629	192.168.2.146.51891	192.168.2.143.4370	7	WRITE	9	—	1	1	11111110
03:02:45.075693	192.168.2.143.56678	192.168.2.146.4370	1	ACK	9	—	—	—	—

Time	The module's internal time. This should correspond to the time configured in the Time and Date configuration screen. The time will be in UTC if NTP protocol is configured.
Header	Indicates whether the message is a receive (In) or a transmit (Out) message, as well as the type and size of the Ethernet frame.
Source IP	Originating or source IP address.
Dest IP	Destination IP address.
Len	Total length of data.
Type	Type of message, for example, Write, Read, Gather/Scatter, and so on.
Seq	Sequence number of the message.
Ack	Indicates whether the data frame is configured to acknowledge or not acknowledged. This is configured in each mapping.
Dest	I/O address at the destination. The destination is the location that the data will be written to or read from.
Cnt	Total I/O count from the address in the Dest field.
Val	Data values. The number of values will depend on the I/O count.

Data logging

The data logging feature allows you to record the status of I/O registers on a regular basis. Data is saved to non-volatile memory, and can be retrieved at a later time. You can enable data logging on 415U-2 version 2.0 modules with the purchase of a feature key license (see "Feature license keys" on **page 60**).

Data is logged to an internal data file in ".csv" format. Each row of the file is a single record, consisting of a timestamp and values of all of the configured log items at that time. When the file reaches a configured maximum number of rows, the file is "rolled," that is, the file is compressed and archived and a new log file is created.

The amount of memory available for storing logged data depends on the device type. The available data logging memory is indicated in the log files. When the memory is full, the oldest data log file is deleted.

Table 16. Data logging

Device	Data logging memory
415U-2	200 KB
415U-2XM	200 MB

Configuring data logging

To configure data logging, you need to specify how frequently the data is to be stored, what data is to be stored, and the maximum number of records stored in each log file. Click **Data and Event Log** on the home page of the Web-based configuration utility to configure these settings (see **Figure 90**).

⚠ **Note**: You need Administrator or Manager privileges to configure data and event logging.

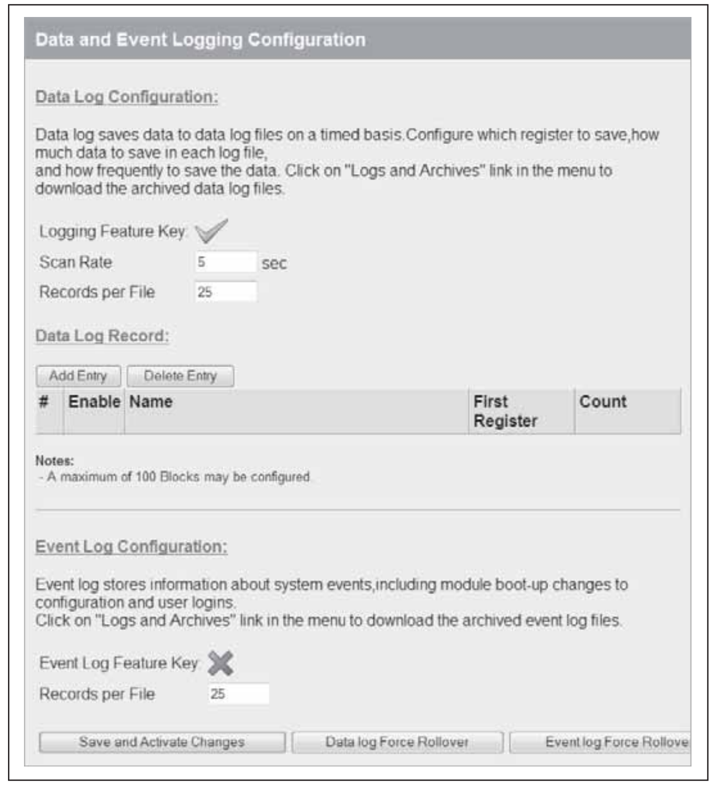


Figure 90. Data and event logging configuration

Data log configuration

Scan Rate	Enter the rate that you want data to be recorded (fastest rate is every 5 seconds).
Records per File	Enter the maximum number of records you want in a file (up to 3,000 records per file). When the maximum is reached, the file is archived and a new data log file is created.
Data Log Record	Each entry in this table specifies a block of registers to be included in the log. To add an entry, click Add Entry and fill in the Name, First Register, and Count information. Select the Enable checkbox to enable data logging for the block. You can configure up to 100 register blocks. Use Delete to remove an entry that you no longer want. For a configuration example, see **Figure 91** and **Table 17**.
Enable	When this checkbox is selected, data logging is enabled for this block of registers. When it is cleared, a placeholder symbol "-" is stored to the log file.
Name	Name to appear in the column heading within the log file to identify data for this entry. If no name is entered, the register number is used as the column heading.
First Register	Address of the first register to be logged.
Count	Number of registers to be logged.
Event Log Configuration	These settings apply only to modules that have the 915U-AT (Audit Trail) feature key enabled. Event Logging is discussed in a separate document.

The configuration example in see **Figure 91** will log six registers in each log record. **Table 17** shows an example of the logged data for this configuration.

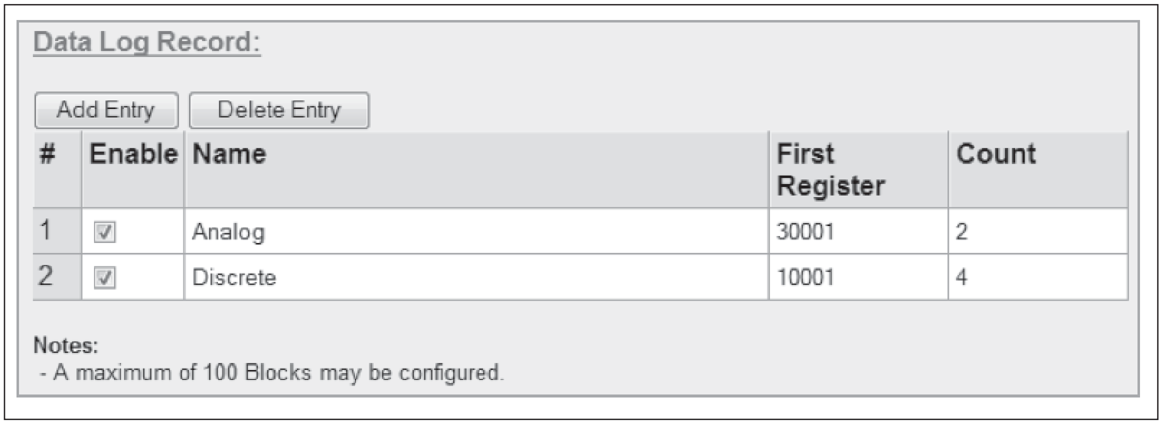


Figure 91. Data log record

Table 17. Data log example

Timestamp	Analog01	Analog02	Discrete01	Discrete02	Discrete03	Discrete04
2014-04-08 03:43:47	8192	8192	0	0	0	0
2014-04-08 03:43:52	8192	8192	0	0	0	0
2014-04-08 03:43:57	8192	8192	0	0	0	0
2014-04-08 03:44:02	8192	8192	0	0	0	0
2014-04-08 03:44:07	8192	8192	0	0	0	0

Viewing current data

To view the latest logged data, click **Logs and Archives** on the home page of the Web-based configuration utility. The latest data is shown in a ".csv" format on the screen.

⚠ **Note**: The Event Log and Configuration items on this page are not used when you have the LOG feature key enabled. These are only relevant to the GMP feature key.

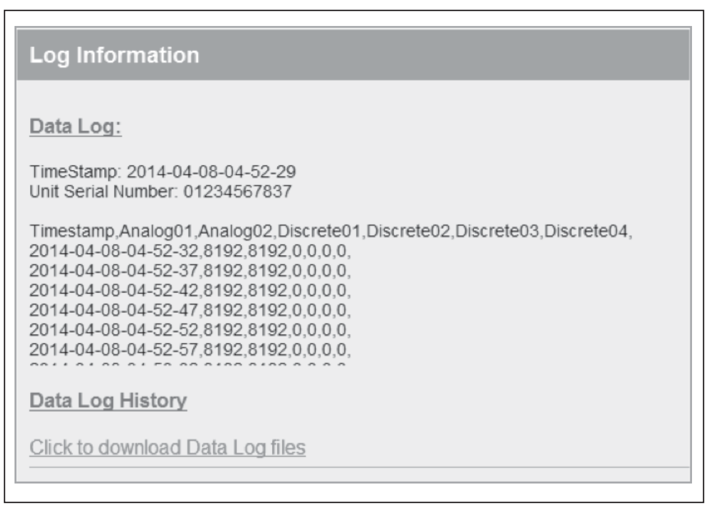


Figure 92. Log information

Retrieving logged data

The module supports remote retrieval of files via HTTP and FTP, as well as local retrieval of files via USB flash drive.

To retrieve logged data files via HTTP

1. Click **Logs and Archives** on the home page of the Web-based configuration utility.
2. Click the link "Click to download data log files."
   This displays a listing of all of the stored data log files. Files are named with the time and date created and the module serial number, in the format yyyymmddhhmmss-nnnnnnnnnnn-DAT.log.

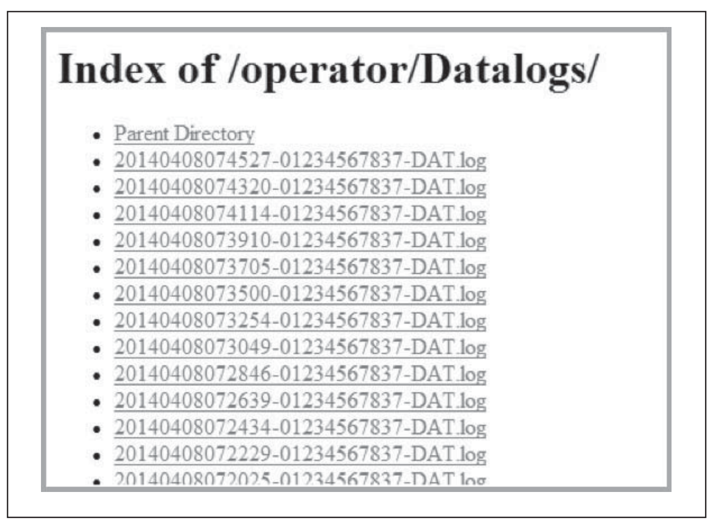


Figure 93. Data log listing

3. Right-click the file that you want to retrieve.
4. Click **Save Target as** to save the file to your local computer.

To retrieve logged data files via FTP

1. Make sure that you have Administrator or Manager access privileges to the Web-based configuration utility
2. Use an FTP client, such as FileZilla, to connect to the module. Log in using your Administrator or Manager login.
   When the FTP connection is complete, you are at the directory /home/user.
3. Change to the directory /home/user/logs/Datalogs.
   A directory listing shows the log files available for retrieval. Files are named with the time and date created and the module serial number, in the format yyyymmddhhmmss-nnnnnnnnnnn-DAT.log.

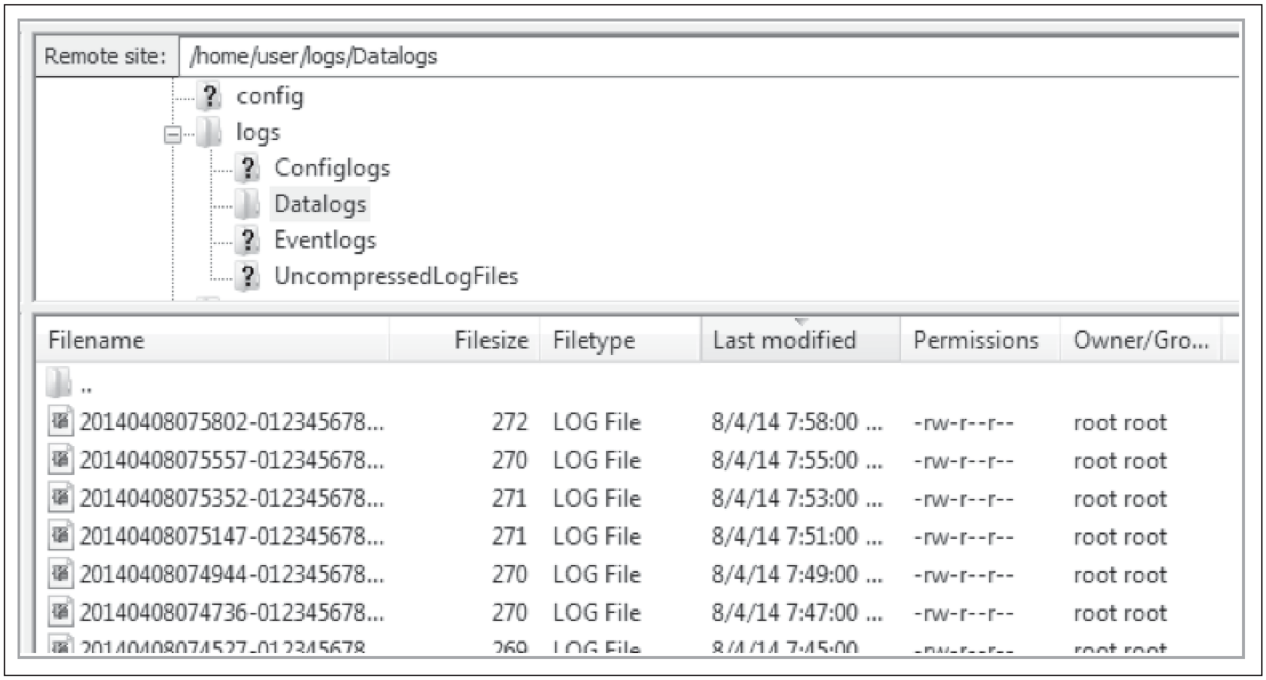


Figure 94. Directory of data log files

4. Use your FTP client to retrieve the files you want.
   You can delete files once they are retrieved using the FTP client. This will speed up over-the-air FTP access to directory information. We recommend leaving log files stored on the module as a backup.

To retrieve logged data files using a USB drive

1. Make sure that the USB drive is formatted for a FAT file system. This is the normal file system on USB drives.
2. Create a directory named "logs" (all lowercase) on the USB drive.
3. Using a small screwdriver, open the hatch on the side of the module.
4. Plug the USB drive into the USB Host port (see **Figure 95**). Within 10 seconds, the module should recognize the USB drive and the OK LED should flash red-green. If the module does not recognize the USB drive, check to make sure that the drive is formatted with FAT file system and that it contains a directory named "logs".

   When the USB drive is recognized, the module copies the data log files to the USB drive. Once all files are copied, the OK LED turns solid green. The data log files are not deleted from the module when they are copied to USB drive.

   If the module encounters an error or if the USB drive does not have sufficient space to fit all of the files, the OK LED turns solid red to indicate a failure. Remove the USB drive and try another one until the files are successfully transferred and the OK LED turns green.

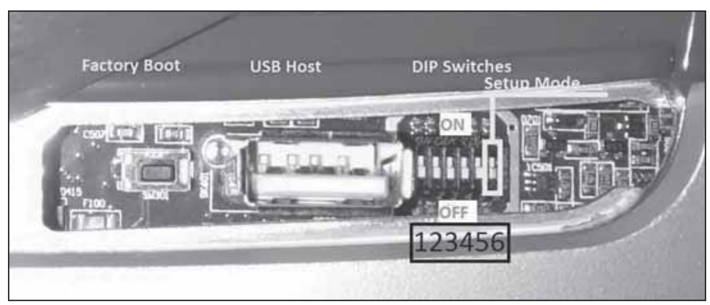


Figure 95. USB port

5. Remove the USB drive from the module USB port.
   The log files are contained in a directory under the "logs" directory. This subdirectory is named with the module device name, or the module serial number if no device name was configured for the module. The device name is configured on the Module Information configuration page. The following example shows the contents of a USB drive after retrieving log files from a module. In this example, the module serial number is 01234567837.

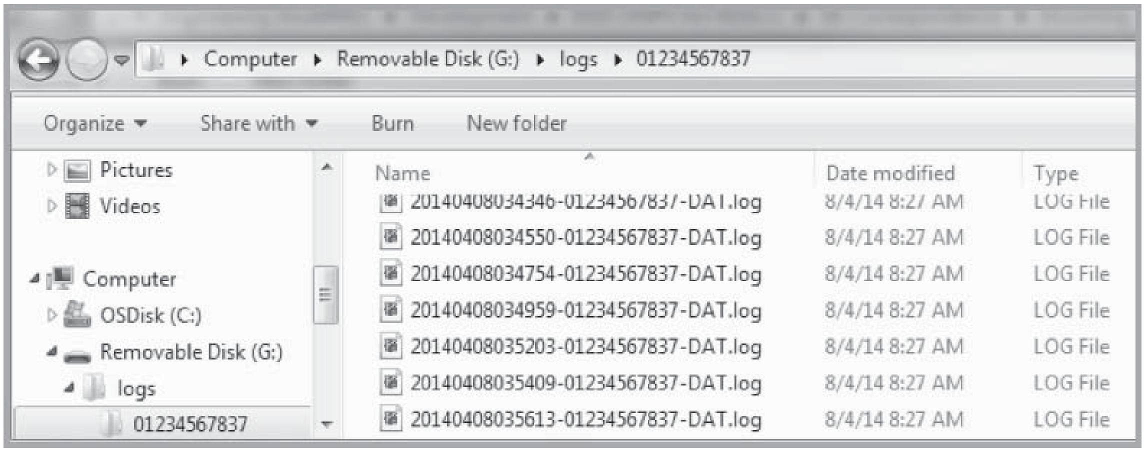


Figure 96. Log file directory on USB drive

You can leave the files on the USB drive. The next time you plug in the USB drive, only the new files are retrieved from the module. You can also use the same USB drive to retrieve data from multiple modules. The data for each module is stored in a separate directory.

If you configure your modules with a device name, the data is stored in a directory with that name. Take care that each module has a unique device name. Data from modules with the same device name will be stored in the same directory.

Retrieving stored log file data

The log files are stored in comma-separated-value (.csv) format. To increase storage space, each log file is compressed using the Tar-Gzip method when it is stored to internal flash memory. The log files can be opened and the compressed .csv files recovered using an archive manager, such as 7-Zip, that can operate with Tar-Gzip (.tgz) files.

Specifications

Specifications for the 415U-2 are provided in the following table.

Table 18. 415U-2 specifications

Item	Specification
Input/Output	
Discrete Input	8 Digital I/O (1–4 Configurable as Pulsed Input or Output) On-State Voltage: < 2.1 Vdc Wetting Current: 3.3 mA Max I/P Pulse Rate: DI 1/2: 50 kHz; DI 3/4: 1 kHz Min I/P Pulse Width: DI 1/2: 10 µsec; PI 3/4: 0.2 msec
Discrete Output	8 Digital I/O (1–4 Configurable as Pulsed Input or Output) On-State Voltage: DO Max, < 0.5 V Maximum Current: 200 mA Max O/P Pulse Rate: PO Max Rate, 1 kHz
Analog Inputs	4 AI (2 Differential, 2 Single Ended) Current Range: 0–24 mA Current Resolution: 14 bits Accuracy (Current): 0.1% Voltage Input Range: AI 1/2: 0–20 V, AI 3/4: 0–5 V Voltage Resolution: 14 bits Accuracy (Voltage): 0.1% full scale
Analog Output	2 AO (Sourcing) Current Range: 0–24 mA Current Resolution: 13 bits Accuracy (Current): 0.1% (20 µA)
Ethernet Ports	
Ethernet Port	10/100base®; RJ-45 Connector, IEEE 802.3
Link Activity	Link, 100Base via LED
Serial Ports	
RS-232 Port	EIA-562 (RJ-45 Connector)
RS-485 Port	2-Pin Terminal Block, Non-isolated ①
Data Rate (Bps)	1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 76800, 115200, 230400 bps
Serial Settings	7 / 8 Data Bits; Stop/Start/Parity (Configurable)
Protocols and Configuration	
Protocols Supported	TCP/IP, UDP, HTTP, FTP, TFTP, Telnet, Modbus RTU Master/Slave, Modbus-TCP Client/Server, WIB I/O
User Configuration	All User Configurable Parameters via HTTP
Configurable Parameters	Unit details, I/O mappings and parameters. For configuration details, see in this manual. Modbus TCP/ RTU Gateway Embedded Modbus Master/Slave for I/O Transfer
Security	Data Encryption: 256-bit AES, Secure HTTP Protocol
LED Indication/Diagnostics	
LED Indication	Power/OK; LAN Link/Activity; RS-232; RS-485; Digital I/O; Analog I/O Status
Reported Diagnostics	Connectivity Information/Statistics, System Log File
Network Management	Optional Network Management System
Compliance	
EMC	FCC Part 15, EN 301 489-5, EN 301 489-3, CISPR22
Hazardous Area	UL Class 1, Division 2; ATEX; IECEx Na IIC
Safety	EN 62368 (RoHS Compliant, UL Listed)
Radio	FCC Part 90, AS/NZS 4295, EN 300 113, EN 300 220
General	
Size	5.91" x 7.09" x 1.38" (180 mm x 150 mm x 40 mm)
Housing	IP20 Rated Aluminum
Mounting	DIN Rail
Terminal Blocks	Removable; Max Conductor 12 AWG 0.1 in^2 (2.5 mm^2)
Temperature Rating	–20 to +140 °F (–30 to +60 °C)
Humidity Rating	0–99% RH Non-condensing
Weight	1.5 lb (0.7 kg)
Power Supply	
Nominal Supply	15 to 30 Vdc; Under/Over Voltage Protection
Battery Supply	10.8 to 15 Vdc
Average Current Draw	220 mA @ 12 V (Idle), 110 mA @ 24 V (Idle)

Note: Specifications subject to change.

① Maximum Distance 4000 ft (1219.2 m).

Troubleshooting

Restoring the factory default settings

Use this procedure to temporarily restore the module's factory default settings.

1. Open the side configuration panel on the module, and set DIP switch #6 to "on."

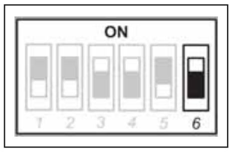


Figure 97. DIP switch #6 in ON position

2. Power cycle the module.
   When the 415U-2 is powered on with DIP switch #6 set to "on," the module goes into Setup mode and temporarily loads its factory-default settings. In Setup mode, wireless operation is disabled. The previous configuration remains stored in non-volatile memory and will only change if a configuration parameter is modified and the change is saved.

⚠ **Important**: Remember to set DIP switch #6 to "off" and power cycle the module to return to normal operation after you have completed configuration. Otherwise, the module will continue to boot into the default IP address.

Configuring PC networking settings

Use this procedure to configure the PC networking settings needed in order to connect the PC to the module for configuration purposes.

1. On the PC, open the **Control Panel**, and then click **Network Settings**.
   The following description is for Windows XP. Other Windows operating systems have similar settings.
2. Open **Properties** of Local Area Connection.
3. Select **Internet Protocol (TCP/IP)** and click **Properties**.

Figure 98. Local area connection properties

4. On the **General** tab, enter IP address 192.168.0.1 and subnet mask 255.255.255.0, and then click **OK**.

Figure 99. TCP/IP properties

5. Verify the Ethernet connection to the module by using the "ping" command:
   1. From the Windows **Start** menu, choose **Run**, and then type: **command**
      A command prompt DOS window appears.
   2. Type "ping 192.168.0.1XX", where "XX" is the last two digits of the serial number shown on the printed label on the side of the module.

LED function

Front panel LEDs

When the module is initially connected to power, it performs internal setup and diagnostics checks to determine if it is operating correctly. These checks take approximately 80 seconds. The following table shows how the LEDs appear when the module is operating correctly.

Table 19. Front panel LEDs

LED	Condition	Meaning
PWR	Green	System OK
PWR	Red	System boot (initial or system fault)
PWR	Orange	Start of system boot
PWR	Fast Flash	System boot, stage 1
PWR	Slow Flash	System boot, stage 2
RF	Green	RF Link established
RF	Flash Off from Green	Radio Receive
RF	Flash Green from Off	Radio Receive (Good Signal)
RF	Flash Red from Off	Radio Receive (Weak Signal)
RF	Orange Flash	Radio transmit
232	Green	Transmitting RS-232 data
232	Red	Receiving RS-232 data
232	Orange	Transmitting and receiving RS-232 data
485	Green	Transmitting RS-485 data
485	Red	Receiving RS-485 data

LED boot sequence

Upon reset, the PWR LED appears solid red for about 2 seconds (system boot), followed by 12 seconds of Orange (start of system boot process). The PWR LED then fast flashes between red and green for 30 seconds (stage 1 of system boot process) followed by a slow flashes for 50 seconds (stage 2 of system boot process). At the end of the boot sequence the PWR should appear solid green. The time periods are approximate, and depend on the hardware and firmware revisions.

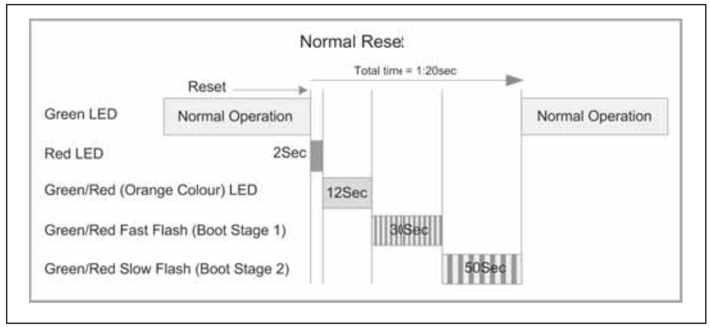
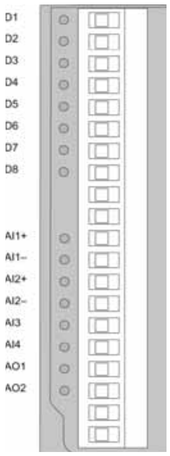


Figure 100. Boot sequence

Input and output LEDs



LED indicator	Condition	Meaning
D 1–8	Orange	Digital input is on
D 1–8	Flashing Orange -(Long On)	Update failure (fail-safe state is on)
D 1–8	Flashing Orange -(Long Off)	Update failure (fail-safe state is off)
AI 1 and 2 +	Orange	Analog input current indication
AI 1 and 2 –	Orange	Analog input voltage indication
AI 3 and 4	Orange	Analog input current or voltage indication
A01 and 2	Orange	Analog output current indication

Digital inputs

LEDs display the status of each of the eight DIOs when used as inputs. If the LED is on, it indicates that the input is on.

Digital outputs

When the DIOs are used as outputs, the LEDs display the status of each of the digital outputs. If an LED is on, it indicates that the output is on. The LEDs also indicate if the output is in a fail-safe state by flashing at different rates. If an LED is mostly on (long on) it indicates that the fail-safe state shown on the Digital Output Configuration page (in MConfig utility) is on. If an LED is mostly off (long off) it indicates that the fail-safe state shown on the Digital Output Configuration page (in the MConfig utility) is off. See “Fail-safe blocks” on **page 33** for details.

Analog inputs

There are two LEDs for each differential analog input. The first LED (+) is used to indicate that the analog input is reading a current (mA). The second LED (–) indicates that the input is reading voltage. Each of the analog input LEDs flash with increasing speed and intensity depending on the level of the input. For example, at 4 mA, the LED appears dimmed and flashes slowly, and at 20 mA the LED appears bright and flashes quickly.

For each of the single-ended analog channels, the LED indicates when the input is reading current or voltage by flashing the LED according to the level of the input. For example, at 4 mA the LED appears dimmed and flashes slowly, and at 20 mA, the LED appears bright and flashes quickly.

Analog outputs

Each analog output has an LED in series that indicates the output current by increasing or decreasing the intensity of the LED. For example, at 4 mA the LED appears dimmed, and at 20 mA, the LED appears bright.

Ethernet LEDs

On the end plate, the Ethernet socket incorporates two LEDs that indicate the Ethernet status.

- **100 M**—Green LED indicates presence of a 100-Mbps Ethernet connection. With a 10-Mbps connection, the LED is off.
- **LINK**—Orange indicates an Ethernet connection. The LED briefly flashes with activity. The front panel LAN LED provides additional indication of the Ethernet status. See **page 73**.

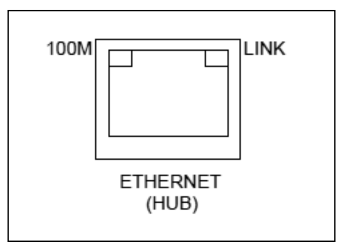


Figure 101. Ethernet socket

Input registers

I/O store registers

Output coils

Output coils	Description
0001 0008	Local DIO1–DIO8 as digital outputs
0009 0020	Spare
0021 0400	Space for locally attached 115s expansion I/O modules. Twenty register per module address, maximum number of modules is 19.
0501 3000	General purpose bit storage used for: Staging area for data concentrator Fieldbus mappings storage Force mapping registers (see "Startup or force configuration" on **page 27**)
3001 10000	Not available

Input bits

Input bits	Description
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 registers per module address, maximum number of modules is 19.
10501 10595	WIBMesh: general purpose bit storage and staging area for data concentrator fieldbus mappings storage. WIBNet: Remote Comms Fail indication. Corresponds to unit address (for example, remote address 1–95).
10596 12500	Continuation of general purpose bit storage. Staging area for data concentrator fieldbus mappings storage.
12501 30000	Not available

Input registers

Input registers	Description
30001 30004	Local AI1–AI4 (analog inputs, current mode) AI1 and AI2: 4–20 mA differential AI3 and AI4: 4–20 mA sink
30005 30006 30007 30008	Local supply voltage (0–40 V scaling) Local 24 V loop voltage (0–40 V scaling) Local battery voltage (0–40 V scaling) 115S supply voltage (0–40 V scaling)
30009	Local AI1–AI4, (analog inputs, voltage mode)
30012	AI1 and AI2: 0–20 V AI3 and AI4: 0–5 V
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 Field station or repeater, the RSSI of the connected upstream device.
30402	Connected Time: When configured as a field station or repeater, the time (in hours) that the connection to the upstream device has been made.
30403	Generation Count: When configured as a Field station or repeater, the generation count of the connection to the upstream device. This is the number of times the connection has been lost and re-established

Input registers	Description	
30404-5	IP Address: When configured as a Field station or repeater, the IP Address of the upstream device.	
	IP Address	Register Location
	First byte	high byte of register 3404
	Second byte	low byte of register 3404
	Third byte	high byte of register 3405
	Fourth byte low byte of register 3405	
30411	Module uptime: The time (in hours) that this module has been up and running.	
30412	Channel Utilisation percentage (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 a 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	Channel Utilisation % average of (last 60 minutes)	
30417	Background Noise (average of last 60 minutes)	
30418	Tx retry % (average of last 60 minutes)	
30419	Tx failed % (average of last 60 minutes)	
30420	Channel Utilisation % average of (last 60 hours)	
30421	Background Noise (average of last 60 hours)	
30422	Tx retry % (average of last 60 hours)	
30423	Tx failed % (average of last 60 hours)	
30494 30500	Internal information registers: serial number, firmware version and patch level	
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 or Repeater, 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 the IP address, the register has the value Zero.	
32256–32500	General purpose word storage	
32501 36000	Not available	
36001 36008	Local pulsed inputs 1–4, big endian format Most significant word at lower/odd address	
36009 36040	Spare	
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) (12.3 => 38001=CCCD, 38002=4144)	
38033–38040	Spare space for floating point values	

Holding registers

Holding registers	Description
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.
40501 42500	General purpose word storage area used for: Staging area for data concentrator Fieldbus mappings storage
42501 46000	Not available
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 (12.3 => 48001=0xCCCD, 48002=0x4144)
48005 48040	Spare space for floating point values
48041 onwards	Not available

Expansion I/O registers

Adding expansion I/O modules to the 415U-2 will automatically add the I/O from the 115S modules to the internal 415U-2 I/O store. To calculate the register location in the I/O store, find the address of the I/O point in the tables in this appendix, and then add the offset. The offset is the Modbus address, multiplied by 20.

Examples:

- Digital input #1 on an 115S-11 with address 5 would be: (5x20) +10001 = 10101
- Digital output #2 on an 115S-11 with address 6 would be: (6x20) +2 = 122
- Analog input #3 on an 115S-12 with address 3 would be: (3x20) +30003 = 30063.
- Analog output #8 on an 115S-13 with address # 7 would be: (7x20) + 40007 = 40147

I/O store for 115S-11 expansion I/O modules

I/O store	Description
0001 + Offset 0016 + Offset	DIO outputs 1–16
10001 + Offset 10016 + Offset	DIO inputs 1–16
10019 + Offset	Modbus Comms Fail indication for this 115S module
10020 + Offset	Modbus Comms Fail indication (inverse) for this 115S module
30001 + Offset 30004 + Offset	115S-11 pulsed input rate 1–4
30005 + Offset 30012 + Offset	115S-11 pulsed input count
30017 + Offset	Modbus Error counter for this 115S module
30018 + Offset	Modbus Last Error code for this 115S module (see “Expansion I/O error registers” on page 64.)
30019 + Offset	Modbus Lost Link counter for this 115S module
30020 + Offset	Module type (0x0101) = 257 / error status
40009 + Offset 40016 + Offset	Pulsed output target 1–8 (1 register per pulsed output)

I/O store for 115S-12 expansion I/O modules

I/O store	Description
0001 + Offset 0008 + Offset	DIO outputs 1–8
10001 + Offset 10008 + Offset	DIO Inputs 1–8
10019 + Offset	Modbus Error indication for 115S module
10020 + Offset	Detected indication for this 115S module
30001 + Offset 30008 + Offset	Inputs AIN 1–AIN 8
30017 + Offset	Modbus Error counter for this 115S module
30018 + Offset	Modbus Last Error code for this 115S module (see “Expansion I/O error registers” on **page 64**)
30019 + Offset	Modbus Lost Link counter for this 115S module
30020 + Offset	Module type (0x0201) = 513 / error status
40009 + Offset 40016 + Offset	Pulsed output target 1–8 (1 register per output)

I/O store for 115S-13 expansion I/O modules

I/O store	Description
0001 + Offset 0008 + Offset	DIO outputs 1–8
10001 + Offset 10008 + Offset	DIO inputs 1–8
10019 + Offset	Modbus Error indication for 115S module
10020 + Offset	Detected indication for this 115S module
30017 + Offset	Modbus Error counter for this 115S module
30018 + Offset	Modbus Last Error code for this 115S module (see “Expansion I/O error registers” on **page 64**)
30019 + Offset	Modbus Lost Link counter for this 115S module
30020 + Offset	Module type (0x0301) = 769 / error status
40001 + Offset 40008 + Offset	Analog output 1–8
40009 + Offset 40016 + Offset	Pulsed output target 1–8 (one register per pulsed output)

Physical I/O registers

I/O	Input	Output
Digital I/O 1	10001	1
Digital I/O 2	10002	2
Digital I/O 3	10003	3
Digital I/O 4	10004	4
Digital I/O 5	10005	5
Digital I/O 6	10006	6
Digital I/O 7	10007	7
Digital I/O 8	10008	8
Analog Input 1 (mA)	30001	—
Analog Input 2 (mA)	30002	—
Analog Input 3 (mA)	30003	—
Analog Input 4 (mA)	30004	—
Input 5 – Local V Supply	30005	—
Input 6 – Local +24 V Analog Loop	30006	—
Input 7 – Local V Battery	30007	—
Input 8 – Local V Expansion I/O	30008	—
Analog Input 1 (Volts)	30009	—
Analog Input 2 (Volts)	30010	—
Analog Input 3 (Volts)	30011	—

I/O	Input	Output
Analog Input 4 (Volts)	30012	—
Pulse Rate 1	30013	—
Pulse Rate 2	30014	—
Pulse Rate 3	30015	—
Pulse Rate 4	30016	—
Analog 1 Set point	10009	—
Analog 2 Set point	10010	—
Analog 3 Set point	10011	—
Analog 4 Set point	10012	—
Analog 5 Set point	10013	—
Analog 6 Set point	10014	—
Analog 7 Set point	10015	—
Analog 8 Set point	10016	—
Analog 9 Set point	10017	—
Analog 10 Set point	10018	—
Analog 11 Set point	10019	—
Analog 12 Set point	10020	—
Analog Output 1	—	40001
Analog Output 2	—	40002
Pulsed Input 1 Count	36001-36002	—
Pulsed Input 2 Count	36003-36004	—
Pulsed Input 3 Count	36005-36006	—
Pulsed Input 4 Count	36007-36008	—
Pulsed Input 1 Rate	30013	—
Pulsed Input 2 Rate	30014	—
Pulsed Input 3 Rate	30015	—
Pulsed Input 4 Rate	30016	—
Pulsed Output 1 Count	—	46001-46002
Pulsed Output 2 Count	—	46003-46004
Pulsed Output 3 Count	—	46005-46006
Pulsed Output 4 Count	—	46007-46008
Analog Input 1 Floating Point (mA)	38001-38002	—
Analog Input 2 Floating Point (mA)	38003-38004	—
Analog Input 3 Floating Point (mA)	38005-38006	—
Analog Input 4 Floating Point (mA)	38007-38008	—
Input 5 – Local V Supply Floating Point	38009-38010	—
Input 6 – Local +24 V Analog Loop Floating Point	38011-38012	—
Input 7 – Local V Battery Floating Point	38013-38014	—
Input 8 – Local V Expansion I/O Floating Point	38015-38016	—
Analog Input 1 Floating Point (Volts)	38017-38018	—
Analog Input 2 Floating Point (Volts)	38019-38020	—
Analog Input 3 Floating Point (Volts)	38021-38022	—
Analog Input 4 Floating Point (Volts)	38023-38024	—
Pulse Rate 1 Floating Point	38025-38026	—
Pulse Rate 2 Floating Point	38027-38028	—
Pulse Rate 3 Floating Point	38029-38030	—
Pulse Rate 4 Floating Point	38031-38032	—
Analog O/P Floating Point	—	48001
Analog O/P Floating Point	—	48002
Analog O/P Floating Point	—	48003
Analog O/P Floating Point	—	48004

115S serial expansion modules I/O registers

	115S-11		115S-12		115S-13	
Description	**Inputs**	**Outputs**	**Inputs**	**Outputs**	**Inputs**	**Outputs**
Digital I/O 1	10001	1	10001	1	10001	1
Digital I/O 2	10002	2	10002	2	10002	2
Digital I/O 3	10003	3	10003	3	10003	3
Digital I/O 4	10004	4	10004	4	10004	4
Digital I/O 5	10005	5	10005	5	10005	5
Digital I/O 6	10006	6	10006	6	10006	6
Digital I/O 7	10007	7	10007	7	10007	7
Digital I/O 8	10008	8	10008	8	10008	8
Digital I/O 9	10009	9	—	—	—	—
Digital I/O 10	10010	10	—	—	—	—
Digital I/O 11	10011	11	—	—	—	—
Digital I/O 12	10012	12	—	—	—	—
Digital I/O 13	10013	13	—	—	—	—
Digital I/O 14	10014	14	—	—	—	—
Digital I/O 15	10015	15	—	—	—	—
Digital I/O 16	10016	16	—	—	—	—
Analog I/O 1	—	—	30001	—	—	40001
Analog I/O 2	—	—	30002	—	—	40002
Analog I/O 3	—	—	30003	—	—	40003
Analog I/O 4	—	—	30004	—	—	40004
Analog I/O 5	—	—	30005	—	—	40005
Analog I/O 6	—	—	30006	—	—	40006
Analog I/O 7	—	—	30007	—	—	40007
Analog I/O 8	—	—	30008	—	—	40008
Pulsed I/O Count 1	30017-30018	30009	—	30009	—	30009
Pulsed I/O Count 2	30019-30020	30010	—	30010	—	30010
Pulsed I/O Count 3	30020-30022	30011	—	30011	—	30011
Pulsed I/O Count 4	30023-30024	30012	—	30012	—	30012
Pulsed I/O Count 5	—	30013	—	30013	—	30013
Pulsed I/O Count 6	—	30014	—	30014	—	30014
Pulsed I/O Count 7	—	30015	—	30015	—	30015
Pulsed I/O Count 8	—	30016	—	30016	—	30016
Pulsed I/O Rate 1	30001	—	—	—	—	—
Pulsed I/O Rate 2	30002	—	—	—	—	—
Pulsed I/O Rate 3	30003	—	—	—	—	—
Pulsed I/O Rate 4	30004	—	—	—	—	—
Supply Voltage	30033	—	30033	—	30033	—
Analog Loop Supply	30034	—	30034	—	30034	—

All expansion I/O is calculated by adding the offset to the I/O address in the table. The offset is calculated by multiplying the module address by 20.
For example:
Digital input #1 on an 115S-11 (address 5) would be: (5x20) + 10001 = 10100
Digital output #2 on an 115S-11 (address 6) would be: (6x20) + 2 = 121
Analog input #3 on an 115S-12 (address 3) would be: (3x20) + 30003 = 30063
Analog output #7 on an 115S-13 (address 7) would be: (7x20) + 40007 = 40147

Device models and locales

Device model	Lower frequency	Upper frequency	Maximum power		Bandwidth	Description
Available locales						
415U-2-H-370-N	360	380	37 dBm	5 W	12.5 kHz	High Power Narrow Band 360 to 380 MHz
Licensed	360	380	37 dBm	5 W	12.5 kHz	Licensed Worldwide
415U-2-H-390-N	380	400	37 dBm	5 W	12.5 kHz	High Power Narrow Band 380 to 400 MHz
Licensed	380	400	37 dBm	5 W	12.5 kHz	Licensed Worldwide
415U-2-H-410-N	400	420	37 dBm	5 W	12.5 kHz	High Power Narrow Band 400 to 420 MHz
Licensed	400	420	37 dBm	5 W	12.5 kHz	Licensed Worldwide
HK	409.7625	409.975	27dBm	500 mW	12.5 kHz	Hong Kong
415U-2-H-430-N	420	440	37 dBm	5 W	12.5 kHz	High Power Narrow Band 420 to 440 MHz
Licensed Non-US	420	440	37 dBm	5 W	12.5 kHz	Licensed Worldwide (Excluding USA)
Licensed US	421.0063	440	37 dBm	5 W	12.5 kHz	Licensed United States
415U-2-H-440-N	430	450	37 dBm	5 W	12.5 kHz	High Power Narrow Band 430 to 450 MHz
Licensed	430	450	37 dBm	5 W	12.5 kHz	Licensed Worldwide
CZ	448.0125	448.1875	27 dBm	500 mW	12.5 kHz	Czech Republic
NO	440.0125	441.9875	27 dBm	500 mW	12.5 kHz	Norway
SE	439.7125	439.9625	27 dBm	500 mW	12.5 kHz	Sweden
ES	433.0875	433.3375	27 dBm	500 mW	12.5 kHz	Spain
415U-2-H-460-N	450	470	37 dBm	5 W	12.5 kHz	High Power Narrow Band 450 to 470 MHz
Licensed	450	470	37 dBm	5 W	12.5 kHz	Licensed Worldwide
NZ	458.5125	458.5875	27 dBm	500 mW	12.5 kHz	New Zealand
UK	458.5125	458.9375	27 dBm	500 mW	12.5 kHz	United Kingdom
ZA	463.975	464.375	27 dBm	500 mW	12.5 kHz	South Africa
FI	468.2	468.2	27 dBm	500 mW	12.5 kHz	Finland
PT	458.1125	458.15	27 dBm	500 mW	12.5 kHz	Portugal
415U-2-H-480-N	470	490	37 dBm	5 W	12.5 kHz	High Power Narrow Band 470 to 490 MHz
Licensed	470	490	37 dBm	5 W	12.5 kHz	Licensed Worldwide
415U-2-H-500-N	490	512	37 dBm	5 W	12.5 kHz	High Power Narrow Band 490 to 512 MHz
Licensed Non-US	490	512	37 dBm	5 W	12.5 kHz	Licensed Worldwide (Excluding USA)
Licensed US	490	511.9938	37 dBm	5 W	12.5 kHz	Licensed United States
415U-2-H-370-W	360	380	37 dBm	5 W	25 kHz	High Power Wide Band 360 to 380 MHz
Licensed	360	380	37 dBm	5 W	25 kHz	Licensed Worldwide
415U-2-H-390-W	380	400	37 dBm	5 W	25 kHz	High Power Wide Band 380 to 400 MHz
Licensed	380	400	37 dBm	5 W	25 kHz	Licensed Worldwide
415U-2-H-410-W	400	420	37 dBm	5 W	25 kHz	High Power Wide Band 400 to 420 MHz
Licensed	400	420	37 dBm	5 W	25 kHz	Licensed Worldwide
HK	409.775	409.9625	27 dBm	500 mW	25 kHz	Hong Kong
415U-2-H-430-W	420	440	37 dBm	5 W	25 kHz	High Power Wide Band 420 to 440 MHz
Licensed Non-US	420	440	37 dBm	5 W	25 kHz	Licensed Worldwide (Excluding USA)
Licensed US	421.0125	440	37 dBm	5 W	25 kHz	Licensed United States
415U-2-H-440-W	430	450	37 dBm	5 W	25 kHz	High Power Wide Band 430 to 450 MHz
Licensed	430	450	37 dBm	5 W	25 kHz	Licensed Worldwide
CZ	448.025	448.175	27 dBm	500 mW	25 kHz	Czech Republic
NO	440.025	441.975	27 dBm	500 mW	25 kHz	Norway
SE	439.7125	439.9625	27 dBm	500 mW	25 kHz	Sweden
ES	433.1	433.325	27 dBm	500 mW	25 khz	Spain
415U-2-H-460-W	450	470	37 dBm	5 W	25 kHz	High Power Wide Band 450 to 470 MHz
Licensed	450	470	37 dBm	5 W	25 kHz	Licensed Worldwide
NZ	458.525	458.575	27 dBm	500 mW	25 kHz	New Zealand
UK	458.525	458.925	27 dBm	500 mW	25 kHz	United Kingdom
FI	468.2	468.2	27 dBm	500 mW	25 kHz	Finland
415U-2-H-480-W	470	490	37 dBm	5 W	25 kHz	High Power Wide Band 470 to 490 MHz
Licensed	470	490	37 dBm	5 W	25 kHz	Licensed Worldwide
415U-2-H-500-W	490	512	37 dBm	5 W	25 kHz	High Power Wide Band 490 to 512 MHz
Licensed Non-US	490	512	37 dBm	5 W	25 kHz	Licensed Worldwide (Excluding USA)

Device model	Lower frequency	Upper frequency	Maximum power		Bandwidth	Description
Available locales						
Licensed US	490	511.9875	37 dBm	5 W	25 kHz	Licensed United States
415U-2-L-370-N	360	380	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 360 to 380 MHz
Licensed	360	380	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
415U-2-L-390-N	380	400	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 380 to 400 MHz
Licensed	380	400	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
415U-2-L-410-N	400	420	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 400 to 420 MHz
Licensed	400	420	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
HK	409.7625	409.975	27 dBm	500 mW	12.5 kHz	Hong Kong
415U-2-L-430-N	420	440	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 420 to 440 MHz
Licensed Non-US	420	440	27 dBm	500 mW	12.5 kHz	Licensed Worldwide (Excluding USA)
Licensed US	421.0063	440	27 dBm	500 mW	12.5 kHz	Licensed United States
415U-2-L-440-N	430	450	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 430 to 450 MHz
Licensed	430	450	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
CZ	448.0125	448.1875	27 dBm	500 mW	12.5 kHz	Czech Republic
ISM	433.0625	434.7775	10 dBm	10 mW	12.5 kHz	Global ISM Band
ISM-AU	433.0625	434.7775	10 dBm	10 mW	12.5 kHz	Australia ISM Band—Allowed up to 14 dBm
ISM-ZA	433.0625	434.7775	20 dBm	100 mW	12.5 kHz	South Africa ISM Band—Allows up to 20 dBm (100 mW)
NO	440.0125	441.9875	27 dBm	500 mW	12.5 kHz	Norway
SE	439.7125	439.9625	27 dBm	500 mW	12.5 kHz	Sweden
ES	433.0875	433.3375	27 dBm	500 mW	12.5 kHz	Spain
415U-2-L-460-N	450	470	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 450 to 470 MHz
Licensed	450	470	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
NZ	458.5125	458.5875	27 dBm	500 mW	12.5 kHz	New Zealand
UK	458.5125	458.9375	27 dBm	500 mW	12.5 kHz	United Kingdom
ZA	463.975	464.375	27 dBm	500 mW	12.5 kHz	South Africa
FI	468.2	468.2	27 dBm	500 mW	12.5 kHz	Finland
PT	458.1125	458.15	27 dBm	500 mW	12.5 kHz	Portugal
415U-2-L-480-N	470	490	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 470 to 490 MHz
Licensed	470	490	27 dBm	500 mW	12.5 kHz	Licensed Worldwide
AU	472.025	472.1	20 dBm	100 mW	12.5 kHz	Australia
415U-2-L-500-N	490	512	27 dBm	500 mW	12.5 kHz	Low Power Narrow Band 490 to 512 MHz
Licensed Non-US	490	512	27 dBm	500 mW	12.5 kHz	Licensed Worldwide (Excluding USA)
Licensed US	490	511.9938	27 dBm	500 mW	12.5 kHz	Licensed United States
415U-2-L-370-W	360	380	27 dBm	500 mW	25 kHz	Low Power Wide Band 360 to 380 MHz
Licensed	360	380	27 dBm	500 mW	25 kHz	Licensed Worldwide
415U-2-L-390-W	380	400	27 dBm	500 mW	25 kHz	Low Power Wide Band 380 to 400 MHz
Licensed	380	400	27 dBm	500 mW	25 kHz	Licensed Worldwide
415U-2-L-410-W	400	420	27 dBm	500 mW	25 kHz	Low Power Wide Band 400 to 420 MHz
Licensed	400	420	27 dBm	500 mW	25 kHz	Licensed Worldwide
HK	409.775	409.9625	27 dBm	500 mW	25 kHz	Hong Kong
415U-2-L-430-W	420	440	27 dBm	500 mW	25 kHz	Low Power Wide Band 420 to 440 MHz
Licensed Non-US	420	440	27 dBm	500 mW	25 kHz	Licensed Worldwide (Excluding USA)
Licensed US	421.0125	440	27 dBm	500 mW	25 kHz	Licensed United States
415U-2-L-440-W	430	450	27 dBm	500 mW	25 kHz	Low Power Wide Band 430 to 450 MHz
Licensed	430	450	27 dBm	500 mW	25 kHz	Licensed Worldwide
CZ	448.025	448.175	27 dBm	500 mW	25 kHz	Czech Republic
ISM	433.075	434.765	10 dBm	10 mW	25 kHz	Global ISM Band
ISM-AU	433.075	434.765	10 dBm	10 mW	25 kHz	Australia ISM Band—Allows up to 25 mW)
ISM-ZA	433.075	434.765	20 dBm	100 mW	—	South Africa ISM Band—Allows up to 100 W
NO	440.025	441.975	27 dBm	500 mW	25 kHz	Norway
SE	439.7125	439.9625	27 dBm	500 mW	25 kHz	Sweden
ES	433.1	433.325	27dBm	500 mW	25 kHz	Spain
415U-2-L-460-W	450	470	27 dBm	500 mW	25 kHz	Low Power Wide Band 450 to 470 MHz
Licensed	450	470	27 dBm	500 mW	25 kHz	Licensed Worldwide
NZ	458.525	458.575	27 dBm	500 mW	25 kHz	New Zealand

Device model	Lower frequency	Upper frequency	Maximum power		Bandwidth	Description
Available locales						
UK	458.525	458.925	27 dBm	500 mW	25 kHz	United Kingdom
FI	468.2	468.2	27 dBm	500 mW	25 kHz	Finland
415U-2-L-480-W	470	490	27 dBm	500 mW	25 kHz	Low Power Wide Band 470 to 490 MHz
Licensed	470	490	27 dBm	500 mW	25 kHz	Licensed Worldwide
AU	472.0375	472.0875	27 dBm	100mW	25 kHz	Australia
415U-2-L-500-W	490	512	27 dBm	500 mW	25 kHz	Low Power Wide Band 490 to 512 MHz
Licensed Non-US	490	512	27 dBm	500 mW	25 kHz	Licensed Worldwide (Excluding USA)
Licensed US	490	511.9875	27 dBm	500 mW	25 kHz	Licensed United States

Modbus error codes

The following are Modbus error response codes that the Master will generate and write to a general purpose analog register (30501, 40501, and so on) in the event of a poll fail.

Dec code	Hex code	Name	Meaning
65281	FF01	Illegal Function	The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It might also indicate that the server (or slave) is in the wrong state to process a request of this type.
65282	FF02	Illegal Data Address	The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of 4 registers, this request will successfully operate on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of 5, this request will fail with Exception Code 0x02 "Illegal Data Address."
65283	FF03	Illegal Data Value	A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request. For example, it may indicate that the implied length is incorrect. It does not mean that a data item submitted for storage in a register has a value outside the expectation of the application program. The Modbus protocol is unaware of the significance of any particular value of any particular register.
65384	FF04	Slave Device Failure	An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.
65285	FF05	Acknowledge	Specialized use in conjunction with programming commands. The server (or slave) has accepted the request and is processing it, but significant time will be required to complete this task. This response is returned to prevent a timeout error from occurring in the client (or master).
65286	FF06	Slave Device Busy	Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.
65288	FF08	Memory Parity Error	Specialized use in conjunction with function codes 20 and 21 and reference type 6, to indicate that the extended file area failed to pass a consistency check.
65290	FF0A	Gateway Path Unavailable	Specialized use in conjunction with gateways. Indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. Typically indicates that the gateway is mis-configured or overloaded.
65291	FF0B	Gateway Device Failed to Respond	Specialized use in conjunction with gateways. Indicates that no response was obtained from the target device. Typically indicates that the device is not present on the network.
65024	FE00	Invalid Responsefrom Slave	Command type or slave address did not match request (probably another unit).
64512	FC00	Server Offline	Could not connect to the Modbus TCP server.
63488	F800	Invalid Local Memory Address	Local address is invalid in the command. The memory location does not exist or is not initialized.
65535	FFFF	No Response to the Poll	There was no response to the poll message.

Full firmware upgrade

You can upgrade the firmware using a USB flash drive containing the firmware files. A full USB upgrade is necessary if a patch file is not available or the existing firmware is a much older version and would require multiple patch files to upgrade to the latest version.

⚠ **Note**: The feature keys and configuration are not changed or erased during a full upgrade.

The following procedure provides instructions for performing a full USB firmware upgrade on a 415U-2.

Requirements

- USB flash drive
- Firmware files (contact ELPRO technical support for these files)
- PC for transferring files

To prepare the USB flash drive

Not all USB flash drives are configured correctly for use as a firmware upgrade drive. Use the following procedure to check the configuration of the USB drive and re-configure the drive if necessary.

1. Plug USB drive into the USB port on the PC and wait until Windows recognizes the drive and completes the driver installation.
2. Open the Windows Start menu, choose Run, and then enter "CMD" to open a command prompt. Then, type "diskpart" at the command prompt. This opens the Diskpart utility.

```
C:\>diskpart
Microsoft DiskPart version 6.1.7601
Copyright (C) 1999-2008 Microsoft
Corporation.
On computer: TEST_COMPUTER
```

3. Type command "list disk" to list available disks, and identify the USB drive based on the size.
   In the following example, the USB drive is a 1911 MB (2 GB) drive, which corresponds to Disk 1.

```
DISKPART> list disk
Disk ### Status Size Free DynGpt
----------------------------------------
Disk 0Online232 GB0 B
Disk 1Online 1911 MB0 B
```

4. When you have identified the USB disk, enter the "select Disk X" command to select this disk.

⚠ WARNING

THE COMMANDS THAT FOLLOW THIS STEP CAN DESTROY THE CONTENTS OF THE SELECTED DISK, MAKE SURE THAT YOU HAVE SELECTED THE CORRECT DRIVE BEFORE CONTINUING. SELECTING THE WRONG DRIVE COULD FORMAT YOUR PC'S HARD DRIVE.

```
DISKPART> select Disk 1
Disk 1 is now the selected disk.
```

5. Enter the command "list partition" to check how the USB drive is partitioned.

   This command indicates whether the drive is correctly configured for use as a firmware upgrade drive on the 415U-2.

   - If the drive contains only one partition and the "Offset" value is non-zero, as shown in the example below, you can proceed to format the drive and use it "as is" for firmware upgrade. Skip to step 7 for instructions on how to format the drive using the Diskpart utility.

```
DISKPART> list partition
  Partition ###  Type       Size     Offset
  ------------   ----       ----     ------
  Partition      1Primary   1910 MB  64 KB
```

   - If the "Offset" is zero or if there is more than one partition, as shown in the examples below, go to steps 6 and 7 below to re-configure the drive.

```
  Partition ###  Type       Size     Offset
  ------------   ----       ----     ------
  Partition      1Primary   1911 MB  0 KB
  Partition ###  Type       Size     Offset
  ------------   ----       ----     ------
  Partition      1Primary   100 MB   64 KB
  Partition      2Primary   1810 MB  101 KB
```

6. Enter the command "clean" to delete all partitions on the disk, and then enter "list disk" to check that all memory is now free. In the example below, the asterisk (*) indicates that Disk 1 is the selected disk.

```
DISKPART> clean
DiskPart succeeded in cleaning the disk.
DISKPART> list disk
  Disk ###  Status   Size    Free     DynGpt
  --------  ------   ----    ------   ------
  *         Disk 0   Online  1911 MB  1910 KB
```

7. Enter the command "create partition primary" to create a partition on the USB drive. Then, enter the "list partition" command and note that there is only one partition, and that the offset is non-zero.

```
DISKPART> create partition primary
DiskPart succeeded in creating the
specified partition
  Partition ###   Type       Size     Offset
  ------------    ----       ----     ------
  Partition       1Primary   1910 MB  64 KB
```

8. Finally, format the drive using the Diskpart command line. The file system format should be selected as FAT32 using the option "fs=fat32". You can select any convenient label. In the example below the label "FW_UPGRADE" was used.

```
DISKPART> format fs=fat32 label=FW_
UPGRADE
100 percent completed
DiskPart successfully formatted the
volume.
```

   Alternatively, you can format the drive from within the Windows GUI environment using the following procedure.

To format the USB flash drive

1. Plug the USB flash drive in to the USB port on the PC.
2. Right-click the drive and select **Format** from the menu.

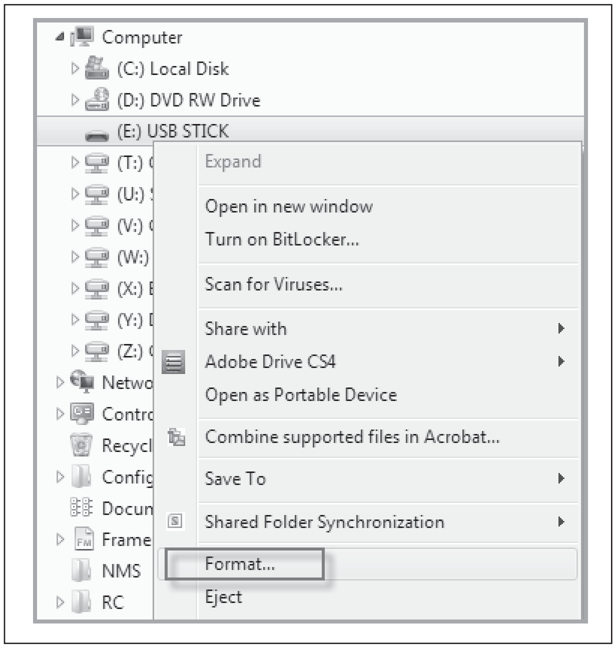


Figure 102. Formatting USB flash drive

3. Make sure that **Quick Format** is not selected, and then click **Start**.

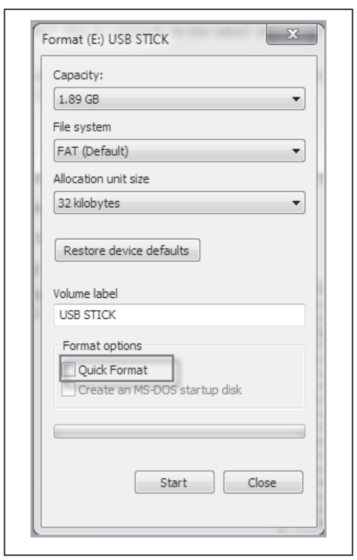
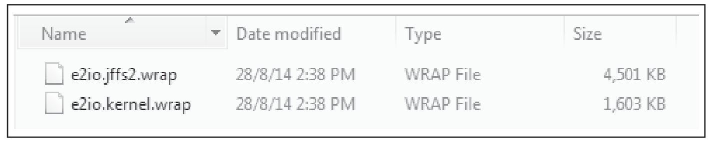


Figure 103. Quick format

4. When formatting is complete, copy the supplied firmware files to the USB flash drive root directory.

The files should look similar to the following figure.



Name	Date modified	Type	Size
e2io.jffs2.wrap	28/8/14 2:38 PM	WRAP File	4,501 KB
e2io.kernel.wrap	28/8/14 2:38 PM	WRAP File	1,603 KB

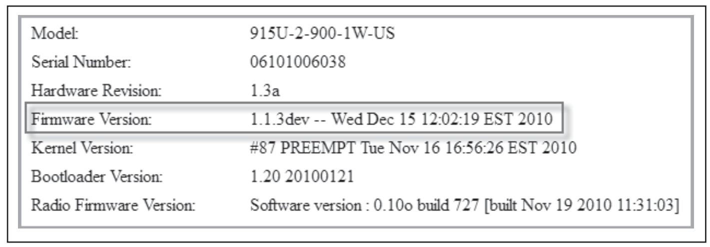
Figure 104. Firmware files

5. Remove the USB flash drive from the PC.

To perform a full firmware upgrade using USB flash drive

1. Connect to the module's Web-based configuration utility and make a note of the current firmware version, which appears on the home Web page.

   This will enable you to compare versions to confirm that the upgrade procedure has been performed successfully.



Model:	915U-2-900-1W-US
Serial Number:	06101006038
Hardware Revision:	1.3a
Firmware Version:	1.1.3dev -- Wed Dec 15 12:02:19 EST 2010
Kernel Version:	#87 PREEMPT Tue Nov 16 16:56:26 EST 2010
Bootloader Version:	1.20 20100121
Radio Firmware Version:	Software version : 0.10o build 727 [built Nov 19 2010 11:31:03]

Figure 105. Firmware version

2. Power off the 415U-2if it is currently powered on.
3. Remove the cover from the small access panel on side of module to reveal a USB port and switches.

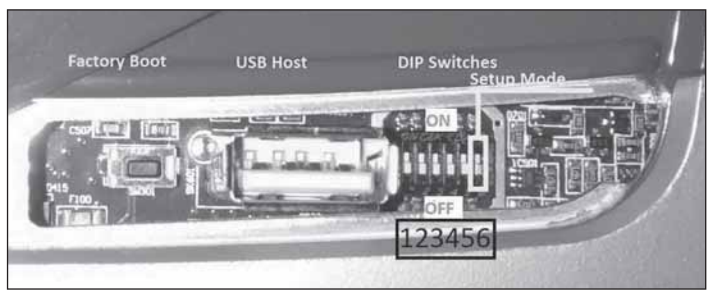


Figure 106. Module USB port and switches

4. Plug USB stick into USB port and power on the 415U-2 module.
5. The PWR LED will flash, as indicated in .

⚠ **Note**: Do not remove the flash drive or interrupt power to the module while the upgrade is in progress. If the upgrade process is interrupted, the module may become unserviceable and will need to be returned to Eaton for repair.

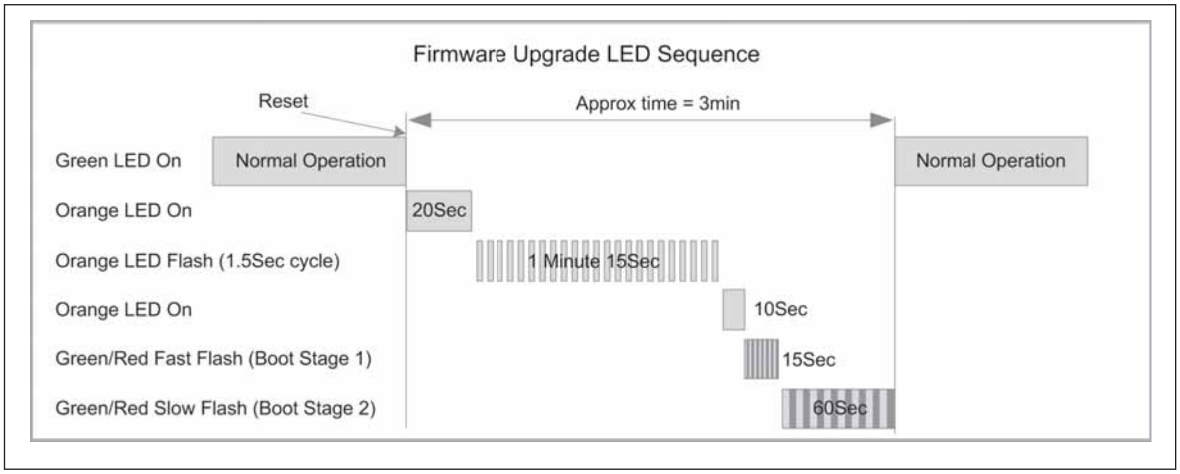


Figure 107. Firmware upgrade LED indicators

6. When the upgrade is complete, remove the USB flash drive from the module's USB port and replace the access panel cover.

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Glossary

Term	Definition
ACK	Acknowledgment.
Access Point	An access point connects wireless network stations (or clients) to other stations within the wireless network and also can serve as the point of interconnection between the wireless network and a wired network. Each access point can serve multiple users within a defined network area. Also known as a base station.
Antenna Gain	Antennas do not increase the transmission power, but instead focus the signal. Rather than transmitting in every direction (including the sky and ground), antenna focus the signal either more horizontally or in one particular direction. This gain is measured in decibels.
AODV	Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks and other wireless ad hoc networks. In AODV, the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a node receives such a message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a time.
AWG	American wire gauge (AWG), also known as the Brown and Sharpe wire gauge, is a standardized wire gauge system used predominantly in the United States and Canada for the diameters of round, solid, nonferrous, electrically conducting wire.
Bandwidth	The maximum data transfer speed available to a user through a network.
COS	Change of state. For a digital input, a COS is a change from “off” to “on,” or a change from “on” to “off.” For an analog input, internal analog input, or pulse input rate, a COS is a configurable value called sensitivity.
CSA	The Canadian Standards Association (CSA), is a not-for-profit standards organization that develops standards in 57 areas. The CSA registered mark shows that a product has been independently tested and certified to meet recognized standards for safety or performance.
DCS	A Distributed Control System (DCS) is a computerized control system used to control the production line in industry. The entire system of controllers is connected by networks for communication and monitoring.
DHCP	Dynamic Host Configuration Protocol is a utility that enables a server to dynamically assign IP addresses from a predefined list and limit their time of use so that they can be reassigned. Without DHCP, an IT manager would need to manually enter in all the IP addresses of all the computers on the network. When DHCP is used, whenever a computer logs onto the network, an IP address is automatically assigned to it.
DIO	Digital input/output.
DIN Rail	A DIN rail is a metal rail of a standard type widely used for mounting circuit breakers and industrial control equipment inside equipment racks.
DNS	Domain name service (DNS) is a program that translates URLs to IP addresses by accessing a database maintained on a collection of Internet servers. The program works behind the scenes to facilitate surfing the Web with alpha versus numeric addresses. A DNS server converts a name like mywebsite.com to a series of numbers like 107.22.55.26. Every website has its own specific IP address on the Internet.
Encryption Key	An alphanumeric (letters and/or numbers) series that enables data to be encrypted and then decrypted so it can be safely shared among members of a network. WEP uses an encryption key that automatically encrypts outgoing wireless data. On the receiving side, the same encryption key enables the computer to automatically decrypt the information so it can be read. Encryption keys should be kept secret.
EIRP	Equivalent isotropically radiated power (EIRP) or, alternatively, effective isotropically radiated power is the amount of power that a theoretical isotropic antenna (which evenly distributes power in all directions) would emit to produce the peak power density observed in the direction of maximum antenna gain. EIRP can take into account the losses in transmission line and connectors and includes the gain of the antenna. The EIRP is often stated in terms of decibels over a reference power emitted by an isotropic radiator with an equivalent signal strength. The EIRP allows comparisons between different emitters regardless of type, size or form.
Hub	A multiport device used to connect PCs to a network via Ethernet cabling or via 802.11. Wired hubs can have numerous ports and can transmit data at speeds ranging from 10 Mbps to multi-Gigabyte speeds per second. A hub transmits packets it receives to all the connected ports. A small wired hub may only connect four computers; a large hub can connect 48 or more.
Hz	Hertz. The international unit for measuring frequency, equivalent to the older unit of cycles per second. One megahertz (MHz) is one million hertz. One gigahertz (GHz) is one billion hertz. The standard US electrical power frequency is 60 Hz, the AM broadcast radio frequency band is 535–1605 kHz, the FM broadcast radio frequency band is 88–108 MHz, and wireless 802.11b/g LANs operate at 2.4 GHz.
IEEE	Institute of Electrical and Electronics Engineers, New York, www.ieee.org. A membership organization that includes engineers, scientists and students in electronics and allied fields. It has more than 300,000 members and is involved with setting standards for computers and communications.
I/O	Input/Output. The term used to describe any operation, program, or device that transfers data to or from a computer.
IP	Internet Protocol (IP) is a set of rules used to send and receive messages across local networks and the Internet.
IP Address	A 32-bit number that identifies each sender or receiver of information that is sent across the Internet. An IP address has two parts: an identifier of a particular network on the Internet and an identifier of the particular device (which can be a server or a workstation) within that network.
ISM	The industrial, scientific and medical (ISM) radio bands are portions of the radio spectrum reserved internationally for industrial, scientific, and medical purposes other than telecommunications.
LAN	Local Area Network (LAN) is a system of connecting PCs and other devices within the same physical proximity for sharing resources such as an Internet connections, printers, files, and drives.
LQI	Link quality indicator (LQI) is used in wireless networks to indicate how strong the communications link is. LQI is a computed value, based on the received signal strength as well as the number of errors received.
Receive Sensitivity	The minimum signal strength required to pick up a signal. Higher bandwidth connections usually have less receive sensitivity than lower bandwidth connections.
Router	A device that forwards data from one WLAN or wired local area network to another.
RSSI	Received signal strength indicator (RSSI) is a measurement of the power present in a received radio signal. In an IEEE 802.11 system, RSSI is the relative received signal strength in a wireless environment, in arbitrary units. RSSI is an indication of the power level being received by the antenna. Therefore, the higher the RSSI number (or less negative in some devices), the stronger the signal.
Transmit Power	The power at which the wireless devices transmits, usually expressed in mW or dBm.

Term	Definition
MAC Address	Media Access Control (MAC) address is a unique code assigned to most forms of networking hardware. The address is permanently assigned to the hardware, so limiting a wireless network's access to hardware (such as wireless cards) is a security feature employed by closed wireless networks. But an experienced hacker armed with the proper tools can still figure out an authorized MAC address, masquerade as a legitimate address, and access a closed network. Every wireless 802.11 device has its own specific MAC address hard-coded into it. This unique identifier can be used to provide security for wireless networks. When a network uses a MAC table, only the 802.11 radios that have had their MAC addresses added to that network's MAC table will be able to get onto the network.
Modbus	Modbus is a serial communications protocol for use with its programmable logic controllers (PLCs).
PLC	A programmable logic controller (PLC) is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures.
Proxy Server	Used in larger companies and organizations to improve network operations and security, a proxy server is able to prevent direct communication between two or more networks. The proxy server forwards allowable data requests to remote servers and/or responds to data requests directly from stored remote server data.
RJ-45	Standard connectors used in Ethernet networks. RJ-45 connectors are similar to standard RJ-11 telephone connectors, but RJ-45 connectors can have up to eight wires, whereas telephone connectors have four.
RTU	A remote terminal unit (RTU) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA system by transmitting telemetry data to a master system, and by using messages from the master supervisory system to control connected objects.
SCADA	SCADA (supervisory control and data acquisition) is a type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world. SCADA systems historically distinguish themselves from other ICS systems by being large scale processes that can include multiple sites, and large distances.
Server	A computer that provides its resources to other computers and devices on a network. These include print servers, Internet servers and data servers. A server can also be combined with a hub or router.
SMA	SMA (SubMiniature version A) connectors are semi-precision coaxial RF connectors for coaxial cable with a screw type coupling mechanism. The connector has a 50 Ω impedance. It is designed for use from DC to 18 GHz.
Sub Network or Subnet	Found in larger networks, these smaller networks are used to simplify addressing between numerous computers. Subnets connect together through a router.
Switch	A type of hub that efficiently controls the way multiple devices use the same network so that each can operate at optimal performance. A switch acts as a networks traffic cop: rather than transmitting all the packets it receives to all ports as a hub does, a switch transmits packets to only the receiving port.
TCP	Transmission Control Protocol (TCP) isprotocol used along with the Internet Protocol (IP) to send data in the form of individual units (called packets) between computers over the Internet. While IP takes care of handling the actual delivery of the data, TCP takes care of keeping track of the packets that a message is divided into for efficient routing through the Internet. For example, when a Web page is downloaded from a Web server, the TCP program layer in that server divides the file into packets, numbers the packets, and then forwards them individually to the IP program layer. Although each packet has the same destination IP address, it may get routed differently through the network. At the other end, TCP reassembles the individual packets and waits until they have all arrived to forward them as single message.
TCP/IP	The underlying technology behind the Internet and communications between computers in a network. The first part, TCP, is the transport part, which matches the size of the messages on either end and guarantees that the correct message has been received. The IP part is the user's computer address on a network. Every computer in a TCP/IP network has its own IP address that is either dynamically assigned at startup or permanently assigned. All TCP/IP messages contain the address of the destination network as well as the address of the destination station. This enables TCP/IP messages to be transmitted to multiple networks (subnets) within an organization or worldwide.
TTL	Transistor–transistor logic (TTL) is a class of digital circuits built from bipolar junction transistors and resistors. It is called TTL logic because both the logic gating function (AND) and the amplifying function are performed by transistors.
WAN	Wide area network (WAN) is a communication system of connecting PCs and other computing devices across a large local, regional, national or international geographic area. Also used to distinguish between phone-based data networks and Wi-Fi. Phone networks are considered WANs and Wi-Fi networks are considered Wireless Local Area Networks (WLANs).
WEP	Wired Equivalent Privacy (WEP) is a basic wireless security provided by Wi-Fi. In some instances, WEP may be all a home or small-business user needs to protect wireless data. WEP is available in 40-bit (also called 64-bit), or in 108-bit (also called 128-bit) encryption modes. As 108-bit encryption provides a longer algorithm that takes longer to decode, it can provide better security than basic 40-bit (64-bit) encryption.
Wi-Fi	Wireless Fidelity. An interoperability certification for wireless local area network (LAN) products based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard.

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Printed in USA
Publication No. MN032002EN / Z17944
May 2016